Part I Basic Sciences Related to Community Medicine

CHAPTER

1

Concept of Health and Disease, Ethics in Medicine and Doctor–Patient Relationship

In community medicine, 'patient' is 'community'
"Analysis of healthcare problems of community is one of the most effective ways of competency based learning in community medicine"

"A teacher can never truly teach unless he is still learning himself. A lamp can never light another lamp unless it continues to burn its own flame. A teacher who has come to the end of his subject, who has no living traffic with his own knowledge, but merely repeats his lessons to his students can only load their minds. He cannot quicken them. Truth not only must inform, but also must inspire. If the inspiration dies out, and the information only accumulates, then truth loses its infinity."
—Rabindranath Tagore

The following four part saying is about knowledge and self-knowledge:

- *He who knows not, and knows not he knows not, is a fool; shun hin*
- *He who knows not, and knows he knows not, is simple; teach him.*
- *He who knows, and knows not he knows, is asleep; awaken him.*
- *He who knows, and knows he knows, is wise; follow him.*

—Bruce Lee

COMPETENCY BASED LEARNING IN COMMUNITY MEDICINE

In the subject of community medicine, the new MBBS regulations identified 20 broad topics with 107 core competencies. Out of these, 89 (83%) are related to domain of knowledge (knows and knows how) focusing on didactic learning, while 18 (17%) are related to skill domain (shows and shows how and performs) focusing on skill learning. At the end of the course, student should be able to demonstrate and/or perform these skills himself or herself. Building these skills in community medicine is an enormous task and a challenge indeed.

New regulations give an impetus to improved doctor–patient relationship and acquisition of effective communication skills. They encourage self-directed learning by choosing a subject of interest by the learner and exposure to clinical experience in the very first year of the MBBS course. Clear directions are there for integrated teaching by way of horizontal and vertical integration. Learning is outcome based under new regulations. Specific core competencies to be acquired, span over the years. Domains of learning, methods of learning as well as methods of formative and sumative assessment have been explicitly stated.[1]

Suggested Methods of Aquisition of Various Competencies

In community medicine "the patient" is "the community" not an individual, hence the focus of learning should be: '**Community diagnosis** and **Community therapy**'. To arrive at community diagnosis, the student should be able to **listen** to chief complaints of community, directly observe, interact with community, and analyse health practices, health seeking behaviours, community structure, analyse and interprets a household survey, and facility survey data, live data of surveillance, service delivery and routine health reports/data of facility. Apart from this the student should be able to identify the root causes/determinants of health problems and be able to communicate effectively with community and organized listening groups. Some of the methods of active and participatory learning are being explained in this chapter. The teacher acts as a facilitator and provides learning material to learner.

Revised curriculum provides a unique opportunity to medical faculty of 596 Medical Colleges to restructure their teaching program, to develop learning resource material, promote problem-based learning, prepare relevant case studies, integrate teaching and learning with healthcare delivery system, use real life situations and live data, exploit modern technologies, develop field practice areas to bring field experiences to classroom setting, involve program officers of state/district in teaching program to achieve competency-based learning. Further, it provides an opportunity to transform conventional field visits to specific skills to be acquired with clear cut

objectives and ensuring achievement of relevant learning objectives. The pivotal responsibility of faculty is to develop positive attitude in students towards community.[2, 3]

Essential Skills for Community Medicine Practice

The most essential skills/competencies include:

1. Positive attitude of mind to work for community.
2. Ability to communicate effectively with people/patient and family on health and disease.
3. Ability to organize community or groups in the community.
4. Ability to generate resources from community.
5. Ability to elicit community participation.
6. Give responsibility to community (sanitation, birth and death registration, reporting outbreaks, maintenance of wells—chlorination of water—disposal of human excreta, animal excreta, and garbage).
7. Ability to assess community health needs.
8. Ability to meet community health needs.
9. Ability to share the health information with community.
10. Ability to lead health team and of training of community volunteers (birth attendants, health guides, *Anganwadi* workers, ASHAs, school teachers, *Mahila Swasthya Sanghs* and others).

The teachers/faculty must reinvent themselves to refine and practice these competencies.

Teaching vs Learning

People resent being taught. Nobody wishes to be taught but everyone wishes to learn and people have strong desire to learn. Emphasis should be on learning. Learning is a lifelong process. Child learning and adult learning differs. There are four ways of learning:

1. **Trial and error:** By trying for oneself (trial and error) and learning from each trial (experiential learning).
2. **Being told:** By receiving instructions either orally or in writing or by demonstration.
3. **Imitation:** By copying the actions of another person usually an instructor or a skilled person.
4. **Thinking:** By organizing one's thoughts about a topic or problem to arrive at an explanation or solution.

Best way of learning is learning by doing. Common saying is:

"I hear, I forget, I see, I remember, seeing is believing, I do, I know."

Adult learning should be problem-centered and experience-centered.

Pedagogy

The art and science of learning/teaching is known as pedagogy. It includes different teaching/training methods and technology to change the knowledge, attitude and behaviour of learner.

Curriculum: It is "a sum total of all planned educational experiences which include four components—**learning objectives**, **content areas** or **subject matter**, **instructional strategies**, **methods** of **learning** and **evaluation**."

Emphasis should be on learning. Lesson plan should include learning objectives, methods of learning, learning aids, contents, feedback and evaluation.

Pedagogic methods: Teaching technology and methods in medical education are—lecture, lecture discussion, demonstration, return demonstration, tutorial, clinical teaching, group discussion, brain storming, buzz session, problem-based learning, panel discussion, symposia, seminar, workshop, conference, convention, institute, completion of project, focus group discussion and case study methods, role play, reflection, cinema, narratives, comics, and skill lab.

Teaching aids: Include audio–visual and other aids, such as—tape recorder, over-head projector, mike, transparencies, video-tapes/cassettes, pictorials, blackboard, computer, laptop, etc.

Problem-based Learning/Participatory Learning

Education is a process to bring about change in behaviour of the students. Three domains—*cognitive* (knowledge), *affective* (attitudes) and *psychomotor* (practical skills) are the main focus of competency based medical education.

Behaviour change can be done by conventional methods of *teacher-centred training* in which the knowledge and skills are imparted to students by traditional methods of lectures and demonstrations; it is a passive process. The second method is, in which the students participate and take active part in self-directed learning. Here, the teacher acts as a facilitator. The learning here is *student-centred* and active.

At present, undergraduate medical education is subject-based teaching in various semesters. One course is not related to other. In the traditional subject-based curriculum, it is assumed that the knowledge gained in pre- and paraclinical periods will be remembered and will be transferred to illness situations. Both assumptions are unsupported. Forgetting is massive and rapid.

Cause to Effect and Effect to Cause Approach

Basic science teachers present material in *cause–effect logic,* in which they organise their own knowledge and in which most of the textbooks are written. The students as clinician have to relearn it in the *effect–cause sequence* within which clinical problems must be worked out. That is, the clinical problem start with an effect of a disease process. The student must work backwards from *effects* through possible explanation to identify what is likely to *cause*. This can be best achieved by integrated curriculum and integrated teaching. Various techniques have been used

to have integrated curriculum, like *system-based learning*, *community-based* and *problem-based learning*.

Problem-based learning is defined as learning that results from the process of working towards the understanding or evaluation of a community health problem. Problems are used as spring board for learning. The health problem is encountered first. It serves as a stimulus for the application and development of **problem-solving skills** and search for **knowledge** to understand the mechanisms (root causes) responsible for the health problem and its solution. The process involved facilitates self-directed independent learning. Once the information has been gathered, digested and understood, the knowledge obtained can be used to solve other problems. The key features of problem-based learning are:

1 Analysis of healthcare problems in community as main method of acquiring and applying knowledge.
2 Self-directed lifelong learning.
3 Use of small tutorial groups.
4 Develop an epidemiological reasoning process.

The problem-based learning creates an atmosphere which encourages active participation, emphasizes the personal nature of learning, accepts the differences between the learners, recognizes the learner's right to commit mistakes, tolerates imperfection, encourages openness of mind and trust in self, facilitates discovery, puts emphasis on self-evaluation and accepts confrontation of ideas.

Problem

The problem selected should be major public health problem. The entire subject may be taught on the basis of problems.

a Problems are presented to the students as written cases or live simulations or actual cases.
b The students analyse these problems and discuss these problems and generate issues which may be basic or clinical.
c These issues are framed into objectives of learning by the students.
d The teacher has a list of learning objectives for that health problem with him. He helps the students to identify the objectives of learning by themselves.
e The students seek the information from library, books, journals and resource persons in different disciplines in the college and wards of the hospitals.
f In subsequent tutorials, the students appraise the information; share it with other students in the group and discuss all aspects of the problem. They critically evaluate their own performance.
g Once the students and tutor are satisfied that the pre-determined objectives have been met, the students write down the summary of discussions. Later on other problems are taken up in the same sequence.
h *Assessment:* The evaluation of students performance is based on their achievement of the programme objectives and their performance in problem-based learning exercises, self-evaluation, peer evaluation and the evaluation by the tutor. Objective-structured clinical examination (OSCE) and objective-structured practical examination (OSPE) and special exercises can be given for evaluation of competency-based learning.

(*Source:* Souvenir-Diamond Jubilee celebration, MCI)

Recently, MCI (2018 Regulations) has revised the curriculum of UGs wherein horizontal (elements in the same phase) and vertical (elements from other phases) integration of teaching and training have been structured.

MCI has been replaced by National Medical Commission in 2020.

Clinico-social Case Review (CSCR)

This is yet another method to learn and comprehend the natural history of disease and effective interventions (levels of prevention).

This approach has two distinct components. One—the clinical review—which consists of standard case management (history taking, examination, clinical diagnosis, confirmative diagnosis, treatment, counselling and follow-up). This is best done by treating physicians and their teams in the outdoor or indoor set-up. Objective here is to treat the illness and reduce its prevalence.

Second part is social review: Social review essentially consists of identification of specific *social factors* and their analysis in respect of presenting *disease* with the *objective*:

a To *recognize* the *sufficient causes* or risk factors or underlying determinants of presenting disease.
b To *treat* the *cause* by effective intervention in order to prevent the disease, reduce its incidence, prevalence and ultimately elimination of disease.

The social review thus begins with a *disease* and searches for its *causes* which are often *multiple*—host factors, environmental factors and factors relating to causative agent of disease (multifactorial etiology).

Example: **Host factors**—age, sex, habits, personal hygiene, marital status, age of marriage, birth interval, migrant worker/labourer, social class (determined by income, education, housing and occupation), immunity and heredity may predispose a person to an illness.

Social and Cultural Factors/Practices of Host

Similarly, use of tobacco, harmful use of alcohol, physical inactivity, high speed driving and not obeying traffic rules (unhealthy lifestyles), unprotected sex with multiple sex partners (lifestyles), non-utilization of available health services or delay in seeking care, incomplete treatment, faulty choice of food—junk food, fast food, inadequate food, delayed initiation of breastfeeding, and weaning, large-sized family, lack of information and knowledge, wrong beliefs and

attitudes, are other factors which could initiate a disease, help in its progression or precipitate a disease or an event. Many harmful cultural practices may worsen a disease.

Environmental Factors

- Unsafe environments, such as unsafe water, indiscriminate defecation, soil pollution, air pollution, overcrowding, urban slums, breeding of mosquitoes, flies, rodents, insects, presence of stray dogs, animals and pets, bad working environment/occupational hazards, could be sufficient causes for disease occurrence.
- Economic loss due to an illness to individual, family, community and nation and cost of treatment and care.
- Impacts of illness on individual, family, community and nation or state are other dimensions of CSCR.

In essence, social and cultural factors have their significant role in either initiating a disease, its progression, recovery or cure.

Example: Inadequate breastfeeding and delayed weaning initiates malnutrition in young children, and an episode of diarrhoea in malnourished child precipitates malnutrition. Girl child or lesser child is predisposed to malnutrition.

Causative Agent Factors—see Chapter 7

A CASE STUDY ON CLINICO-SOCIAL CASE REVIEW

Clinical Review

A low birth weight (1.8 kg) male baby was born to Maya at first referral unit. Baby could not suck the breast milk and expressed milk was given to this baby by nurses. Baby was kept with mother for 10 days when the breastfeeding got established and baby started thriving on breastfeeds. Thereafter, the mother and baby were sent home. This baby started having episodes of cough and difficult breathing requiring hospitalization on two occasions. At the age of 10 months, the hospital admission was on account of difficult and fast breathing and the child recovered after 7 days time and sent home after counselling. The baby was due for measles vaccine and this opportunity was missed in the hospital. Weight-for-age at the time of discharge was 6 kg.

Social Review

Maya was lesser child and most of her time got spent in care of younger brother and sister and household chores. She could not be enrolled in school and got married around 16 years of age, she looked very weak and pale, and got easily tired after household work, became pregnant after 2 months of marriage. She had to work in farm and family, to bring fodder, fuel and cook meals. *Anganwadi* worker registered Maya as pregnant women around fifth month and this family was identified as below poverty line family, but Maya could never go to *Anganwadi* because she was too much occupied. Similarly, antenatal care visits to sub-centre located at a distance of 2 km could not happen. At last, Maya was brought to sub-centre with swollen face and legs with labour pains. Female health worker with the help of ASHA arranged free transport up to first referral unit (FRU). Free medicines and material were provided at FRU for safe delivery and incentive money was given to Maya from funds under *Janani Suraksha Yojana* (JSY) under the umbrella of National Rural Health Mission.

Several issues can be identified out of this clinical-social case review, such as girl child—the lesser child, deprivation of education to girls, undernutrition, age of marriage and teenage pregnancy, workload, anaemia in pregnancy, toxaemia, below poverty line family, health seeking behaviour, incentives for safe delivery, missed opportunities, causes of low birth weight babies, breastfeeding and management of low birth weight babies, weight gain pattern in low birth weight babies, etc. It could be a part of problem-based learning and learning of epidemiological methods.

These reviews can be an opportunity for vertical *integrated teaching* by the departments of paediatric, obstetric and gynae and community medicine, to identify causes of low birth weight and occurrence of repeated episodes of illness in young children as also integrated management of childhood illness (IMCI) apart from gender disparity.

Competency addressed: The student should be able to:
CM 1.2: Define health and describe the concept of holistic health.

CONCEPT OF HEALTH AND HOLISTIC HEALTH

SDG-3 "Ensure healthy lives and promote well being for all at all ages". WHO at 70 has chosen the theme of world health day on 7 April 2019 'universal health coverage: everyone, everywhere'.

There is renewed focus on the "One Health" which proposes to take measures to protect the health of animals, environment and humans.

"Health should be seen and believed as development function." Health is difficult to define but easier to understand. To many of us, it may mean absence of disease or infirmity and to many it may mean sound body and sound mind and sound function of the body: A concept close to holistic health.

'**Holistic health**' can be **defined** as an approach to life. Rather than focusing on illness or specific parts of the body, this ancient approach to **health** considers the **whole person** and how he or she interacts with his or her environment. **Holistic health** emphasises the connection of mind, body, and spirit.

ATTAINING HOLISTIC HEALTH

Well-being is made up of physical health, social and emotional nurture, mental stimulation, focus clarity and spiritual nourishment. Therefore, in order to feel at our very best we need to start a holistic self care path to create a personal well-being plan. Start by categorising the physical, mental, emotional and spiritual parts and then choose one or more activity that will serve you in the most enjoyable and meaningful way.

For example

Physical—a daily 45 minute walk

Mental—commit to a 15 minute morning meditation

Spiritual—rediscover a passion, interest or hobby by making time to incorporate in your week. 'India is a Centre of World Holistic Healthcare'—"PM Modi".

"Good health is the most precious thing anyone can have. When people are healthy, they can learn, earn, work and support themselves and their families. When they are sick, nothing else matters (Dr Tedros Adhanom Ghebreyesus WHO Director General 2019)".[4]

To an anatomist: Healthy body means it should confirm to normal anatomical structures.

To a physiologist: Health means normal body functions.

To a biochemist: It means normal biochemical levels/values.

To a pathologist: It means normal cellular make-up.

To a geneticist: It means full realization of genetic potential.

Similarly, to a clinician it means no abnormality in structure and function and usually when a clinician fails to detect anything in a person by his clinical wisdom and laboratory tests, he/she labels a person no abnormality detected (NAD).

To a psychiatrist: It means well adjusted and a balanced personality.

Definition

World Health Organization (WHO) has given a comprehensive definition of health which includes important dimensions, such as physical, mental and social health. WHO in its constitution has defined health in the largest sense of the term that states:

"**Health** is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." WHO's 199 member states have endorsed this statement.[1] The Executive Board of the World Health Organization (WHO) proposed redefining 'health' as "a dynamic state of complete physical, mental, social and spiritual well-being, and not merely the absence of disease or infirmity" (WHO 1998).

WHO recognizes "health as a fundamental human right of an individual, family and community and it sets a most important social goal of the enjoyment of highest attainable standard of health by all nations or countries "without distinction of race, religion, political belief, economic or social condition". Realization of this goal requires the action of many other social and economic sectors in addition to health sector. Health is thus a multisectoral subject. Inter- and intra-sectoral coordination is essential to achieve the goal of health for all.

"One health" has been defined by WHO as "an approach to designing and implementing, programs, policies, legislations and research in which multiple sectors communicate and work together to achieve better public health outcomes".

In the international conference on primary healthcare jointly organized by the WHO and UNICEF in Alma Ata, USSR, in September 1978, fundamental principles of health were enunciated and a declaration was made; this declaration endorsed the earlier resolution of 30th World Health Assembly (1977).

"The attainment by all citizens of the world by the year 2000 of a level of health, that will permit them to lead a socially and economically productive life."

This is popularly known as 'Health for all' (HFA) and it is to be achieved through primary healthcare approach, in a spirit of social justice and as a part of overall development. Development of health is to be based on self-determination and self-reliance in health on the part of individual, the community and the nation. Ottawa Charter (1986) further lends support to health promotion.

DIMENSIONS OF HEALTH

There are three dimensions of health: *Physical, mental* and *social*. A fourth dimension of *spiritual health* has been added.

Physical Well-being

It means adequate body weight, height and circumferences as per age and sex with acceptable level of vision, hearing, locomotion or movements, acceptable levels of pulse rate, blood pressure, respiratory rate, chest circumference, head circumference, and waist–hip ratio. The body structures and functions confirming to laid down standards within the range of normal development and functions of all the systems. Some of the physical health standards are:

- Birth weight should range between 2.7 and 2.9 kg 'cut-off' level of low birth weight is 2.5 kg.
- Standard growth charts have been evolved to monitor growth of young children.

Body mass index: Normal range is 18.5–25 and waist–hip ratio normal range is 0.6–0.9 and triceps skinfold thickness 12–15 mm and sub-scapular skinfold 18–20 mm.

Similarly, ideal weights as per age and height for male and female have been worked out. Reference Indian adult man and woman have been defined.

Reference Indian Adult Man and Woman (NNMB)

Reference man is in age group 19–39 years and weighs 65 kg with a height of 1.77 m with a BMI of 20.75 and is

free from disease and physically fit for active work; on each working day, he is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work he spends 8 hours in bed, 4–6 hours in sitting and moving about, 2 hours in walking and in active recreation or household duties.

Reference woman is in age group 19–39 years, non-pregnant non-lactating (NPNL) and weighs 55 kg with a height of 1.62 m and a BMI of 20.95, is free from disease and physically fit for active work; on each working day she is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work she spends 8 hours in bed, 4–6 hours in sitting and moving about, 2 hours in walking and in active recreation or household duties.

Reference Body Weight and Height

Reference body weights and heights of Indians as under physical health are easier to understand and easier to measure. Periodical health examination and pre-placement health examination determine the level of health of an individual. We want best of physical health standards to be attained by all individuals and we are most particular for recruitment in army for physical standards apart from mental health.

Mental Well-being

The positive dimension of mental health is stressed in WHO's definition of health as contained in its constitution.

Mental health is defined as "a state of well-being in which the individual realizes his or her own abilities, can cope with normal stresses of life, can work productively and fruitfully and is able to make a contribution to his or her community".

A mentally normal person has the ability to mix-up with others, he/she makes friendship, behaves in a balanced manner, keeps himself tidy and observes adequate personal hygiene, well oriented to time, place and person and environments and is unduly not suspicious of others, he is cheerful and happy and enjoys life with a purpose and he thinks positively and has normal development and contributes fully and is useful and productive to society and nation. He/she is a balanced person and emotionally stable and realizes his/her shortcomings and strengths and abilities. People are judged by others. The friend circle or family members are the one's who can endorse the mental health status of an individual first of all.

Social Well-being

It is third dimension of health. It means ability of a person to adjust with others in his social life, at home, at work-place and with people. Men interact with men and they inter-relate and interdepend on each other and play their effective role in accordance with a situation. Essentially, social well-being includes harmonius inter-relation and interaction of human beings.

Social well-being is a composite function of **income level, literacy, occupation** and working conditions, marital harmony, institution of family, social groups and cultural and behavioural pattern of the society and stressful situation. Social well-being is conditioned by the influence of environments as well. Social well-being can be measured on a scale by taking into consideration indicators like income, literacy and occupation (as discussed under socio-economic status of family).

Competency addressed: The student should be able to:
CM 1.2: Describe the concept of **spiritual health**.

Spiritual Well-being

The WHO at its 37th World Health Assembly has added the spiritual dimension to health. The recognition of this dimension speaks of the importance of multidimensional well-being of *swasthya* (health).

Spiritual health has been defined as "that part of the individual which reaches out and strives for meaning and purpose in life. It includes integrity, principles and ethics, the purpose in life, commitment to some higher beings and beliefs in concepts that are not subject to the state-of-the-art explanation".

Positive health: A person who enjoys all the four dimensions of health (physical, mental, social and spiritual) is said to be in a state of positive health. The concept of perfect positive health cannot become a reality because a person can never be in perfect state of all the four dimensions.

Medical Classification: Officers

Health of serving officers is continuously monitored through periodical medical check-ups during the entire length of their service. Similarly, periodical medical examination of industrial workers is done regularly.

Medical Classification

Medical classification of serving officers is done by medical board after assessing his fitness under five factors, indicating by the code word 'SHAPE' which represents the following factors:

- **S** Psychological
- **H** Hearing
- **A** Appendages
- **P** Physical capacity
- **E** Eyesight

Medical classification under the system is based on functional capacity of the individual as a whole for military duties. Thus, classification done under this system enables the administrative authorities to assign appropriate assignment to officers depending upon their employment capacity. Functional capacity of an officer under each factor is denoted by numerals 1–5 against each code letter, indicating declining functional efficiency. The numerals

are written next to the code letter, except that where an officer is in grade 1 in all factors, his categorization may be denoted by writing SHAPE-1 instead of writing S1 H1 A1 P1 E1. General evaluation of numerals is as under.

1 Fit for all duties anywhere.
2 Fit for all duties but may have limitations as to type of duties of employability. Employment restrictions are given separately by the medical board.
3 Excepting for 'S' factor fit for routine or sedentary duties but may have limitations of employability at high altitude (above 2700 meter), extreme cold area/ hilly terrain and for lone assignments for which specific recommendations are given.
4 Temporary unfit for military duties on account of hospitalization/sick leave.
5 Permanent unfit for military duties.

Competency addressed: The student should be able to:
CM 1.1: Define and describe the concept of **public health**.

CONCEPT OF PUBLIC HEALTH

I. Public Health

- Winslow defined **public health** as "the art and science of preventing diseases, prolonging life, and promoting health through organized community efforts and informed choices of society organizations, public and private communities, and individuals."

  It means organizing healthcare systems, resources and infrastructure. Health management is an example of public health.
- WHO and Acheson report defined **public health** as, "the science and art of preventing diseases, prolonging life and promoting health through organized efforts of society."
- Focus of public health is total population (healthy and sick both).

How to Achieve Goal of 'Health'?

Public health system achieves goal of health by:

1 **Providing organized health services** (promotive, preventive curative and rehabilitation services)
2 **Promoting healthy behaviours** and lifestyles (universal exclusive breastfeeding, handwashing, physical activity and avoid tobacco and alcohol).
3 **Promoting healthy environments** (household and external) water supply and sanitation, prevent indoor and outdoor air pollution, accidents and mosquito breeding or vector breeding.
4 **Implementing health legislations** against tobacco use, food adulteration, epidemic/pandemic, etc.

II. Concept of Preventive Medicine

"It is the science and art of preventing diseases, prolonging life and promoting health".

Generally the preventive medicine focuses on individual health or groups, such as high-risk groups and advocates screening of high-risk groups/individuals. The concept can be extended to general population. This term and concept became popular in the United States of America.

In India we adopted the term of 'social and preventive medicine' or 'preventive and social medicine' and subsequently the term 'community medicine' has been adopted.

III. Concept of Social Medicine

"Social medicine is the study of socio-economic, cultural, environmental and health services and genetic factors and conditions which influence the health of population". This term and concept became popular in United Kingdom during the industrial revolution.

IV. Community Medicine/Community Health

Last JM defined community medicine as "the field concerned with the study of health and disease in the population or a defined community or group. Its goal is to identify the health problems and needs of defined populations (community diagnosis) and to plan, implement and evaluate the extent to which health measures effectively meet these needs".

The Ottawa Charter (1986) is the pivot of principles and practices of health promotion. It recognizes the fundamental conditions and resources for health—peace, shelter, education, food income, a stable ecosystem, sustainable resources, social justice of equity. The Ottawa Charter on health promotion advocates five key strategies:

1 Building healthy public policy
2 Create supportive environments
3 Strengthen community action
4 Develop personal skills
5 Reorient health services.

Competency addressed: The student should be able to:
CM 1.2: Define and describe the **relativeness of health**.

RELATIVENESS OF HEALTH

Health is a relative phenomenon. It is biological 'normal' state based on statistical norms/standards. The use of reference values to diagnose or screen for disease implies that health is relative concept. Clinical examination, evaluation of laboratory data and diagnostic imaging findings all require comparison to 'normal' standard. Normality itself is also relative. Very often normal values differ between geographical areas, between sexes or age groups. For example, 'normal' blood pressure differs between sexes, and also varies with age and its pattern is not the same in all human populations. A statement of normal values must indicate the population referred to similarly, pulse rate, heart rate, height, weight, serum

cholesterol and haemoglobin levels vary from person to person. The establishment of 'normal' values permits the selection of appropriate actions in medical practice.

Variability is inherent in biomedical measurements upon which decision on individual patient care or community health programmes are based. It is therefore necessary to establish **standards** on which decision can be made. These standards are often referred to as **normal values** and are generally based on measurements made on **healthy** population in statistical reasoning. What occurs most frequently is considered as **normal**. The problem is often where to draw a cut off line between **normal** and **abnormal**.

Two types of normal values are usually required for medical decisions:

i **Point normal** values, and
ii Normal **range**

- Point normal values are derived from population/ sample mean values (mean, median or mode).
- Normal range in medical sciences is as mean ±1.96 SD, which ensures 95% of randomly selected healthy people would fall within the limits in a normal distribution. It is easy to compute normal range in term of the mean and standard deviation by using the property of normal distribution.

Competency addressed: The student should be able to:
CM 1.2: Define and describe **determinants of health**.

DETERMINANTS OF HEALTH

Determinants of health are underlying causes of ill-health and development. These are—"the **causes** for the **causes**" these can be addressed by collective action across multiple sectors—health, education, nutrition, water and sanitation, poverty reduction, etc. 'Health in all Public Policies' and healthy public policies can be effective interventions.

Health is a development function. Much more health comes through sectors other than health sector, such as water and sanitation (environments) nutrition, literacy women and child development and healthy lifestyles (behaviours). These are also known as determinants of health. Hence, integration of health services with determinants of health achieves better health. The National Health Mission adopts a synergistic approach by effective integration of *Health* concerns with determinants of good health, viz. *nutrition*, *sanitation*, hygiene and safe drinking water through district action plan for health.

1. Environment

This is considered to be the most important determinant and input to health. The environment is defined as "the aggregate of all external conditions and influences affecting the life and development of an organism, human behaviour and society". A composite of physical, economic pressures, culture and education contributes largely to the background to which one's genetic apparatus reacts. Harmonious environment relationship to man contributes to an improved state of health (Fig. 1.1).

Rightly so the national health planners have included in their agenda to control and improve the natural physical environments, e.g. **air, water, soil, and noise**.

Man-made Environment

In man-made environment or artificial environment included items are **housing, transport, industries** and **communication** (roads, rail, air and sea).

Environment forms the fulcrum in the chain of transmission (epidemiological triad) as shown in Fig. 1.2. There is continuous interaction between agent, host and environment:

Agent ⇄ Environment ⇄ Host.

If there is an equilibrium between agent, host and environment, the balance is maintained and the individual, family and community enjoy perfect health. If the environments become favourable for agent (disease producing stimulus/factors/conditions/microorganisms) the balance is tilted, health is disturbed and the result is disease or bad outcome. Treating and modification of environments favourable to human host promotes health and prevents diseases.

Over 80% of diseases are due to bad environments like unsafe water supply, wide spread insanitary conditions due to indiscriminate defecations, poor disposal of waste water, garbage and refuse apart from air pollution leads to wide spread filthy conditions and are perpetual threat to endemic diseases and outbreaks. Mosquitoes and fly breed enormously and pose threat to occurrence of several diseases. Environment is a global concern and all energies are now focused to save the planet (our earth) by improving the deteriorating environments. While talking of environments, community treatment has been successful by handling the environment by three methods:

i *Socio-economics (poverty):* The term social and economics although susceptible to different definitions are completely interdependent in relation to environment. Economic life is chief determinant of social existence, hence the term socio-economics. The poor governments do not have enough money and so are the people of that government. *Poverty affects* the health in that productivity is lost due to partial disability. There is vicious circle because *people are poor as they are sick and sick because they are poor.* However, the high economics does not always assure good health. They may purchase things which impair health.

ii *Wealth distribution (employment):* Remunerating jobs, freedom from unemployment provides for improving living standards which in turn can help provide personal and environmental health, these are considered purchasable commodities. Wealth ensures

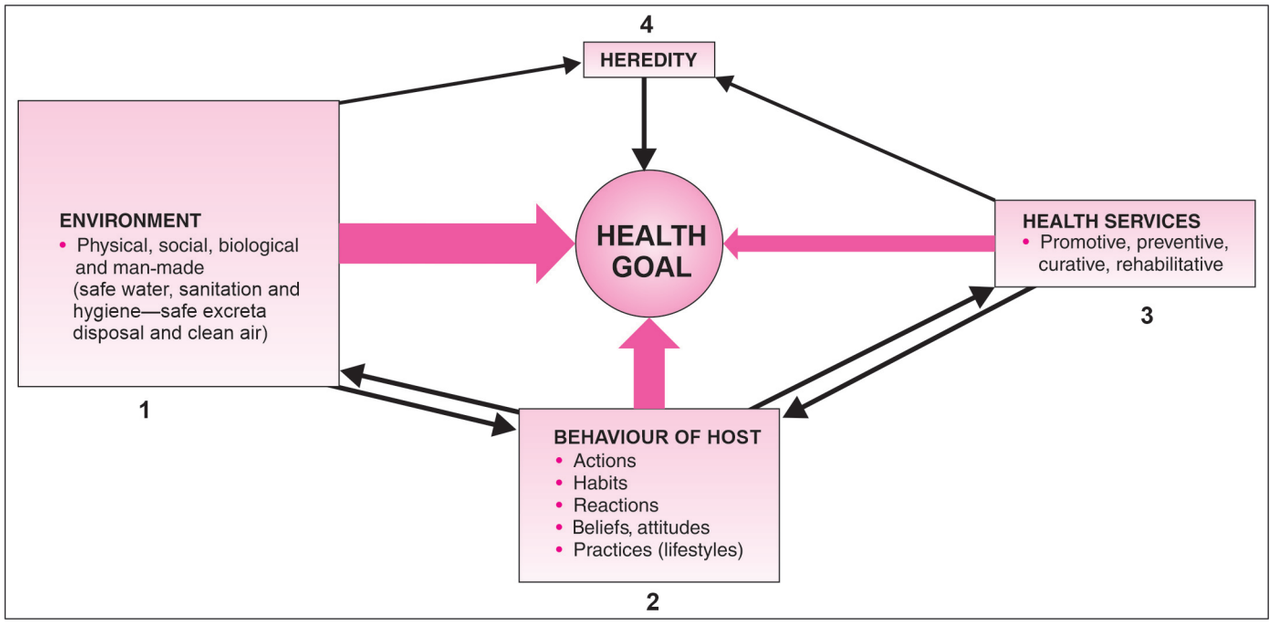


Fig. 1.1: Determinants of health (WHO*)

*The direction of the arrow indicates the direction of impact while the width of the arrow indicates the relative weight or importance of the input to health (WHO). "One health approach": Focuses on measures to protect the health of animals, environment and humans.

good housing facility, nourishment, clothing, recreation, good use of leisure, and all these contribute to health.

iii *Education:* Besides socio-economics education is another variate for contribution to health. Educational progress conditions biological, domestic and technical progress. Its positive contribution to economic growth including health is recognized by all. Planning for education is thus considered planning for health and vice versa. 'Education for all' and universal elementary education are the thrust areas which will contribute substantially to improved health for all including environments besides **health-seeking behaviour.**

iv. *The Environment (Protection)* Act of 1986 is an Umbrella Act for the *protection of the environment*. Relevant to the water environment, this Act has among others the following features:

- Nationwide programme for prevention, control and abatement of environmental pollution.
- Empower any person to enter, inspect, sample and test.

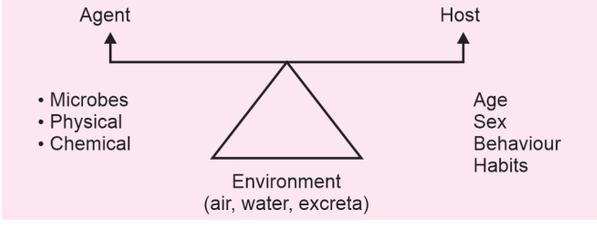


Fig. 1.2: Characteristics of agent, host and environmental factors

- Establish/recognize environmental laboratories.
- Regulate, close, prohibit industries, processes, and operations.
- Require Government organizations to furnish information, etc.

The Central Pollution Control Board (CPCB) is the national apex body for assessment, monitoring and control of water and air pollution. Well-managed and integrated water and sanitation programmes are crucial to health and development. A clean environment and adequate safe water are essential prerequisites for all children to grow, develop and attain good health. There is now distinct change in the strategy for promoting sanitation by the government. The Central Rural Sanitation Programme now promotes sanitation as a seven-component package: Handling of drinking water, disposal of waste water, disposal of human excreta, disposal of garbage and animal excreta, home sanitation and food hygiene, personal hygiene and village sanitation. Investments for ensuring access to safe drinking water will bring the desired health benefits only when complemented by investment in all the seven components of sanitation.

A staggering 29% of Indians defecate in open risking the environments and leaving the excreta to seep through the soil and contaminate the water table and water bodies with pathogens which come back into food chain. This is a key causative factor behind the high prevalence of soil and waterborne diseases in rural India as also in urban slums. According to World Health Organization, 80% of all diseases, such as diarrhoea, cholera, typhoid fever

infective hepatitis, vector-borne diseases, etc. are caused due to lack of safe water and sanitation.

END OPEN DEFECATION BY 2030

As per UNICEF 2020 data, 71% of households have toilets. This percentage is lower in villages where 67% use toilet (Table 1.1). Total sanitation campaign (TSC)/ **Swachh Bharat Abhiyan** (Gramin and Urban) is a sound beginning. Its objectives are to bring about improvement in the general quality of life in rural areas, accelerate sanitation coverage and generate demand for toilets in all schools and *Anganwadis* in rural areas through awareness and behaviour change through education involving Panchayati Raj Institutions (PRIs). *Nirmal Gram Puraskar* a National Award under total sanitation campaign has been launched on Feb. 24, 2005 by the Government. PRIs can look forward to get cash prizes ranging from 50,000 to 5,00,000 if:[5–7]

- All households in the village have access to toilets with full usage.
- There is no open defecation.
- All *Anganwadi* centres have access to sanitation facilities.
- There is general cleanliness all around.
- Kerala is the first state to end open defecation.
- India was declared open defecation free in Oct 2020.

Table 1.1: Households basic sanitation services 2021

Country	*Improved sanitation coverage (%)*		
	Urban	*Rural*	*Total*
China	95	88	92
India	79	67	71
Iraq	100	100	100
Pakistan	82	60	68
Sri Lanka	93	94	94
World	**88**	**66**	**78**

Environment being Compulsory Subject

50 hours compulsory core module course in *Environmental studies*, spread over to 6 months, at undergraduate level in all streams has been introduced by various universities in view of direction of the Hon'ble Supreme Court of India; with effect from 2004 to 2005. This course will enhance knowledge, skills and attitudes to environment. The syllabus is divided into eight units covering 50 lectures including field work activities of five lecture hours.

2. Behaviour of Host (Fig. 1.1)

i It is considered second largest area or determinant/ input to one's health and at some places it is even higher than environment. Like most personally held values and beliefs, certain habits are first learnt from family, community and school, all of these play an important role in general behaviour pattern. In terms of satisfactory survival, one's behaviour may not be the most rational and will therefore require modification through effective behaviour change communication (BCC) in most of non-communicable diseases.

ii Each society and indeed individual has cultural values, ideologies and interests relating to health and health services. The beliefs inimical to survival indicate need for health promoting changes in cultural pattern. But it may also be determined whether such changes are desirable or even tolerable. Behaviour change communication is to create healthy lifestyles, healthy habits, responsible reproductive behaviour, values of traditional and indigenous foods, safe sex and practice of personal hygiene to promote health and prevent diseases. Proper evaluation of beliefs, social values and motivation should determine the needed changes and in which way the services are to be provided to be acceptable.

iii Attitude change is a major change and may bring about permanent behavioural change (feeding young children, promotion of universal exclusive breastfeeding, feeding and eating habits—a core cultural variable, adequate diet for physical and mental alertness).

iv Primary values are respected and self-image is not destroyed.

v Geographical social mobility and dissatisfaction foster change.

vi Attitudes are also related to utilization of services provided. Even for the existing services, the utilization rates are low at 50% or even less for antenatal care, use of iron and folic acid and vitamin A prophylaxis.

vii ***Habits (habit means repetitive behaviour in an individual):*** Habits die very hard. In the word 'HABIT' if you remove 'H' ABIT of it is there, if you further remove 'A' BIT of it is there, if you remove 'B' IT is still there. Habits do not change by sheer will power. It demands change in beliefs and attitudes and it requires practice and skills.

3. Health Services

Availability, accessibility, affordability and acceptability of health services are considered an important determinant/ input to health. Health services utilization depends on quality of services offered as also faith and satisfaction derived from services apart from accessibility. Health services include promotive, preventive, curative and rehabilitative services available through various health systems. Utilization of health services depends upon health behaviour and socio-economic conditions (income, literacy and occupation of a person).

4. Heredity

Genetic inheritance may provide the initial significant contribution to one's state of health, may be modified by

environments and specifically by health services. Even before individual's birth, comprehensive health planning will need to include such aspects of healthcare as prenatal counselling and prenatal care apart from marriage and genetic counselling.

Ecology of health: Ecology is defined as mutual relationship between living organisms and their environment. Ecology of health is the study of relationship between variations in man's environments and his state of health.

Social Determinants of Health[8]

Social determinants of health are the 'causes for the causes'. Social determinants of health are the conditions in and under which people are born, grow, live, work and age, and broader set of forces, and systems that shape the conditions of daily life are referred to as **social determinants** of **health** (WHO).

These include early year's experiences, education, economic status, employment and decent work, housing and environment and effective systems of preventing and treating ill health. Actions on these determinants, such as eradicating poverty and hunger, ensuring food security, access to safe drinking water and sanitation, employment and decent work and social protection, protecting environments and delivering equitable economic growth will ensure economically productive and healthy society. It requires 'Health in all policies' with action by sectors outside the purview of health to attain better health and development.

Village Health Sanitation and Nutrition Committees (VHSNC), Urban Health Sanitation and Nutrition Committes and Mahila Arogya Samiti in Urban Slums

Following the launch of revised guidelines for VHSNCs, as a part of guidelines for community processes VHSNCs are envisaged as a standing/subcommittee of the Panchayat and the role of ASHA as member secretary has been strengthened. Village Panch has been made the chairperson and VHSNC has been reconstituted. Over 5.55 lakh VHSNCs have been constituted by March 2021.

Composition of VHSNC

- Minimum of 15 members, chairperson—mahila panch—scheduled caste preferred.
- Member secretary—ASHA.
- Members: Elected Gram Panchayat members—5, ANM, AWW, school teacher, PHED, NGO members/self-help groups volunteers 10, including users of health services.

Untied grant: ₹10,000 per annum for local actions, e.g. village sanitation and reduction of breeding of mosquitoes.

Objectives VHSNC: To provide a platform for convergent actions on social determinants and all public services directly or indirectly related to health.

Convergent Actions on Social Determinants of Health

A year-long campaign—VISHWAS (**village** based **initiative** to **synergise health water** and **sanitation**) has been launched which will be conducted by each VHSNC/UHSNC in its village across all the states. ASHA will play key role in facilitating this process, but the campaign will be led by VHSNC members, and core group of volunteers from community. Eleven monthly campaigns will be conducted on selected themes, viz.

- Open defecation free village day, school and *Anganwadi* sanitation day, liquid and solid waste management, healthy lifestyles/health promotion, vectors control day—dengue and malaria, safe water and personal hygiene, integrated diarrhoea control fortnight, breast-feeding week. National Nutrition week/month in September.
- Each of these monthly campaigns days will aim at building a platform for convergence of all programmes, resources and community action on the day's theme. A manual for the campaign has been prepared. The campaign has been rolled out in October 2017. These activities are part of strategic information, education and communication (IEC) plan of Ministry of Health and Family Welfare (MOH and FW) using mass media along with mid-media, social media and inter-personal communication.

National Urban Health Mission (NUHM) envisaged a woman collective/Samiti in urban slums/slum-like settlements as a leadership platform for community level actions. As per guidelines, Mahila Arogya Samiti (MAS) has been constituted at the level of 50–100 households. MAS is expected to generate demand, ensure optimal utilization of services, increase community ownership and sustainability, and to establish community-based monitoring system. Over 62000 MAS have been formed in urban slums as part of urban health centres under NUHM.

International classification of functioning, disability and health (ICF) recognizes the role of environmental factors, more than biological or medical, in creation of disability. In doing so, it takes into account body functions and structures, activities of people, participation and their involvement in all areas of life, as well as environmental factors which affect these experiences.

Against this background, measuring or assessing individual functioning involves systemic recording and mapping of various qualifiers, facilitators or barriers in relation to impairment, activity limitation and participation restriction. The term 'capacity' refers to what an individual can do in a standard environment and 'performance' refers to what a person actually does in his/her current or usual environment. The gap between the two provides useful guide to what can be done to the environment of the individual to improve the performance. Apart from the scope of using ICF model into legislation and social policy, it has abundant application value in clinical settings for rehabilitation programming.

Rather than enlist behaviours through assessment on "what an individual cannot do", following ICF the focus has shifted to "what they can do".

Concept of Disease

The WHO has defined health, but not disease because of its variations, e.g. mild, moderate, severe, fatal, and disease without clinical manifestations. Definition, given by Webster, "A condition in which the body health is impaired, a departure from a state of health, an alteration of human body interfering in performance of vital functions".

Morbidity: Any departure, subjective or objective, from a state of physiological or mental well-being, whether due to diseases, injury or impairment.

Disease means 'lack of ease' or 'disorder of structure or function'. Disease produces specific symptoms or that affects a specific part of the body.

Examples: Fever, cough, diarrhoea, vomiting, convulsion, injury to any part of the body that may result in loss of body part or may affect the function of the body parts such as loss of vision, hearing, etc.

Extent: Overall 7.5% of people are sick at any given point of time, 6.8% in rural and 9.1% in urban areas, respectively (NSSO 75th Round 2018).

Pattern: Occurrence of disease varies by time, places, and persons.

Spectrum: Disease has a spectrum, it may be sub-clinical with no symptoms or signs or it may be early disease with mild symptoms and signs or it may be in **advance** or at severe stage with frank signs and symptoms. The outcome of disease may be full recovery with or without treatment, recovery with sequelae or disability or a person may die of fatal disease. Those who recover may become carriers of that disease (infectious disease).

Duration: A disease may be of short duration lasting for a few days less than a week or 2 weeks or it may be of long duration. A disease of short duration is called **acute disease**, e.g. acute diarrhoea fever, cough or a disease may have longer duration and we call it a **chronic disease** such as tuberculosis, leprosy, typhoid fever. Symptoms of ailment persisting **more than one month** or if a course of treatment of an ailment continuing for a month or more is called a chronic ailment. Some diseases such as diabetes, hypertension, HIV are lifelong and require lifelong continuous treatment and follow-up.

Major categories: A disease may be **communicable**, i.e. spreads from person to person or may spread by or transmitted by a vector or a common source such as unsafe drinking water or food. These diseases are caused by micro-organisms. Other categories of diseases are **non-communicable** diseases (NCDs) which are chronic in nature, expensive to treat and are caused by unhealthy behaviours or lifestyles and are multifactorial.

Measuring disease burden: Disease burden is measured by disability adjusted life years (DALYs). One DALY equals to 1 year of healthy life lost due to premature death or disability. Other measures of disease are incidence and prevalence rates, spells of sickness and duration of sickness.

Competency addressed: The student should be able to:
CM 1.3: Describe the **characteristics** of **agent, host** and **environmental factors in health and disease and multifactorial etiology** of disease.

Figure 1.2 displays the characteristics of agent, host and environments in health and disease. The detail of characteristics of agent, host and environment is described in Chapter 7 on pages 245–251.

Causes—single or multifactorial: A disease may be caused by a single agent or specific micro-organism (bacteria, viruses, protozoa, rikettsial, spirochaetes and fungi, etc.) or may result from combination of several risk factors, we call it a multifactorial disease, e.g. cardio-vascular diseases, diabetes, cancers, etc. are multifactorial (*see* pages 256, 300 and 468).

Ayurveda propagated disease theory based on 'Imbalance of Tridosha'—**Vata** (air), **Pita** (bile) and **Kapha** (mucus).

Competency addressed: The student should be able to:
CM 1.4: Describe and discuss the natural history of disease.

The natural history of any disease refers to the phases through which the disease passes, in the absence of any intervention. Clear knowledge of natural history of a disease helps in identifying the stages vis-à-vis appropriate intervention to prevent and control the disease or eliminate and eradicate a disease. The natural history of any disease begins as soon as the organism of a disease (infectious (disease) enters the body of a susceptible host or else a disease provoking stimulus or accumulation of risk factors or condition/exposure/circumstance or combination of these factors start operating in the **susceptible host**.

Pre-pathogenic phase: During this period the host stays healthy without any disease and the **agent, host** and **environment** remain in balance.

Pathogenic phase: This begins/starts as soon as the disease producing organism or stimulus enters the human body, the body of host reacts and chain of events follow as depicted in Fig. 1.3.

If the natural history of a disease is known and most probable risk factors/exposures are known then appropriate levels of prevention/interventions can be applied in healthy population or in sick persons to promote health, to prevent disease, cure disease, limit disability and to rehabilitate persons.

Competency addressed: The student should be able to:
CM 1.5: Describe the application of interventions at various **levels of prevention**.

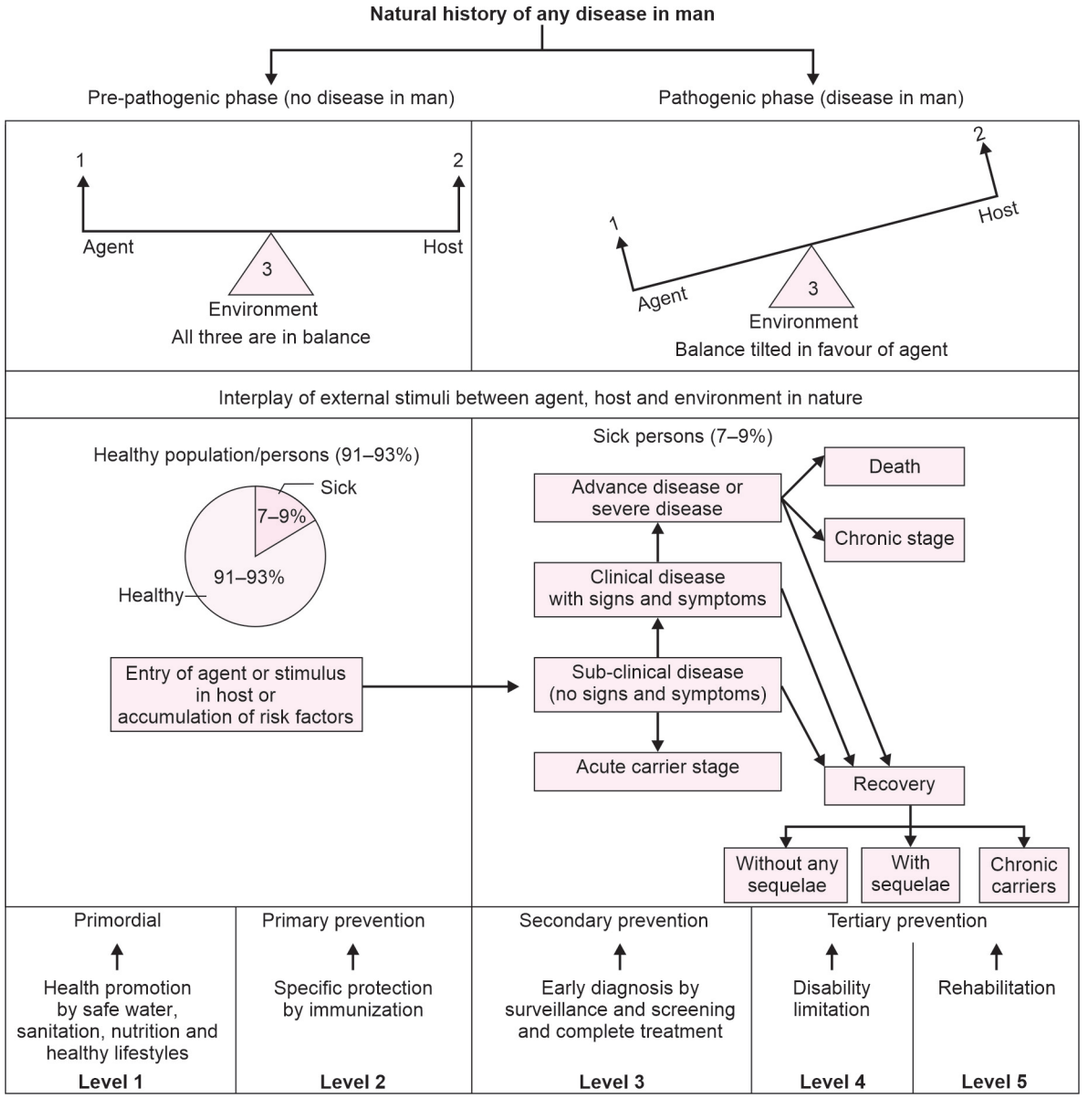


Fig. 1.3: Natural history of disease and levels of prevention

LEVELS OF PREVENTION

The word 'prevention' is derived from Latin '*praevenire*' means 'to come before'. The prevention is anticipatory medicine. It comes before the disease occurs. Anticipatory actions or proactive measures are preventive in nature. Preventive actions can be taken at any stage of the spectrum of health and disease. Most of the preventive measures are focused on 'healthy people', to ensure that they stay healthy and do not contract or develop disease or diseases. The goal of prevention is to 'achieve health for all' or 'health in all'[9] to ensure adequate level of health which permits them to lead a productive and socially useful life (Fig. 1.4).

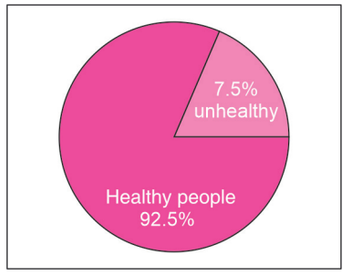


Fig. 1.4: Proportion of ailing persons in a 15 days period

Clearly, the concern and focus of prevention is on 92.5% 'healthy people' to ensure that they stay healthy but the concept of prevention can be applied to 7.5% of unhealthy

or sick also to restore their health at the earliest and to prevent deaths and disability in sick persons.

LEVELS OF PREVENTION—APPLICATION OF INTERVENTIONS AT VARIOUS LEVELS

Following levels of prevention are applicable:

1. **Primordial**
2. **Primary** → Focus on healthy people/total population
3. **Secondary**
4. **Tertiary** → Focus on sick people (who have already developed a disease)

All these levels are important and complementary, although primordial prevention and primary prevention have the most to contribute to the health and well-being of the whole population.

1. Primordial Prevention

This is the real prevention, which does not allow the people to fall sick. The goal of primordial prevention is **healthy nations, healthy population, healthy cities, towns** and **villages,** healthy homes, healthy environments, and work place.

Aim

The aim of primordial prevention is to prevent the emergence of 'unhealthy lifestyles' in population or to prevent the emergence of 'risk factors' in the community.

Primordial prevention is a *strategy* to reduce risks and promote healthy lifestyles.

In developing countries with high mortality, 10 selected leading risk factors have been identified for appropriate actions, these are:

i Underweight/malnutrition
ii Unsafe sex
iii Unsafe water, sanitation and hygiene
iv Indoor smoke from solid fuels
v Zinc deficiency
vi Iron deficiency
vii Vitamin A deficiency
viii High blood pressure
ix Tobacco use
x Cholesterol

The policy and legislation on tobacco and smoking have been adopted by many governments in the world including India. Tobacco epidemic can be prevented by effective legislation against tobacco. WHO global initiative has motivated many countries to adopt effective policy on tobacco.

People should not take onto smoking (tobacco use) or adopt unhealthy lifestyles in relation to diet, exercise, and physical activity.

The world is living dangerously either because it has little choice or because it is making wrong choices. Today there are more than 8 billion people coexisting on this fragile planet. On the one side there are many millions who dangerously face high and heavy concentrated burden from poverty, undernutrition, unsafe sex, unsafe water, poor sanitation and hygiene, iron deficiency and indoor smoke from solid fuels. On the other side lies unhealthy consumption, particularly tobacco and alcohol. The risks from blood pressure and cholesterol, strongly linked to heart attacks and strokes are also closely related to excessive consumption of *fatty, sugary* and *salty foods*. They become even more dangerous when combined with deadly forces of tobacco and excessive alcohol consumption. Obesity a result of unhealthy consumption coupled with lack of physical activity is itself a serious health risk.

India is facing a double burden of disease, i.e. infectious diseases due to lack of safe water, sanitation, and chronic non-communicable diseases due to *unhealthy lifestyles*.

Primordial Prevention Strategies

(a) At Government Level: Healthy Public Policies

The Government especially Health Ministry should play a stronger role in formulating risk prevention strategies which are population- or community-based strategies.

- Provision of safe water and ensuring sanitation to rural, tribal and urban areas (The *Swachh Bharat Abhiyan*).
- Policy on nutrition to improve nutrition by effective agriculture policy on "food for all and good nutrition for all" particularly improving the nutrition of most vulnerables: Infants, young children, adolescent girls, pregnant women and lactating mothers.
- Revised National Nutrition Policy on promotion of healthy diets.
- Controlling food industry to prevent production and sale of junk foods, salt and *trans*-fats reduction in processed foods.
- Healthy foods through mid-day meal in schools.
- **Tobacco, alcohol and substance abuse:** Tobacco of course is a major risk factor for cardiovascular diseases. In terms of intervention, the greatest tobacco-related improvements in population health would be a combination of tobacco taxation (Sin tax), comprehensive ban on advertising and restriction of smoking in public places and sale of cigarettes/bidis to children should be implemented. 'Legislations on tobacco' by all nations has been adopted in view of great health risks of tobacco.
- Policy on crop alternative to tobacco.
- Controlling/regulating behaviour of road users through Road Safety Motor Vehicle Act—licensing for driving, use of safety belts and helmets.
- Prevention of air pollution (indoor and outdoor).
- Promoting non-health sectors involvement in developing policies for control of NCDs and intersectoral coordination—agriculture, education, food industry,

women and child development, ministry of sports, etc. (multisectoral action plan for NCDs).
- Protection of environments.
- Improved safety at workplace.

Thus, the **primordial prevention** can be achieved by combination of education and legislation on tobacco and food, promotion of physical activity, healthy and clean eating and observing personal hygienic practices. These measures should begin right during **childhood** period, continued during **adolescence**, and maintained in **youth, adulthood** and old age. These measures will reduce emergence of risk behaviours in the population.

Competency addressed: The student should be able to:
CM 1.6: Describe and discuss the concepts, the principles of health promotion and education, IEC and BCC.

This competency overlaps with Chapter 4, hence also covered in Chapter 4. Health education is an important mean of health promotion and prevention of diseases.

(b) At Community Level

- **IEC and BCC** for healthy lifestyles.
- *Education:* Health education for adopting healthy behaviours through mass media and inter-personal communication focusing on predominant risk factors—undernutrition, unsafe sex, unsafe water and bad sanitation, high blood pressure, high cholesterol, overweight and tobacco use.

2. Primary Prevention

Once the risk factors have emerged in the community or unhealthy behaviours are practiced on large scale, the primary prevention has prime place.

Aim

The aim of primary prevention is to limit the *incidence* of disease by controlling underlying causes/risk factors.

or

To prevent the development of disease/diseases in population, by *modification* of *risk factors*.

Strategies of Primary Prevention (Fig. 1.3)

A Health promotion.
B Specific prevention/protection against disease, trauma and accidents.

A. Health Promotion

Health promotion means improving positive health in general by observing time honoured 'best practices' like personal hygiene, brushing teeth, handwashing, avoiding smoking and alcohol, regular physical exercise, adopting healthy habits of eating, etc. *Best health practices (lifestyles)* are established and practiced in the family first of all and at school and workplace and with peers in later life.

Measures for health promotion: Health promotion can be achieved through health education programmes, which could be formal and non-formal. Health education should be part and parcel of general education. Adequate nutrition, **Universal exclusive breastfeeding** improving environmental sanitation (safe water, safe disposal of human and animal excreta, reduction of air pollution), regular physical exercise and yoga promotes health and prevents diseases in population.

B. Specific Protection

- Immunization, against vaccine preventable diseases prevents many diseases. Most of the countries including India have national immunization programmes to prevent diseases. Immunization against polio is an important strategy for polio eradication. Smallpox was eradicated by effective vaccination programme. Hep B vaccine prevents liver cancer.
- ***HPV*** vaccine prevents cervical cancer.
- Specific nutrients like mega doses of vitamin A and iron and folic acid tablets to young children, pregnant and lactating women and adolescent girls prevent blindness due to vitamin A deficiency and anaemia, respectively. Iodine consumption by salt iodization prevents goitre/iodine deficiency disorders.
- ***Contraception:*** To prevent births, contraceptives are used widely. This is the priority number one in India to limit the size of population by spacing and terminal methods of contraception.
- Prevention of HIV and AIDS as also STIs, hepatitis B by condom use are examples of specific protection.
- ***Accidents prevention:*** Use of helmets and safety belts prevents head injuries and fatal accidents. Safety devices used in industries to prevent injuries and accidents are also an example of specific protection against accidents and injuries.
- Avoidance of allergens, radiation by specific protection.

Approaches

We have two approaches in primary prevention, which are population-based and high-risk approach.

(a) Population-based Approach

In population-based approach, the intention is to cover the whole population for adopting healthy lifestyles through behaviour change communication. Universal immunization focuses on coverage of all infants. Similarly, safe water for all, the focus is whole population; universal elementary education is also population-based strategy. Other population-based approaches are legislation against smoking and tobacco and fixing legal age for marriage

and risk reduction against HIV/AIDS, universal salt iodization are the examples of population-based strategies to prevent diseases or epidemic prone diseases. Regulating salt content and *trans*-fats in manufactured foods, maintenance of healthy diets, reduction of salt intake and saturated fats, promoting physical activities and control of tobacco use are key population-based strategies.

Advantages

- Population-based approaches are useful and these make high impacts in reducing the incidence of diseases and are sustainable and cost effective.
- The population approach does not require any screening programme to identify high-risk groups.
- Population-based approaches are more rewarding in risk reduction in population and treating **underlying cause.**

(b) High-risk Approach

The focus of primary prevention in this approach is select individuals who have high risk such as commercial sex workers or bridge population who practice high-risk sexual behaviour, and people with sexually transmitted infection (STD clinic attendees). This strategy is being followed in National AIDS Control Programme in the country.

Smokers are also high-risk individuals and similarly persons having family history of diabetes and hypertension are high-risk individuals.

Individual screening programmes for identification of high-risk individuals for coronary heart disease, hypertension and obesity have not met with much success. Screening is a costly affair and very few can afford it.

Focus on high-risk individuals will deal with only margin of the problem as it covers small number of persons and will not have much impact on reduction of disease incidence or **underlying cause** in population. Individual measures to reduce risk-like screening for blood pressure, cholesterol, diabetes and weight and height measurement, may produce small effects as these involve lot of cost, and effect of individual approach pays least.

Advantages

High-risk approach seems to be attractive as some argue that scarce resources should be used for high-risk people but this does not yield much results.

Implications

The distribution and determinants of risks in a population have major implications for strategies of prevention. Geoffrey Rose observed that in vast majority of diseases "natural history of disease presents us with continuum, not a dichotomy". Risk typically increases with across the spectrum of a risk factor. Use of dichotomous labels such as 'hypertensive' and 'normotensive' are therefore not a description of natural order, but rather an operational convenience. Following this line of thought, it becomes obvious that the 'deviant minority' (e.g. hypertensive) who are considered to be high-risk are only part of risk continuum; rather than a distinct group. This leads to one of the most fundamental axioms in preventive medicine "a large number of people exposed to a small risk may generate many more cases than a small number of exposed to high-risk". Rose pointed out that wherever this axiom applies, a preventive strategy focusing on high-risk individuals will deal with only margin of the problem and will not have any impact on the large proportion of disease occurring in large proportion of people who are at moderate risk. For example, people with slightly raised blood pressure; suffer more cardiovascular events than the hypertensive minority. While the high-risk approach may appear more appropriate to individuals and their physicians, it can have only little effect at a population level. It does not alter the underlying cause of illness, relies on having adequate power to predict future disease, and requires continued and expensive screening for few high-risk individuals.

The relation between risk factors and disease events is continuous and most events occur in people in the middle range of risk factors distribution who are not normally judged as at high risk.

The effort expended on measuring risk factors in individuals is, therefore questionable (Robert Beaglehole). Screening for risk factors in individuals (checking blood pressure, overall check-up, check-up for diabetes and monitoring of cholesterol, etc.), cost time and lot of money and resources should be directed towards primary **prevention** based on **population strategies** of **risk reductions**.

In contrast, population-based strategies that seek to shift the whole distribution of risk factors have the potential to control population incidence. Such strategies aim to make healthy behaviours and reduced exposure into social norms and thus lower the risk in entire population. The potential gains are extensive, but the challenges are great as well, a preventive measure that brings large benefits to the community appears to offer little to each participating individual, this may adversely affect motivation of population at large (known as **prevention paradox**). Population-based approach is most often applied to prevention of cardiovascular diseases.

Population-based strategies to reduce salt content of manufactured food, maintenance of healthy diets, promotion of physical activity and control of tobacco industry should be priority to control epidemic of cardiovascular diseases.

3. Secondary Prevention

This level of prevention is directed towards those individuals who have developed disease. Early detection and prompt treatment at any stage can alter the course/outcome of disease.

Aim

Aim of secondary prevention is to reduce *prevalence* of disease in the community by curing that disease.

The secondary prevention is valid in our country for early detection and prompt treatment of tuberculosis, leprosy, malaria, blindness and cancer in the country.

Strategies (Early Diagnosis and Prompt Treatment)

- The strategy of secondary prevention is to detect the disease at early stage and ensure prompt treatment to reduce its severity and duration. *Example:* Detection of malaria by active and passive fever surveillance offers prompt treatment in homes, similarly sputum examination of those persons having cough of 2 weeks or more helps early detection of tuberculosis and prompt treatment with DOTS strategy.
- By having population-based screening programmes, for persons above 30 years of age, we can detect the diseases at early stage. Screening of vision to detect refractive errors, to detect cataract, to detect precancerous lesions, diabetes, blood pressure measurement for treatment of hypertension in middle-aged and elderly people. Similarly, growth monitoring of children and birth weighing can detect growth faltering at the earliest to treat it at an early stage.
- Surveillance and screening programmes help early case detection and prompt treatment. Periodic medical examination of industrial workers and army personnel helps in early detection of disease and its prompt treatment. This aims at detect susceptible persons/ factory workers and remove them from exposure before they suffer any permanent incapacitation.

4. Tertiary Prevention (Disability Limitation and Rehabilitation)

The tertiary prevention is the last level of prevention. It is applied when the individual has reached an advanced stage of disease. It indicates that the first two levels have failed.

Aim

- To limit the progress and development of complications of established disease.
- To reduce impairment and disability.
- To provide rehabilitation measures.
- To prolong life.
- To prevent deaths.

Disability Limitation

Once a disability (impairment, activity limitation, participation restriction) has occurred, measures can be taken to prevent its progression to handicap. Disability can be limited to minimum by advanced treatment at referral centres or established clinics by physiotherapy, and by training of disabled for self-care.

Rehabilitation

Once the disability has progressed to the stage of *handicap,* then attempt is made to rehabilitate the individual. It is a restorative medicine using the remaining capacities of an individual and making him/her self-reliant and useful member in the community. The rehabilitation consists of physical, occupational and social rehabilitation measures. These are very costly.

Examples of rehabilitation: Rehabilitation of paraplegics, amputees (those who have lost limbs), blinds, deaf, mentally retarded, leprosy cases and polio cases. These persons are being provided support for rehabilitation at established centres either by government or by voluntary organizations.

Example: Artificial limbs and foot, hearing aids, spectacles, wheelchair for mobility, speech therapy, crutches, etc.

Community-based rehabilitation (CBR) is the preferred approach wherein family and community takes responsibility and government provides support. CBR programmes are designed and run by local communities. CBR seeks to ensure that people with disabilities have equal access to rehabilitation and other services and opportunities—health, education, and livelihoods. Developed by WHO in 1980s CBR is practiced in more than 90 countries and represents move away from institutions towards community self reliance. Tertiary prevention is a costly and a challenging task.

Competency addressed: The student should be able to:
CM 1.7: Enumerate and describe **health indicators**.

HEALTH INDICATORS

It is somewhat easier to define health for an individual or person or child or adolescent or youth but to define 'community health' is somewhat more difficult. 'Community health' parameters are different from health parameters of an individual. Community health can be measured through indicators of economics (gross national product, gross national income and per capita income), life expectancy, under five mortality, infant mortality, literacy level, composite index like human development index, maternal mortality, etc.

The other indicators of community health are environmental indicators, demographic, access to health services, healthcare utilization and health policy indicators.

A community is healthy when it enjoys sound health where disease and death rate is acceptably low, it is not threatened with bad environments and its economy is sound and the health practices are sound and based on scientific evidences. Its literacy levels are high and demographically it has balanced sex ratio and people live long, quality of life is good and human development index is high. A village is said to be healthy if it has safe source of improved water supply, safe method of waste water disposal, paved streets, disposal of garbage, refuse and animal excreta by manure pits, people use sanitary latrines, female literacy is high, girls enrolment is universal, deliveries are conducted by trained persons,

birth rate and death rate are within acceptable limits, immunization coverage is high, children are well-nourished and housing condition is good.

INDICATORS OF QUALITY OF LIFE

Gross National Income (GNI) Per Capita

Definition: The gross national income (GNI), formerly referred to as gross national product (GNP) measures the total domestic and foreign value added claimed by the resident producers, at a given period in time, usually a year expressed in constant 2017 international dollars converted using purchasing power parity (PPP) conversion rates.

Limitations of GNI

Growth of GNP does not necessarily 'trickle down' to the poor and governments often struggle to intervene to ensure the distribution of economic progress to the poor but it percolates very slowly.

The GNI is concerned with production which is traded or monetarized, it does not reflect such factors as growing of food for family consumption or the unpaid labour of women or do it yourself building of homes, or local collection and consumption of water or firewood and varieties of activities in home settings in rural and urban areas.

Average income statistics fail to reflect real levels of 'social income' provided by such government financed services as health and education.

Large proportion of GNI does not enter world trade, official exchange rate cannot reflect domestic purchasing power.

Moreover, GNI is an average figure. GNI of India was International $ 6590 per annum per person in the year 2021.

Gross Domestic Product (GDP) Per Capita

Definition: The average per capita market value of the sum of gross values added of all resident institutional units engaged in production, for a given national economy, at a given period in time, usually a year, expressed in international dollars using purchasing power parity rates.

GDP measures the total output of goods and services for final use occurring within the domestic territory of a given country, it provides an aggregate measure of production. GDP for the year 2021 in India was $6590.

Life expectancy in India: In India as a result of Covid-19 pandemic the life expectancy of 69.7 years in 2019 has declined to 67.2 years in 2021, which is now 68.9 years for women and 65.8 years for men.

Healthy life expectancy (free from disability): Reflects overall health of country's population in India from 2000 (54.2 years) to 2019 (59.3 years) improved by 6.1 years. Lost healthy life expectancy (HALE) represents equivalent years of full health lost through years lived with morbidity and disability.

HUMAN DEVELOPMENT INDEX

The human development index (HDI) remains an aggregate measure of progress in three dimensions—**health, education** and **income.** Inequities in human development persist

According to the revised human development report (HDR) methodology, HDI includes following parameters in three dimensions.

1 Life expectancy at birth.
2 Mean years of schooling and expected years of schooling.
3 Gross national income (GNI) per capita.

In the revised methodology, the health dimension is still assessed by life expectancy at birth and is calculated using a minimum value of 20 years and maximum value of 85 years, with the data provided by the UN Population Division. In the calculation of revised education component, education index is measured by mean years of schooling for adults aged 25 years and older and expected years of schooling for children of school-entry age. It is preferred over literacy rate as mean years of schooling are measured more frequently in most of the countries, and can better discriminate between countries.

The mean years of schooling are estimated by the United Nations Educational, Scientific and Cultural Organization (UNESCO), institute for statistics, based on educational attainment data from various census and surveys. The expected years of schooling are based on enrolment by age at all levels of education, capped at 18 years, and are produced by the UNESCO, institute for statistics.

Further, in the revised methodology, standard of living is being measured by gross national income (GNI) which is a better measure than gross domestic product for globalized economies, as significant difference may be there between income of a country and its residents. Also, some residents who live abroad send their income back to the country and some living in a country send their income abroad, which gets covered in GNI.

Following indices are used to represent aforementioned parameters:

1. Life expectancy index (LEI)

$$\text{Life expectancy index} = \frac{\text{Life expectancy} - 20}{85 - 20}$$

85 and 20 are maximum and minimum assumed values of life expectancy at birth, respectively. LEI is 1 when life expectancy at birth is 85 and 0 when life expectancy at birth is 20.

2. Education index (EI):

$$\text{Education index} = \frac{\text{Mean years of schooling index} + \text{Expected years of schooling index}}{2}$$

A. Mean years of schooling index (MYSI)

$$\text{MYSI} = \frac{\text{Mean years of schooling}}{15}$$

15 is projected as maximum value of mean years of schooling in any country till 2025.

B. Expected years of schooling index (EYSI)

$$\text{EYSI} = \frac{\text{Expected years of schooling}}{18}$$

18 is equivalent to achieving master's degree in most countries.

3. Income index (II):

$$\text{Income index} = \frac{\text{In}\,(\text{GNIpc}) - \text{In}\,(100)}{\text{In}\,(75000) - \text{In}\,(100)}$$

The value of income index is 1 when GNI per capita is $75,000 and 0 when GNI per capita is $100. The higher the GNI per capita of a country, the higher would be the value of its income index.

Finally, the HDI is calculated as geometric mean of these three normalized indices, with equal weightage to all, which though is often criticized as all these dimensions not necessarily contribute equally in human development.

HDI of India in 2021

Life expectancy at birth = 67.2 years
Mean years of schooling = 6.7 years
Expected years of schooling = 11.9 years
GNI per capita = 6590$.

1. Life expectancy index (LEI)

$$\text{Life expectancy index} = \frac{67.2 - 20}{85 - 20} = 0.726$$

2. Education index (EI)

$$\text{MYSI} = \frac{6.7}{15} = 0.447$$

$$\text{EYSI} = \frac{11.9}{18} = 0.661$$

$$\text{Education index} = \frac{0.447 + 661}{2} = 0.554$$

3. Income index (II)

$$\text{Income index} = \frac{\text{In}\,(6590) - \text{In}\,(100)}{\text{In}(75000) - \text{In}\,(100)}$$

Income index = 0.626

Geometric mean of 1, 2 and 3 indices

$$= 3\sqrt{0.726 \times 0.554 \times 0.686} = 0.633$$

Human development index is geometric mean of all three indices works out 0.633 for the year 2021 in India (Tables 1.2 and 1.3).

Table 1.2: Ranking of countries based on HDI scores (Human Development Report 2021—UNDP)

Rank	*Name of country*	*HDI score*
1	Switzerland	0.962
2	Norway	0.961
5	Australia	0.951
132	India	0.633
191	South Sudan	0.385

Between 1990 and 2019, India's HDI value increased from 0.434 to 0.645, an increase of nearly 50%, an indication of country's remarkable achievement in lifting 271 million of people out of poverty. However in 2021 the HDI declined to 0.633 due to Covid-19 pandemic Table 1.3.

Table 1.3: Trend of HDI in India

Year	*1990*	*2000*	*2010*	*2015*	*2019*	*2020*	*2021**
HDI	0.434	0.491	0.575	0.629	0.645	0.642	0.633

* However in 2021 the HDI decilined to 0.633 due to Covid-19 pandemic.

The Covid pandemic has infected and killed millions of people worldwide. It has upended the global economy, interrupted education dreams, health services and treatment, and disrupted lives and livelihood. The Covid crisis deepened in health, with a drop in life expectancy at birth. For the first time, indicators of human development have declined—drastically, unlike anything experienced in other recent global crises. (UNDP special Report 2022—New threats to human security in the Anthropocene. "Demanding greater solidarity"). Covid-19 pandemic has caused unprecedented decline in human development index values in the last two years—2019 to 2021. The HDI adjusted for Covid-19 had yet to recover about five years of progress.

Revised Multidimensional Poverty Index (MPI)

Revised and updated global MPI in September 2018 includes three dimensions—health, education and standard of living and 10 indicators (nutrition, child mortality, years of schooling, school attendance, cooking fuel, improved sanitation, drinking water, electricity, housing and assets). Based on this index nearly 27.9% of people in India were poor in 2015–16.[10]

PHYSICAL QUALITY OF LIFE INDEX

Physical quality of life index (PQLI) is one of the indicators used to measure the level of human development.

This index takes into consideration of the following components:

- Infant mortality rate
- Life expectancy at age one
- Literacy rate

For the lowest level of IMR of Kerala of 16 against the 90 of UP or MP, the score for Kerala would be 100 and for UP it would be only 5.6 where zero score is allotted to absolutely defined lowest performance and score of 100 denotes absolutely defined highest performance. After allocating the scores to each component, aggregate score of three components is averaged out. Each component has equal weightage. The PQLI is a composite index and measures social well-being of human development of a defined geographical territory. The PQLI does not include the component of GNP meaning thereby that economic development is not a pre-requisite for human development. PQLI is not totally dependent upon economic development.

MEASUREMENT OF HEALTH STATUS THROUGH HEALTH INDICATORS

Since morbidity and mortality only relate to sick persons and persons who die. What about those who survive? The objective of nations all over the world is to improve the quality of life (physical, social and mental well-being). Therefore, the population or community health and development is judged through other indicators in addition to morbidity and mortality indicators. The quality of life of survival is judged through some of the following *indicators*, positive and negative both.

Policy Indicators

- Allocation of financial resources for health, e.g. allocation of percentage of budget on health and percentage of GDP spent on health.
- Percentage of public health investment on primary healthcare, secondary and tertiary healthcare.
- Policy on social insurance and coverage of most vulnerables and poor people, e.g. 'Ayushman Bharat'.
- **Equitable** access to health services and equity in medical education and human resource development.
- Decentralized management of health institutions and delegation of authority to Panchayati Raj Institutions.
- Convergence and intersectoral coordination.
- Public–private and NGOs partnership.
- Use of rational drugs and drug policy.
- Population norms for health facility and IPHS.

1. Basic Indicators

Under-five mortality (negative indicator). India ranks at 53rd place with under-five mortality of 32 (2021).

- Infant mortality rate (negative indicator)
- Neonatal mortality rate
- Gross national income (positive indicator)
- Life expectancy at birth (positive indicator)
- Total adult literacy (positive indicator)
- Net primary school enrolment ratio

2. Nutrition Indicators

- Percentage of infants with low birth weight
- Early initiation of breastfeeding (%)
- Exclusively breastfed up to 6 months (%)
- Introduction of solid, semisolid or soft foods at 6–8 months (%)
- Malnutrition prevalence in under-five (underweight, wasting and stunting).
- Vitamin A supplementation coverage
- Households consuming iodized salt.

3. Health Indicators

- Population using improved drinking water source.
- Percentage of population using adequate sanitation facilities.
- Percentage of routine vaccines financed by government.
- Immunization status of pregnant women and infant.
- ORS use rate and ARI management rate at health facility.
- Children sleeping under impregnated bed nets (%).
- Percentage of under-five with fever receiving antimalarial drugs.

4. HIV/AIDS

- HIV incidence per 1000 uninfected population.
- Adults (15–49 years) prevalence rates.
- Estimated number of people living with HIV/AIDS.
- HIV prevalence among young people (15–24 years).
- Comprehensive knowledge of HIV (%).
- Women living with HIV (%).

5. Education

- Adult literacy rate
- Primary school gross enrolment ratio
- Net primary school enrolment ratio
- Primary school entrants reaching grade 5
- Secondary school gross enrolment ratio.

6. Demographic Indicators

Population, population annual growth rate, crude birth and death rate, life expectancy, total fertility rate, percentage of urban population, average annual growth rate of urban population (%).

7. Economic Indicators

GNI per capita, GDP per capita average annual growth rate, percentage of central government expenditure

allocated to health, education and defence, and percentage of population below $ 1.5 a day.

8. Women

Life expectancy of female, women literacy, gross enrolment ratio for girls, contraceptive prevalence, antenatal care coverage, skilled attendant at delivery (%) and maternal mortality ratio and lifetime risk of maternal death.

9. Child Protection

Child labour (5–14 years), birth registration, female genital mutilation, and child marriage.

10. Adolescents

Adolescents indicators include adolescents as proportion of total population, marital status, age at first birth, adolescent birth rate (15–19 years), attitudes towards domestic violence, secondary education and comprehensive HIV knowledge.

11. Equity

Equity indicators include birth registration, skilled attendance at birth, underweight prevalence in children, immunization—measles coverage and use of improved sanitation facilities in poorest and richest 20%.

Competency addressed: The student should be able to:
CM 1.8: Describe the **demographic profile** of India and discuss its impact on health.

DEMOGRAPHIC PROFILE OF INDIA AND ITS IMPACT ON HEALTH

Size of Population and its Implications on Health

- Large size of population over 1412 million in July 2022 poses a challenge for universal health coverage. To set up health facilities, such as number of sub-centres, PHCs, CHCs and required manpower, physical infrastructure and finances as per Indian Public Health Standards and population norms, it becomes an uphill task.
- Nearly 66% of population is rural and 34% urban and half of urban population may be living in urban slums, which have high density of population and consequently high risk of respiratory infections and TB and Covid-19. Disparity or divide between rural and urban population/urban slums persists, as most of health resources are concentrated in favour of urban areas (hospitals, doctors, private nursing homes and big hospitals). Universal coverage of health for this much population remains a big challenge.

Sex Ratio—Demographic Implications

The demographic divide between women and men continues to exist till date. Out of total population of 1210 million in 2011, we had 587 million females against 623 million males, which means 36 million females are missing in India. Overall female sex ratio was 943 per 1000 men. Many well to do states like Haryana and Punjab have low female sex ratio, indicating high mortality in female.

The overall female sex ratio has improved to the level of 1020 in 2019–21 for the first time in India. Thus survival rates in women have improved.

a. Most Disturbing Sign of Demography: Declining Female Child Sex Ratio (CSR) Census 2011

The population of 0–6 years girls is declining. At national level this ratio is 914. Most worrisome feature of low child sex ratio of 830, 846, 886 and 867 was observed in the prosperous states of Haryana, Punjab, Delhi, and Chandigarh, respectively. Jhajjar district in Haryana had the lowest child sex ratio of 774. This is significant pointer towards sex selective abortions, this needs to be curbed by stringent implementation of PNDT Act. CSR has improved to 928 due to implementation of PNDT.

Population Structure

a. Infant and Young Children (0–4 Years)

The overall 0–4 year population which forms the base of pyramid is shrinking due to fall in fertility rate and success of F.P prog. currently it is 8.2% of total population.

Newborns, infants and young children below 5 years of age constitute 8.2% of total population. They are most vulnerable to diseases and deaths. High infant mortality of 28 and under 5 mortality of 32 is a problem. Their prime health needs are survival, feeding (breastfeeding, exclusive breastfeeding, complementary feeding), early childhood care and education, growth and development, immunizations and management of childhood illness like diarrhoea, ARIs and fevers.

They are supreme assets and future human resource of the country. Hence, the health services provision should be over-riding priority. Invest in their education and health.

b. Population of 5–14 Years (School Going Children)

These children constitute nearly 18.3% of India's population. They are vulnerable age group.

Major health implications for this population are supervision and monitoring of their growth and development, adequate diet, universal enrolment and retention in schools, screening and correction of 4Ds—common **defects** (visual and hearing impairment, dental caries), developmental **delays** and learning disorders, **diseases** and **deficiencies**. Major intervention includes health education to promote 'healthy lifestyles', healthy

behaviours and habits (eating healthy foods, avoiding tobacco use, promoting physical activities, using toilets, handwashing and personal hygiene, drinking clean water) besides health protection by immunizations, iron folic acid supplementation and deworming. Major challenge is coverage of all schools (government and private) under universal health coverage and RBSK and RKSK prog.

Adolescent Age 10–19 Years

Adolescents constitute Nearly 18.3 to 20% of population of India. Health implications in this age group are to provide them correct and complete information on 'healthy lifestyles' menstrual hygiene, reproductive and sexual health, prevention of RTI, STDs, and HIV, adequate and healthy diet, avoiding drugs, alcohol and tobacco use, prevention of accidents road safety, right age of marriage and child bearing, contraception and prevention of non-communicable diseases. Main health intervention is health education and counselling by peer educators, through curriculum and education system and implementation of RKSK.

Population of 15–59 Years—Working Population

This is economically productive population. They constitute nearly 62% of India's population.

Health Implications

The health needs of this age group is a necessity for economic development. They must be healthy at home and at workplace, and do not fall sick and should have safeguards in terms of financial security in the event of sickness to prevent catastrophic expenditure. Nearly 60 million people are pushed to poverty every year in India due to catastrophic health expenditure. Health protection schemes and workplace safety for this segment of population is an imperative need for national economy and productivity.

Men and women in reproductive age group (15–49 years) constitute nearly 52% of population in India. The health implications in this age bracket are to address reproductive and sexual health of men and women—to reduce high fertility, to control STI/RTI and HIV, to reduce high maternal morbidity and mortality due to anaemia, unsafe abortions, repeated pregnancies, besides problem of oral, breast and cervical cancers and other lifestyle chronic diseases—NCDs.

Population of 60+ (Geriatric Population)

Demographic transition in India has led to increased population of older persons above the age of 60 which now constitute nearly 12% of total population of India. People live longer and life expectancy has increased to 69.7 years a sign of socio-economic development.

Health Implications

Due to demographic shift of ageing population India has to address the health problems of aged people in terms of chronic non-communicable diseases and degenerative diseases which require expensive lifelong treatment and care. To address health and social problems of elderly people is a challenging task in universal health coverage.

Population of 30–65 constitutes 37% of total population. This age group is being targeted for population-based screening of common cancers (oral, breast and cervical) and non-communicable diseases, and lifestyles management.

Competency addressed: The student should be able to:
CM 1.9: Demonstrate the role of effective communication skills in health in a simulated environment.

Objective of this skill is to arrive at community diagnosis and communication needs assessment.

Role of Effective Communication Skills in Health and Disease

Communication skills of health managers (Doctors) and workers, ASHAs and *Anganwadi* volunteers are crucial, critical and much depends on their training. Good communication skills are essential to elicit correct history (chief complaints), effective counselling and to enhance patient satisfaction.

Communication

Communication is a core competency for Indian medical graduates. Communication skills are necessary for community and patient diagnosis, satisfaction, building good relationship of trust and respect, speedy recovery and improved health outcomes besides health promotion and adopting healthy lifestyles.

How to achieve this skill

a. Listening to community or client: In community medicine "the patient" is 'community' not an individual. Listening to community you serve is the most important skill in communication. Active listening means analysing the mind of community/client. It is first step in community diagnosis and patient diagnosis.

Student listens to rural/urban community, their chief complaints and priority demands, interacts with elected leaders (formal) and informal leaders and organized groups such as village/urban health sanitation and nutrition committee, *Mahila Arogya Samiti* in urban areas, AWWs, health workers, school teachers, NGOs and family members in allotted families. Transact walk in community helps mapping of sources of water supply, excreta disposal practices, breeding places, housing, health facilities, schools, electricity and market places. Information collected by listening and direct observation is recorded in diary/practical Logbook and analysed to arrive at community diagnosis.

Active Listening

"You can't learnin' nothin' you're doin' all the takin."

—Lyndon B Johnson, US President

Listening actively is different from hearing. **Hearing** is physiological function while active listening is analysis of what is being said, how it is being said, and body language of person or client/patient/community. Listening is the key skill to effective communication. Active listening analyses the mind of persons, their profile, helps to assess their health and communication needs and community diagnosis. Listen attentively, show that you are listening, by maintaining eye contacts, nodding your head and reflecting feelings. Active listening is a part of participatory leadership and management. Most health managers spend around 50% of their time to listening, talking, writing and reading (communication). Too much of the communication between provider and client is one way. Field workers need to spend more time listening to them, than talking, discussing their health and family planning needs. Training in listening and counselling is necessary.

Interpreting Body Language

Listen to what is not being said. Communication is not only verbal, everyone communicates their feelings "non-verbally", though what is popularly called "body language", learn how to interpret body language. Learn to pay attention to body language, and be sensitive to what your staff and colleagues are trying to communicate to you non-verbally. It can help you to identify problems. Body language examples:

- Touching face frequently *means* anxiety, and discomfort
- Rubbing nose *means* anxiety, wishes to avoid
- Foot tapping *means* impatience, anger
- Elbow on table, hands forming steeple—confident, secure
- Hand over mouth *means* playing, wishes to hide, anxiety
- Avoiding eye contact *means* anxiety, distrust, discomfort, hiding.

Empathy

Empathy is part of being human in active listening. Through empathy we connect with other's emotions and share in their felt health needs/experiences. Key component of empathy is emotional connection with the person/client or community. Empathy is an experience of understanding another person's condition from their perspective by placing yourself in another's shoes and feeling what they are feeling. It is known to increase helping behaviour. Empathy includes mirroring what a person is feeling, to identify and understand another person's emotions (being happy, sad, angry, shy, nervous).

b. Speaking is another important skill. What to speak, how to speak, when to speak and whom to speak are essential elements. It means, the communicator should have latest knowledge and speak scientifically. Convey message which is sense making and has proven scientific evidence.

Speaking/Talking

Most of communication in our life is verbal/oral communication. Verbal communication by doctors to patients builds a relationship of trust and works more than healing with medicines or other interventions. Use sympathetic/empathic tone, easy to understand language, addressing or focusing on concern of audience/community talk with people not at them, people do not learn much from telling. They learn from what they think, feel, discuss, see and do together. Skill of group formation, group discussion, focus group discussion is most rewarding in gathering information.

Other communication skills are *reading, writing* and *reasoning*.

c. Reading: It means acquiring latest knowledge on health-development, health system policies and services to inform people to enhance utilization of services.

d. Writing: It means developing clear and precise health messages in local dialects, facts for health and their critical analysis. Clear and concise written job descriptions and instructions with health teams helps them to perform what is expected of them.

Writing skills: Learn to write effectively. clear writing is clear thinking. Writing effectively means your thoughts are clear, and concise. Write clear instructions for health workers. Updated, written job descriptions must be available with the health workers so that workers understand what is expected out of them. Technical directions are best written so there is no possible misinterpretation and so there is a ready reference later on. Quite often, medical officers are required to write a brief note for district collector for supporting plans of action and intersector coordination. Similarly, drafting a press release for clearance and health messages for actions or adopting healthy behaviour/lifestyle by people are other examples of writing skills. Always write in active voice; short sentences. Because of need to communicate to illiterate persons, familiar pictures/pictorials are used to convey messages. The term "visual literacy" has been used for a Person's familiarity with pictures and conventions of graphic design.

e. Reasoning: A sound skill of reasoning in communication is imperative. It involves creative thinking. Good reasoning for adopting healthy lifestyles/best practices helps promoting health, preventing diseases and health seeking behaviours and utilization of services by community.

Expected outcomes: Student contacts and interacts with community, its elected and non-formal leaders and organised groups of men and women and allotted families and households record his/her observations in logbook. Minimum frequency of contacts to be determined locally.

Competency addressed: The student should be able to:
CM 1.10: Demonstrate the important aspects of the doctor–patient relationship in a simulated environment.

Objective of this skill is to abide by the prescribed ethical and legal codes of conduct and practice to improve quality of relationship between providers and the community. Doctor is bound by medical ethics of "The physician's pledge". Nuremberg code of ethics in medical research, Declaration of Helsinki and duties of physician to their patients as per Medical Council of India. In public health, the patient is "**Community**". A typical rural health centre is responsible to a defined population of 30,000 and urban health centre to 50,000 population. **The way** in **which providers** of **public health services** are **connected** with community they serve is **known** as **community relationship**. The households, families, community, Village and Urban Health Sanitation and Nutrition Committees, ASHAs, AWWs are connected with dynamic health system of subcentres (health and wellness centres), PHCs, CHCs and district hospitals for continuum of comprehensive primary healthcare across lifecycle. The system maintains sustained contacts with the families and the community by regular home visits and outreach services, leading to community participation and satisfaction and also increased use of public health services at all these levels.

How?: "These interactions and sustained contacts must be demonstrated to the students. Students observe the ethical practices of honourable role models—faculty of medical college silently to emulate in their life later on. Thus 'faculty must practice what they teach on ethics'. Most textbooks on community medicine do not have a chapter on medical ethics. Hence, the UGs and faculty are deprived of this information".

DOCTOR–PATIENT RELATIONSHIP (DPR)

DPR as derived from "The physician's pledge" is one to one, rational, based on mutual trust, value system and is reciprocal, give and take and each one has a specific role to play. DPR is the cornerstone to patient care. Good interaction and contacts between doctor and patient enhances satisfaction. Empathy (sharing feelings of patient) and effective communication (providing correct information) builds mutual trust and avoids litigation.

Types of DPR

1 **Paternalistic model:** In this model the doctor should make all the decisions. Assumption her is doctor knows the best.
2 **Informative model:** Here doctor provides all the relevant information for the patient to make decision.
3 **Deliberative model:** Here doctor deliberates through dialogue and discussions and helps the patient to select the best treatment among alternatives.
4 **Interpretive model:** Here doctor helps the patient to articulate his/her values through interpretation and provides interpretation which is truly wanted.

Empathy and effective communication is part of therapy and is linked to outcomes of care through sustained DPR on treatment adherence, satisfaction and improved health status.

Consent: Voluntary agreement by patient to allow medically trained person to touch, examine and perform treatment. The consent is implied, or expressed consent and best is informed consent.

Duty of Care for Doctor

Qualified in modern system of medicine, is competent for giving medical advice and treatment, duty of care in deciding what treatment to give, update his/her knowledge and skills, maintain medical records, medical certificate register, display details and observe all statutory laws and regulations. **Negligence** is an offence under consumer protection Act.

Know Your Patient Well

- His/her health literacy and socio-economic status.
- His prime concern, perception of illness, outlook and attitude, health seeking behaviour, coping mechanism, his/her expectation and expectation of patient's attendants.

Patients autonomy and dignity decisions must be respected. Patients have right to seek second opinion and can withdraw from a research study anytime rights should be ensured.

Duty of Patient

As laid down by government of India and various health Acts and regulations.

Responsibilities of Patients

To keep the facility clean, avoid spitting in corners, avoid over-crowing by attendants, respecting visiting hours, not causing any harm to public property including violence against healthcare professionals.

Expected Outcomes

The student interacts with health workers and health volunteers (ASHAs, AWWs), identifies their nature and frequency of contacts with the community they serve. Students observe their acceptability and ability to organize community and documents his/her observations in the logbook for self directed learning.[10]

The new MBBS curriculum has a course called Attitudes, Ethics, Communication (AETCOM) which runs across years. It has 27 modules of 140 hours spreadover 4 years. Students will be assessed for how they communicate

with patients, how they counsel people for organ donations or other challenging procedures, how sensitively do they offer care and obtain informed consent. All these will count along with competencies. It is an ambitious course, hopefully it gets implemented. Medical faculty must demonstrate to students "the humane approach to patient and community". AETCOM cannot be taught merely by lectures/sermons, its practice must be seen to be believed. The Medical College faculty must practice it first of all. AETCOM must be integrated with different phases—pre, para and clinical phases rather than a separate dis-integrated modular, course in isolation. One such approach is clinico-social case review, problem-based learning and sustained community and family contacts as explained under pedagogy (Fig. 1.5).[11, 12]

LEARNING OF AETCOM

Learning Modules for Professional Year I—34 Hours

Module 1.1: What does it mean to be a doctor?
Module 1.2: What does it mean to be a patient?
Module 1.3: The doctor–patient relationship.
Module 1.4: The foundation of communication—1.
Module 1.5: The cadaver as our first teacher.

Learning Modules for Professional Year II—37 Hours

Module 2.1: The foundation of communication—II.
Module 2.2: The foundation of bioethics.
Module 2.3: Healthcare as a right.
Module 2.4: Working in a healthcare team.
Module 2.5: Bioethics continued—case studies on patient autonomy and decision making.
Module 2.6: Bioethics continued.
Module 2.7: Bioethics continued.
Module 2.8: What does it mean to be a family member of sick patient.

Learning Modules for Professional Year III— 25 Hours

Module 3.1: The foundation of communication—III
Module 3.2: Case studies on bioethics—Disclosure of medical errors.
Module 3.3: The foundation of communication—IV
Module 3.4: Case studies on bioethics—Confidentiality.
Module 3.5: Case studies in bioethics—Fiduciary duties

Learning Modules for Professional Year IV—44 Hours

Module 4.1: The foundation of communication—IV.
Module 4.2: Case studies in medico-legal and ethical situations.
Module 4.3: Case studies in medico-legal and ethical situations.
Module 4.4: Case studies in ethics, empathy and doctor–patient relationship.
Module 4.5: Case studies in ethics the doctor–industry relationship.
Module 4.6: Case studies in ethics and doctor–industry relationship.
Module 4.7: Case studies in ethics and patient autonomy.
Module 4.8: Dealing with death.
Module 4.9: Medical negligence–consumer protection Act.

The programme suggests a hybrid problem oriented approach to explore the various facets of "Real Life Issues" that will confront students in their careers see (Fig. 1.5).

Attitude: A human attribute indicating a particular mental state or an outlook to life. It mainly includes affective domain chiefly related to feelings, moods, settled way of thinking, thoughts and emotions and inclinations.

ETHICS IN MEDICINE (MORAL PRINCIPLES)[13]

Ethics is the branch of philosophy dealing with the distinction between right and wrong with the moral consequences of our actions (last 1989); it refers to moral issues involved in statistical investigations in medicine, the scientific integrity of the investigator and the obligations implicit in the doctor–patient relationship. Doctor is at the central stage bound by medical ethics of "The physician pledge". (WMA Declaration Geneva)

Doctor is responsible for care of sick individuals, healthcare of community and training of health teams. The ethical responsibilities extend to very large domain and in particular the area of medical ethics has become much more important *in view* of recent advances in medicine like:

- ***Genome project:*** Genetic counselling in hereditary diseases, *in vitro* fertilization, growing foetus in the womb of surrogate mothers are important areas.
- Termination of pregnancy on medical grounds (MTP Act).

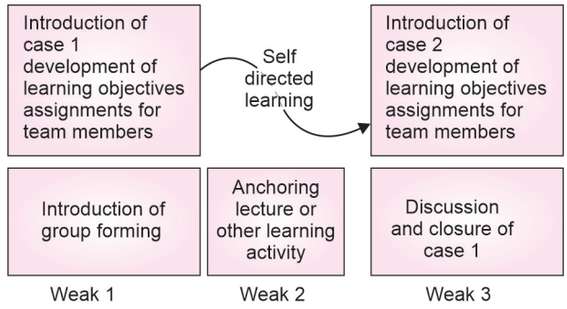


Fig. 1.5: Hybrid problem based learning suggested for AETCOM cases

- Ethics in contraceptives and family planning practices.
- HIV/AIDS.
- Legal and ethical conflicts under Human Organs and Tissues Transplantation Act.
- Vaccine and drug trials and medical research.
- Distribution and allocation of resources according to health needs of masses in urban and rural areas.
- Doctor–patient relationship.
- Health policies.
- Policies of care of terminal ill patients and voluntary passive euthanasia.

It is mandatory that every medical institution should have an ethical committee to approve the plan of research work in relation to human **beings** and **animals.**

LAWS PERTAINING TO PRACTICE OF MEDICINE

Consumer Protection Act—Avoid Negligence

(Relates to AETCOM 4.9)

- The doctors must practice medicine ethically in terms of doctor–patient relationship, avoid unnecessary investigations and consultation and avoid negligence in care. *Consumer Protection Act* (CPA) safeguards the **rights of client** and it improves the quality of medical care. Under CPA, the negligence in medical care is an offence. Negligence means that a person who holds himself ready to give medical advice and treatment implied, undertakes that he is possessing skill and knowledge for the purpose. Such a person, who is consulted by a patient, owes him certain duties, namely a duty of care in deciding what treatment to give or a duty of care in the administration of that treatment. A breach of any of these duties gives a right of action for negligence to the patient. Doctors in private practice, hospitals, clinics who charge for patient care/hospital paid by an insurance firm for treatment/hospitals having free as well as paying patients come under the purview of this Act.

Clinical Establishment Act, 2010

Main Features

- Grading of clinical establishment.
- Standard treatment guidelines.
- Protection of patient rights—such as rights to information, access to medical records informed consent, second opinion and confidentiality.
  - Standard of care and prices/fees of services.
  - Negligence and unfair practice.
  - Organ and tissue transplantation.

HIPPOCRATIC OATH

Modern Version

I swear to fulfil, to the best of my ability and judgement, this covenant (solemn agreement):

- I will respect the hard-won scientific gains of those physicians in whose steps I walk and gladly share such knowledge as is mine with those who are to follow.
- I will apply, for the benefit of the sick, all measures which are required, avoiding those twin traps of over treatment and therapeutic nihilism.
- I will remember that there is art to medicine as well as science, and that warmth, sympathy and understanding may outweigh the surgeon's knife or the chemist's drug.
- I will not be ashamed to say "I know not", nor will I fail to call in my colleagues when the skills of another are needed for a patient's recovery.
- I will respect the privacy of my patients, for their problems are not disclosed to me that the world may know. Most especially must I treat with care in matters of life and death. If it is given me to save a life, all thanks. But it may also be within my power to take a life; this awesome responsibility must be faced with great humbleness and awareness of my own frailty. Above all, I must not play at God.
- I will remember that I do not treat a fever chart, a cancerous growth, but a sick human being, whose illness may affect the person's family and economic stability. My responsibility includes these related problems, if I am to care adequately for the sick.
- I will prevent disease whenever I can, for prevention is preferable to cure.
- I will remember that I remain a member of society, with special obligations to all my fellow human beings, those sound of mind and body as well as the infirm.
- If I do not violate this oath, may I enjoy life and art, respected while I live and remembered with affection thereafter. May, I always act so as to preserve the finest traditions of my calling and may I long experience the joy of healing those who seek my help.

WORLD MEDICAL ASSOCIATION (WMA) DECLARATION OF GENEVA—OCTOBER 2017

The Physician's Pledge

As a member of the medical profession:

- **I solemnly pledge** to dedicate my life to the service of humanity.
- **The health and well-being of my patient** will be my first consideration.
- **I will respect** the autonomy and dignity of my patient.
- **I will maintain** the utmost respect for human life.
- **I will not permit** considerations of age, disease or disability, creed, ethnic origin, gender, nationality, political affiliation, race, sexual orientation, social standing or any other factor to intervene between my duty and my patient.
- **I will respect** the secrets that are confided in me, even after the patient has died.

- **I will practise** my profession with conscience and dignity and in accordance with good medical practice.
- **I will foster** the honour and noble traditions of the medical profession.
- **I will give** to my teachers, colleagues, and students the respect and gratitude that is their due.
- **I will share** my medical knowledge for the benefit of the patient and the advancement of healthcare.
- **I will attend to** my own health, well-being, and abilities in order to provide care of the highest standard.
- **I will not use** my medical knowledge to violate human rights and civil liberties, even under threat.
- **I make these promises** solemnly, freely, and upon my honour.

NUREMBERG CODE OF ETHICS IN MEDICAL RESEARCH

1. The voluntary **consent** of the human subject is absolutely essential. This means that the **consent** should be free and without force, fraud, deceit duress or any other ulterior motive. The person giving consent should have the legal capacity to do so. It should be intelligent and given only after understanding the nature of experiment, its purpose, duration, methods, its hazards and after effects that may arise out of the experiment.
2. The experiment should be such as to yield fruitful results for the good of society, unprocurably by other methods or means of study, and not random and unnecessary in nature.
3. The experiment should be so designed and based on the results of animal experimentation and a knowledge of the natural history of the disease or other problems under study that the anticipated results will justify the performance of the experiment.
4. The experiment should be conducted to avoid all unnecessary physical and mental suffering and injury.
5. The experiment should be conducted where there is a prior reason to believe that death or disabling injury will occur; except, perhaps in those experiments where the experimental physicians also serve as subjects.
6. The degree of risk to be taken should never exceed that determined by the humanitarian importance of the problem to be solved by the experiment.
7. Proper preparations should be made and adequate facilities provided to protect the experimental subject against even remote possibilities of injury, disability or death.
8. The experiment should be conducted only by scientifically qualified persons. The highest degree of skill and care should be required through all stages of the experiment of those who conduct or engage in the experiment.
9. During the course of the experiment, the human subject should be at liberty to bring the experiment to an end if he has reached the physical and mental state where continuation of the experiment seems to him to be impossible.
10. During the course of the experiment, the scientist in charge must be prepared to terminate the experiment at any stage, if he had probable cause to believe, in the exercise of good faith, superior skill and careful judgement required of him, that a continuation of the experiment is likely to result in injury, disability, or death to the experimental subject.

This code got to the subjects of consent the voluntariness of consent, the right of a patient to withdraw if he wished, and the basic question of doing things in accordance with proper medical standards and safeguards. However, among other limitations, it did not explicitly deal with the subject of children. Probably nobody at that time, thought it would be necessary. Administer the **assent** form if the respondent is less than 18 years old and take **informed consent** from the respondent parent/guardian/care-giver.

DECLARATION OF HELSINKI (it Relates to AETCOM Modules 2.5 and 2.7)

World Health Association has prepared the following recommendations as a guide to every doctor in biomedical research involving human subjects. They should be kept under review in future. It must be remembered that these are only a guide to physicians all over the world. Doctors are not relieved from criminal, civil and ethical responsibilities under the laws of their own countries.

I. Basic Principles

1. Biomedical research involving human subjects must conform to generally accepted scientific principles and should be based on adequately performed laboratory and animal experimentation and on a thorough knowledge of the scientific tradition.
2. The design and performance of each experimental procedure involving human subjects should be clearly formulated in an experiment protocol which should be transmitted to specially appointed independent committee for consideration, comment and guidance.
3. Biomedical research involving human subject should be conducted only by scientifically qualified persons and under the supervision of a clinically competent medical person. The responsibility for the human subject must always rest with a medically qualified person and never rest on the subject of the research, even though the subject has given his or her consent.
4. Biomedical research involving human subjects cannot legitimately be carried out unless the importance of the objective is in proportion to the inherent risk to the subject.
5. Every biomedical research project involving human subjects should be proceeded by careful assessment of predictable risks in comparison with foreseeable benefits to the subject or to others. Concern for the interests of the subjects must always prevail over the interest of science and society.

6 The right of the research subject to safeguard his or her integrity must always be respected. Every precaution should be taken to respect the privacy of the subject and to minimize the impact of the study on the subject's physical mental integrity and on the personality of the subject.

7 Doctors should abstain from engaging in research projects involving human subjects unless they are satisfied that the hazards involved are believed to be predictable. Doctors should cease any investigation if the hazards are found to outweigh the potential benefits.

8 In publication of the results of his or her research, the doctor is obliged to preserve the accuracy of the results. Reports of experimentation not in accordance with the principles laid down in this declaration should not be accepted for publication.

9 In any research on human beings, each potential subject must be adequately informed of the aims, methods, anticipated benefits and potential hazards of the study and the discomfort it may entail. He or she should be informed that he or she is at liberty to abstain from participation in the study and that he or she is free to withdraw his or her consent to participation at any time. The doctor should then obtain the subject's freely given informed consent, preferably in writing.

10 When obtaining **informed consent** for the research project the doctor should be particularly cautious if the subject is in a dependent relationship to him or her or may consent under duress. In that case, the informed consent should be obtained by a doctor who is not engaged in the investigation and who is completely independent of the official relationship.

11 In case of legal incompetence, informed consent should be obtained from the legal guardian in accordance with national legislation. Where physical or mental incapacity makes it impossible to obtain informed consent, or when the subject is a minor, permission from the responsible relative replaces that of the subject in accordance with national legislation.

12 The research protocol should always contain a statement of the ethical considerations involved and should indicate that the principles enunciated in the present declaration are complied with.

II. Medical Research Combined with Professional Care (Clinical Research)

1 In the treatment of the sick person, the doctor must be free to use a new diagnostic and therapeutic measure, if in his or her judgement it offers hope of saving life, re-establishing health or alleviating suffering.

2 The potential benefits, hazards and discomfort of the new method should be weighed against the advantages of the best current diagnostic and therapeutic methods.

3 In any medical study, every patient including those of a control group, if any should be assured of the best proven diagnostic and therapeutic methods.

4 The refusal of the patient to participate in a study must never interfere with the doctor–patient relationship.

5 If the doctor considers it essential not to obtain informed consent, the specific reasons for this proposal should be stated in the experimental protocol for transmission to the independent committee.

6 The doctor can combine medical research with professional care, the objective being the acquisition of new medical knowledge, only to the extent that medical research is justified by its potential diagnostic or therapeutic value for the patient.

III. Non-therapeutic Biomedical Research Involving Human Subjects (Non-clinical Biomedical Research)

1 In the purely scientific application of medical research carried out on human beings, it is the duty of the doctor to remain the protector of the life and health of that person on whom biomedical research is being carried out.

2 The subjects should be volunteers—either healthy persons or patient for whom the experimental design is not related to the patient's illness.

3 The investigator or the investigating team should discontinue the research if in his/her or their judgement it may, if continued, be harmful to the individual.

4 In research to man, the interest of science and society should never take precedence over consideration related to the well-being of the subject.

EUTHANASIA (Relates to AETCOM Modules 2.6 and 4.8)

'Thanatology' is a branch of science that deals with scientific study of death and practices associated with it. Euthanasia has its origin from Greek word, the term *Eu* means well and *Thanatos* means death and it literally means an easy death.[2] It is a form of peaceful or dignified death which is specially advocated when life becomes a punishment and dying comes as pleasure to patient, suffering from some incurable disease like cancer with severe intolerable and uncontrollable pain.

Honourable SC permits 'living will' for passive euthanasia: The supreme court recognises right to die with dignity and allows an individual to execute an 'advance directive' or 'living will' authorising someone to widhdraw his/her life support if he/she went into a permanent vegetative state (PVS) because of an incurable and irreversible medical condition. Life support could be widhdrawn only after a medical board approved it. With this verdict India joins nations such as UK, Germany and the Netherlands which have advance directive laws allowing an individual to execute a 'living will'.

But active euthanasia which involves administering some medicines or lethal injection to end life, continues to be illegal in India.

Advantages of legal recognition of brain death in terminal injury:

- It will facilitate organ transplantation.
- It will ensure economy of intensive care resources.
- It will have maximum impact in the matter of property rights, negligence claims, insurance and workers compassionate.

INDIAN MEDICAL COUNCIL (PROFESSIONAL CONDUCT, ETIQUETTE AND ETHICS) REGULATION, 2002

(Amended upto 8th October 2016
Medical Council of India

Duties of Physicians to their Patients[13]
(Medical Council of India)

Obligations to Sick *(Relates to AETCOM Modules 1.1, 3.4 and 3.5)*

2.1.1 Though a physician is not bound to treat each and every person asking his services, he should not only be ever ready to respond to the calls of the sick and the injured, but should be mindful of the high/character of his mission and the responsibility he discharges in the course of his professional duties. In his treatment, he should never forget that the health and the lives of those entrusted to his care depend on his skill and attention. A physician should endeavour to add to the comfort of the sick by making his visits at the hour indicated to the patients. A physician advising a patient to seek service of another physician is acceptable, however, in case of emergency a physician must treat the patient. No physician shall arbitrarily refuse treatment to a patient. However, for good reason, when a patient is suffering from an ailment which is not within the range of experience of the treating physician, the physician may refuse treatment and refer the patient to another physician.

2.1.2 Medical practitioner having any incapacity detrimental to the patient or which can affect his performance vis-à-vis the patient is not permitted to practice his profession.

2.2 ***Patience, delicacy and secrecy:*** Patience and delicacy should characterize the physician. Confidences concerning individual or domestic life entrusted by patients to a physician and defects in the disposition or character of patients observed during medical attendance should never be revealed unless their revelation is required by the laws of the state. Sometimes, however, a physician must determine whether his duty to society requires him to employ knowledge, obtained through confidence as a physician to protect a healthy person against a communicable disease to which he is about to be exposed. In such instance, the physician should act as he would wish another to act toward one of his own family in like circumstances.

2.3 ***Prognosis:*** The physician should neither exaggerate not minimize the gravity of patient's condition. He should ensure himself that the patient, his relatives or his responsible friends have such knowledge of the patient's condition as will serve the best interests of the patient and the family.

2.4 ***The patient must not be neglected:*** It relates to AETCOM module 4.9. A physician is free to choose whom he will serve. He should however, respond to any request for his assistance in an emergency. Once having undertaken a case, the physician should not neglect the patient, nor should he withdraw from the case without giving adequate notice to the patient and his family. Provisionally or fully registered medical practitioner shall not wilfully commit an act of negligence that may deprive his patient or patients from necessary medical care.

2.5 ***Engagement for an obstetric case:*** When a physician who has been engaged to attend an obstetric case is absent and another is sent for and delivery accomplished, the acting physician is entitled to his professional fees, but should secure the patient's consent to resign on the arrival of the physician engaged.

3. DUTIES OF PHYSICIAN IN CONSULTATION

Unnecessary Consultations should be Avoided

3.1.1 However, in case of serious illness and in doubtful or difficult conditions, the physician should request consultation, but under any circumstances such consultation should be justifiable and in the interest of the patient only and not for any other consideration.

3.1.2 Consulting pathologists/radiologists or asking for any other diagnostic laboratory investigation should be done judiciously and not in a routine manner.

3.2 ***Consultation for patient's benefit:*** In every consultation, the benefit to the patient is of foremost importance. All physicians as engaged in the case should be frank with the patient and his attendants.

3.3 ***Punctuality in consultation:*** Utmost punctuality should be observed by physicians in making themselves available for consultations.

3.4 ***Statement to patient after consultation:*** All statements to the patient or his representatives should take place in the presence of the consulting physicians, except as otherwise agreed. The disclosure of the opinion to the patient or his relatives or friends shall rest with the medical attendant.

3.4.2 Differences of opinion should not be divulged unnecessarily but when there is irreconcilable difference of opinion the circumstances should be frankly and impartially explained to the patient or his relatives or friends. It would be open to them to seek further advise as they so desire.

3.5 ***Treatment after consultation:*** No decision should restrain the attending physician from making such subsequent variations in the treatment if any unexpected change occurs, but at the next consultation, reasons for the variations should be discussed/explained. The same privilege, with its obligations, belongs to the consultant when sent for in an emergency during the absence of attending physician. The attending physician may prescribe medicine at any time for the patient, whereas the consultant may prescribe only in case of emergency or as an expert when called for.

3.6 ***Patients referred to specialists:*** When a patient is referred to a specialist by the attending physician, a case summary of the patient should be given to the specialist, who should communicate his opinion in writing to the attending physician.

3.7 ***Fees and other charges:***

3.7.1 A physician will clearly display his fees and other charges on the board of his chamber and/or the hospitals he is visiting. Prescription should also make clear if the physician himself dispensed any medicine.

3.7.2 A physician will write his name and designation in full along with registration particulars in his prescription letter head.

Note: In government hospital where the patient load is heavy, the name of the prescribing doctor must be written below his/her signature.

4. Responsibility of physicians to each others
5. Duties of physician to public and to paramedical profession

6. UNETHICAL ACTS

A physician will not aid or abet or commit any of the following acts which shall be construed as unethical.

6.1 ***Advertising:*** Soliciting of patients directly or indirectly by a physician, by a group of physicians or by institutions or organizations is unethical. A physician will not make use of his/her (or his/her name) as subject of any form or manner of advertising or publicity through any mode either alone or in conjunction with others which is of such a character as to invite attention to him or to his professional position, skill, qualifications, achievements, attainments, specialities, appointment, associations, affiliations or honours and/or of such character as would ordinarily result in his self-aggrandizement. A physician will not give to any person, whether for compensation or otherwise, any approval, recommendation, endorsement, certificate report or statement with respect of any drug, medicine, nostrum remedy, surgical, or therapeutic article, apparatus or appliance or any commercial product or article with respect of any propriety, quality or use thereof or any test, demonstration or trial thereof, for use in connection with his name, signature, or photograph in any form or manner of advertising through any mode nor shall he boast of cases, operations, cures or remedies or permit the publication of report thereof through any mode. A medical practitioner is, however, permitted to make a formal announcement in press regarding the following:

- On starting practice
- On change of type practice
- On changing address
- On temporary absence from duty
- On resumption of another practice
- On succeeding to another practice
- Public declaration of charges.

6.1.2 Printing of self-photograph or any such material of publicity in the letter head or on signboard of the consulting room or any such clinical establishment will be regarded as acts of self-advertisement and unethical conduct on the part of the physician. However, printing of sketches, diagrams, picture of human system shall not be treated as unethical.

6.2 ***Patent and copyright:*** A physician may patent surgical instruments, appliances and medicine or copyright applications, methods and procedures. However, it will be unethical if the benefits of such patents or copyrights are not made available in situations where the interest of large population is involved.

6.3 ***Running an open shop (dispensing of drugs and appliances by physicians):*** A physician should not run an open shop for sale of medicine for dispensing prescriptions prescribed by doctors other than himself or for sale of medical or surgical appliances. It is not unethical for a physician to prescribe or supply drugs, remedies or appliances as long as there is no exploitation of the patient. Drugs prescribed by a physician or brought from the market for a patient should explicitly state the proprietary formulae as well as generic name of the drug.

6.4 Rebates and Commission

6.4.1 A physician will not give, solicit or receive nor will he offer to given solicit or receive, any gift, gratuity, commission or bonus in consideration of or return for the referring, recommending or procuring of any

patient for medical, surgical or other treatment. A physician will not directly or indirectly, participate in or be a party to act of division, transference, assignment, subordination, rebating, splitting or refunding of any fee for medical, surgical or other treatment.

6.4.2 Provisions of para 6.4.1 shall apply with equal force to the referring, recommending or procuring by a physician or any person, specimen or material for diagnostic purposes or other study/work. Nothing in this section, however, will prohibit payment of salaries by a qualified physician to other duly qualified person rendering medical care under his supervision.

6.5 ***Secret remedies:*** The prescribing or dispensing by a physician of secret remedial agents of which he does not know the composition, or the manufacture or promotion of their use is unethical and as such prohibited. All the drugs prescribed by a physician should always carry a proprietary formula and clear name.

6.6 ***Human rights:*** The physician will not aid or abet torture nor will he be a party to either infliction of mental or physical trauma or concealment of torture inflicted by some other person or agency in clear violation of human rights.

6.7 ***Euthanasia:*** Practising euthanasia will constitute unethical conduct. However on specific occasion, the question of withdrawing supporting devices to sustain cardiopulmonary function even after brain death, shall be decided only by a team of doctors and not merely by the treating physician alone. A team of doctors shall declare withdrawal of support system. Such team shall consist of the doctor-in-charge of the patient, CMO/MO in-charge of the hospital and a doctor nominated by the incharge of the hospital from the hospital staff or in accordance with the provisions of the Transplantation of Human Organ Act, 1994.

7. MISCONDUCT

The following acts of commission or omission on the part of a physician will constitute professional misconduct rendering him/her liable for disciplinary action:

7.1 **Violation of the regulations:** If he/she commits any violation of these regulations.

7.2 If he/she does not maintain the medical records of his/her indoor patients for a period of 3 years as per regulation 1.3 and refuses to provide the same within 72 hours when the patient or his/her authorized representative makes a request for it as per the regulation 1.3.2.

7.3 If he/she does not display the registration number accorded to him/her by the State Medical Council or the Medical Council of India in his clinic, prescriptions, certificates, etc. issued by him/her or violates the provisions of regulation.

7.4 **Adultery or improper conduct:** Abuse of professional position by committing adultery or improper conduct with a patient or by maintaining an improper association with a patient will render a physician liable for disciplinary action as provided under the Indian Medical Council Act, 1956 or the concerned State Medical Council Act.

7.5 **Conviction by court of law:** Conviction by a court of law for offences involving moral turpitude/ criminal acts.

7.6 **Sex determination tests:** On no account sex determination test shall be undertaken with the intent to terminate the life of a female foetus developing in her mother's womb, unless there are other absolute indications for termination of pregnancy as specified in the Medical Termination of Pregnancy Act, 1971. Any Act of termination of pregnancy of normal female foetus amounting to female foeticide shall be regarded as professional misconduct on the part of the physician leading to erasing from panel, besides rendering him liable to criminal proceedings as per the provisions of this Act.

7.7 **Signing professional certificates, reports and other documents:** Registered medical practitioners are in certain cases bound by law to give, or may from time to time be called upon or requested to give certificates, notification, reports and other documents of similar character signed by them in their professional capacity for subsequent use in the courts or for administrative purposes, etc.

7.8 A registered medical practitioner will not contravene the provisions of the Drugs and Cosmetics Act and Regulations made thereunder. Accordingly, prescribing steroids/psychotropic drugs when there is no absolute medical indication; selling schedule 'H' and 'L' drugs and poisons to the public except to his patient; in contravention of the above provisions shall constitute gross professional misconduct on the part of the physician.

7.9 Performing or enabling unqualified person to perform an abortion or any illegal operation for which there is no medical, surgical or psychological indication.

7.10 A registered medical practitioner will not issue certificates of efficiency in modern medicine to unqualified or non-medical person.

Note: The foregoing does not restrict the proper training and instruction of bonafide students,

midwives, dispensers, surgical attendants, or skilled mechanical and technical assistant and therapy assistants under the personal supervision of physicians.

7.11 A physician should not contribute to the lay press articles and give interviews regarding diseases and treatments which may have the effect of advertising himself or soliciting practices; but is open to write to the lay press under his own name on matters of public health, hygienic living or to deliver public lectures, give talks on the radio/TV/internet chat for the same purpose and send announcement of the same to lay press.

7.12 An institution run by a physician for a particular purpose such as a maternity home, nursing home, private hospital, rehabilitation centre or any type of training institution, etc. may be advertised in the lay press, but such advertisements should not contain anything more than the name of the institution, type of patients admitted, type of training and other facilities offered and the fees.

7.13 It is improper for a physician to use an unusually large signboard and write on it anything other than his/her name, qualifications obtained from a university or a statutory body, titles and name of his speciality, registration number including the name of the State Medical Council under which registered. The same should be the contents of his prescription papers. It is improper to affix a signboard on a chemist's shop or in places where he does not reside or work.

7.14 The registered medical practitioner will not disclose the secrets of a patient that have been learnt in the exercise of his/her profession except:

- In a court of law under order of the presiding judge;
- In circumstances where there is a serious and identified risk to a specific person and/or community; and
- Notifiable diseases.

In case of communicable/notifiable diseases, concerned public health authorities should be informed immediately.

7.15 The registered medical practitioner will not refuse on religious grounds alone to give assistance in or conduct of sterility, birth control, circumcision and medical termination of pregnancy when there is medical indication, unless the medical practitioner feels himself/herself incompetent to do so.

7.16 Before performing an operation the physician should obtain in writing the **consent** from the husband or wife, parent or guardian in the case of minor, or the patient himself as the case may be. In an operation which may result in sterility the **consent** of both husband and wife is needed.

7.17 A registered medical practitioner will not publish photographs or case reports of his/her patients without their permission, in any medical or other journal in a manner by which their identity could be made out. If the identity is not to be disclosed, the consent is not needed.

7.18 In the case of running of a nursing home by a physician and employing assistants to help him/her, the ultimate responsibility rests on the physician.

7.19 A physician will not use touts or agents for procuring patients.

7.20 A physician will not claim to be specialist unless he has a special qualification in that branch.

7.21 No act of *in vitro* fertilization or artificial insemination will be undertaken without the **informed consent** of the female patient and her spouse as well as the donor. Such consent will be obtained in writing only after the patient is provided, at her own level of comprehension, with sufficient information about the purpose, methods, risks, inconveniences, disappointments of the procedure and possible risks and hazards.

7.22 *Research:* Clinical drug trials or other research involving patients or volunteers as per the guidelines of ICMR can be undertaken, provided ethical considerations are borne in mind. Violation of existing ICMR guidelines in this regard will constitute misconduct. **Consent** taken from the patient for trial of drug or therapy which is not as per the guidelines will also be construed as misconduct.[12]

7.23 If a physician posted in rural area is found absent on more than two occasions during inspection by the head of the district health authority or the chairman, Zila Parishad, the same will be construed as a misconduct if it is recommended to the Medical Council of India/State Medical Council by the state government for action under these regulations.

7.24 If a physician posted in a medical college/institution both as teaching faculty or otherwise will remain in hospital/college during the assigned duty hours. If he is found absent on more than two occasions during this period, the same will be construed as a misconduct if it is certified by the principal/medical superintendent and forwarded through the state government to Medical Council of India/State Medical Council for action under these regulations.

Table 1.4 gives major health problems in India

Table 1.4: Major health problems in India

Total projected population in July 2022	1412 million
Total fertility rate	2
Crude birth rate 2020	19.5
Sex ratio NFHS-5 (2019–21)	1020
Female illiteracy 2011	31.6%
People below poverty line 2012	21.9%
Human development index rank 2021	132
Disease burden	
COVID-19 pandemic-India 2nd hard hit country globally	
India's share in global disease burden 2015	19%
India's share in global incidence of TB 2020	26%
Burden of TB in India 2019–21 (prevalence)	4.3 million
Leprosy—new cases per year	1.27 lakh
HIV burden—people living with HIV/AIDS 2021	2.40 million
STI/reproductive tract infections—episodes per year	30 million
Malaria incidence per year 2020	338494 cases
Filaria cases—line—listed cases 2019	654013 cases
Iodine deficiency disorders-Endemic dist	348
Any mental morbidity in adults	10.6%
Anaemia in pregnancy	52%
Maternal mortality ratio (2018–20)	97
Infant mortality rate 2020	28
Under-five mortality rate 2020	32
Low birth weight babies	22%
Underweight children below 5 years	32%
Proportion of deaths due to NCDs	62%
Proportion of deaths due to CCDs, maternal	
Communicable, maternal, perinatal and nutritional	27%
Injuries	11%
Outbreaks—dengue, chikungunya, H1N1, JE	**Frequent**
Tobacco use in adults	28.6%
Diabetes in adults (NFHS-5)	Women 13.5% Men 15.6%
Hypertension in adults (NFHS-5)	Women 21.3% Men 24.0%
Overweight and obese	Women 24.7% Men 23%
Coronary heart disease	1.6 to 7.4% in rural and 6.5 to 13.2% in urban areas
Chronic obstructive resp. diseases	3.3 to 5.4%

8.1 to 8.7 Punishment and Disciplinary Action

If the medical practitioner is found to be guilty of committing professional misconduct, the appropriate Medical Council may award such punishment as deemed necessary or may direct the removal altogether or for a specified period, from the register of the name of the delinquent registered practitioner. Deletion from the register will be widely publicized in local press as well as in the publications of different medical association/societies/bodies.

Other Attributes for Good Doctor–patient Relationship

Being Kind

- **A friendly word, a smile,** a hand on shoulder or some other sign of caring often means more than anything else you can do. Treat others as your equals.
- **Treat the sick as person/people:** Be especially kind to those who are sick or dying, and be kind to their families. Let them see that you care.
- **Have compassion:** Kindness often helps more than medicine. Never be affraid to show you care.
- **Practice what you teach** (or who will listen to you) people are more likely to pay attention to what you do than what you say.

Note: Ten competencies of Chapter 1 are thematic in nature, applicable to the entire subject of community medicine and rest of the topics/chapters and national health programmes. These competencies build a theme on the subject. Most of these competencies are overlapping and inter-related. Challenge for teacher is to organize lesson plans in such a manner that it links a competency to specific national health programme as described in the textbook.

PRINCIPLES AND PRACTICE OF MEDICINE IN HOSPITAL AND COMMUNITY

The approaches in clinical medicine and community medicine are distinct. The purpose of this elucidation is not to undermine the discipline of clinical medicine or hospitals, but to emphasize that the 'medicine as a social science' has much wider scope and bigger responsibility. The preventive and social medicine/community medicine specialists have to be best physician first to accomplish the tasks in the community. The areas and skills of two disciplines are clear cut and distinction has been drawn between the two to enhance the understanding of students of community medicine. Clinical medicine and preventive and social medicine (community medicine) need each other and interdepend and inter-relate in many of the critical areas; however, the approach differs (Table 1.5).

The prevention is not the monopoly of preventive and social medicine alone the 'preventive outlook and attitude of mind' applies equally to all branches of medicine and its specialities. All branches of clinical medicine—surgery, obstetrics and gynaecology, paediatrics or any of their sub-specialities, aim at early diagnosis and prompt treatment and application of health promotive and preventive aspects in their respective speciality.

Table 1.5: Principles of practice of medicine in hospital and community

Areas/outlook	*Clinical medicine*	*Community medicine/preventive and social medicine/public health*
Focus	Treats individual/disease	Treats community (holistic approach), prevents spread of disease
Concern	Sick persons (individual)	Both sick and healthy people (community)
Responsibility	Of those who come to seek help	Whole community (defined community)
Goal	To relieve symptoms, signs and to cure patient	• To eliminate and eradicate disease • To reduce incidence and prevalence of diseases
Skills/competence	Clinical skills	Epidemiological, biostatistic and managerial skills
Treatment/prescription	Treats patients with pills, drugs, injections and therapeutics	• Treats causes through national health programmes • Treats environments—safe water—safe excreta disposal • Raises community immunity by mass immunization • Mass treatment like MDA for filaria—mass deworming, vitamin A prophylaxis • Iodized salt • DOTS (directly observed treatment, short course chemotherapy) • Health legislation and behaviour change communication
Workstation	Hospitals and special clinics	Health centres, community/institutions
Teaching training	Bedside—patient side	In community
Diagnostic and evaluation tools	Uses clinical parameters (treatment success rate)	• Uses epidemiological tools: – Surveys, surveillance and outbreak investigations – Health records and epidemiological studies – Reduction of disease, death, and disability rates
Requirement	Patient compliance and cooperation	Community participation/community organization
Intersectoral coordination	Mainly health sector	Intersectoral coordination is essential between health, ICDS, education, development and agriculture
Results	Quickly achieved and visible	Takes longer time to see the results
Laboratory	Hospital wards	Community

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CHAPTER

2

Relationship of Social and Behavioural Sciences (Humanities) to Health and Disease

"Know the community you serve before knowing medicine"
"In community medicine the concern is community"

HISTORICAL DEVELOPMENT OF MEDICINE AND SOCIAL SCIENCES FROM SYMPTOMS TO UNIVERSAL HEALTH COVERAGE

BEFORE 1850: EMPIRICAL ERA

Focus during this era was on symptoms. Accordingly the art of medicine revolved around treatment of **symptoms** only.

1850 TO 1900: BACTERIOLOGICAL ERA (BASIC SCIENCE ERA)

Focus—in this era basic sciences of medicine developed and **focus** shifted to causative organisms and **disease**. Medicine became science and microorganisms of various diseases were discovered and grown on cultures. Koch's postulates were developed, stating that:

a. The micro-organism must be present in every case of disease as a necessary cause.
b. One should be able to isolate the organism on culture.
c. The isolated organism when inoculated should be able to produce disease in susceptible host.
d. The organism must then be recovered from the host and identified.

The Koch's postulates are not wholly true in all circumstances as we may not be able to isolate *Mycobacterium tuberculosis* from all those persons who have TB disease.

1900–1950: PREVENTIVE MEDICINE AND CLINICAL SCIENCE ERA

This was an era of preventive medicine, social and clinical sciences.

Focus—shifted to diagnosis and treatment of a **patient**. The whole approach became **patient** centred (Table 2.1).

1950–1977: COMMUNITY MEDICINE/COMMUNITY HEALTH OR PUBLIC HEALTH ERA

Focus—shifted from individual patient diagnosis and treatment to **community diagnosis and treatment** or **community health** or **public health.** Whole community should be the concern of **medicine as social science**.

1978 ONWARDS HEALTH FOR ALL ERA

World Health Organization in the year 1977 adopted a strategy of 'health for all by 2000 AD' through 'comprehensive primary healthcare approach' which holds the ground even today. **Focus** remains to achieve good health in all—whole India.

Now the nation is committed to achieve 'universal health coverage' by adopting revised National Health Policy of 2017.[1]

"Nation's greatest asset is its people".
Have a Good Look at your Community.
"Know community before knowing medicine"

What is Community?

Definition: There is no universal definition of community. "Community often refers to a group of people residing in a specific geographical area, who have common interests, heritage, common bonds and shared assets and common socio-economic patterns". Community size could be a village, a group of villages or as big as a country—like India. Community could be rural, urban or tribal community.

For the practice of community medicine/community health/public health, understanding and knowledge of community is essential. "Know the community you serve before knowing medicine".

Concept of Rural Community: A Case Study[2]

India is a land of diversities. It has 28 states and 8 union territories. Nearly 66% of population lives in rural areas

Table 2.1: Historical development of medicine as social science from symptoms to universal health coverage

Period →	*Before 1850*	*1850–1900*	*1900–1950*	*1950–1977*	*1978–2017 and beyond*
Eras →	Empirical health era	Bacteriological or basic science era	Preventive medicine and clinical science era	Community health or public health era	Health for/in all era 'universal coverage'
Focus →	**Symptoms** →	**Bacteria or disease** →	**Individual** ⟶	**Community** ⟶	**Community**
Sciences →	Unknown	Basic sciences	Social sciences and clinical sciences (Humanities)	Community health sciences (social and managerial sciences)	Community health sciences, behavioural sciences, and management sciences

in 663049 villages. Rural communities are scattered in small villages, or hamlets which may be difficult to reach. Rural people are engaged primarily in agriculture or farm work, nearly 40% are landless labourers and work as manual casual labourers. About 85% of the farmers are small (with 1–2 hectare land) and marginal (with up to 1 hectare land) farmers. Their relationships are intimate, kinship is very strong and most families are joint families and caste system is very strong. The system of governance is by local self government (Panchayati Raj Institutions—PRIs), which is a three-tier structure—**village, block** and **district** (as recommended by Balwant Rai Mehta Committee in 1957 elaborated in Table 2.2).

All adult members, above 18 years of the village constitute *Gram Sabha* who have voting rights and they keep a watch over the functions of village *Panchayat*. Village *Panchayat* has a responsibility to register births and deaths and is responsible for village development. State Government has transferred the **funds, functions,** and **functionaries** to village *Panchayat* for health developmental activities. Block development and Panchayat officer (BDPO) is an executive officer of *Panchayat Samiti* at the block headquarter who executes the development activities planned by PRIs. Village *Panchayat* gives land for construction of sub-centres, schools, *Anganwadis* and other institutions. Over 5.55 lakh VHSNC are functional.

Khap Panchayat

Khap Panchayat is the union of few villages. Generally there are 10–15 members who constitute the *Khap panchayat*. *Khap Panchayat* is concerned with the affairs of the *Khap* it represents. Lately, they have emerged as Qasi-Judicial bodies that pronounce harsh punishments based on age-old customs, and traditions often bordering on regressive measures to modern problems. These institutions have no official government recognition or authority and not governed by law, but it can exert significant social influence within a community. These exist mostly in North India—UP, Haryana and Rajasthan.

Rearing cattle is almost universal in a village. Cattle sheds are located near dwellings and animal excreta is disposed of or dumped near to dwellings. Many people defecate in open (33%) and do not have toilet/use toilet which lead to soil pollution, worm infestation and water pollution. Sources of water supply are hand-pumps, wells and piped water supply.

Inequities in Mortality and Fertility

Rural community has high birth rate of 21.1, per 1000, high death rate of 6.4 per 1000 population and high infant mortality rate of 31 per 1000 live births (SRS 2022). Density of population is low. Each village has common land *(shamlat)* meant for generating revenue for village *Panchayat*.

Concept of Urban Community: A Case Study

Census of India defines urban area as: (a) All areas with municipality, corporation, cantonment board or notified area committee; (b) place satisfying the following three criteria simultaneously—a minimum population of 5000, at least 75% of males working population engaged in non-agricultural vocations and density of population at least 400 per square km.

In India, 34% of population lives in urban areas. Urban community is different from rural community. In urban

Table 2.2: Three-tier system of local self government (PRIs)* local rural bodies

Levels	*System of administration/Governance*	*Membership*
Village	*Gram Panchayat*	*Sarpanch* (village headman) and members of Panchayat who are directly elected from village, one-third seats are reserved for women
Block	*Panchayat Samiti*	All *Sarpanches* and president
District	*Zila Parishad*	All presidents of *Panchayat Samitis*

*PRIs (Panchayati Raj Institutions), under the landmark 73 constitutional amendment Act of 1992 PRIs are local self governments, delegated and made responsible for 29 subjects including primary healthcare, education and family planning.

areas, **class** rather than caste is a stronger system. People are primarily engaged in non-agricultural vocations. Density of population is very high and land cost is very high. The system of governance is by municipal committees/ corporations, or cantonment board.

Urban Local Bodies

Each census ward elects a municipal commissioner/ counsellor. Each municipal committee or corporation elects its president/mayor.

One-third of urban population or even more than that lives in urban slums with deplorable or sub-human conditions; living in **households** of poorly built localities usually with inadequate infrastructure and unhygienic environments lacking in proper sanitary and drinking water facilities. Urban dwellers have less interaction with each other and live in isolation. Most families are nuclear families. The occupation is business, service or industrial work. Urbanization is inevitable. Most health parameters for urban areas are much better except in urban slums which may be worse than rural areas. Urban birth rates are low at 16.1 per thousand, death rate is 5.1 per thousand population and infant mortality rate of 19 per thousand live births (SRS 2022). Health facilities in urban areas are well developed in terms of hospitals, nursing homes, private practitioners and public health services.

Tribal Community

About 8.2% of population of India is tribal population. These people live in forest areas, hilly area which are difficult to reach, without much civic amenities. Their socio-economic status is poor and they are marginal communities with minimum access to health facilities. Health facilities and health infrastructure in these areas are poorly developed and so is the road infrastructure. Tribals are marginal farmers and practice shifting cultivation. Health facility norms for population coverage have been relaxed for tribal areas.

Tribal areas are most vulnerable to—falciparum malaria, with problem of drug resistance, tuberculosis, sickle cell anaemia, thalassaemia and glucose-6-phosphatase deficiency (G6PD). Their customs and cultural practices have profound effect on health.

Female sex ratio is better in tribal areas, breastfeeding practices are universal.

Thus, knowing your community is an imperative need for the practice of community medicine. Take a good look at your community, respect your people, their traditions, ideas and culture and help them build on the knowledge and skills they already have. It is a common proverb:

"Go in search of your people
Love them, learn from them
Plan with them, serve them
Begin with what they know
Build on what they have."

Assess Felt Needs

What things in your people's daily lives (living conditions, lifestyles, ways of doing things, beliefs, etc.) do they feel help them to be healthy? What do people feel to be their major problems, concerns and needs—not only those related to health but also in general?

1. *Felt-needs:* Means what people feel are their biggest problems?
2. *Real needs:* As determined by experts and steps people can take to meet these problems in lasting way.
3. Willingness or readiness of people to plan and take the needed steps.
4. *Resources:* 'People' themselves are the biggest resource. People count first in resources, their skills, materials, and/or money needed to carry out the activities decided upon.

Example: Let us suppose that a man who smokes a lot comes to you complaining of cough that has been steadily getting worse:

1. His felt—need is to get rid of cough.
2. His real need is (to correct the problem) to give-up smoking.
3. To get rid of his cough will require his willingness to give-up smoking. For this he must understand how much it really matters.
4. One resource that may help him to give-up smoking is information about the harm it can do to him and his family. Another is the support and encouragement of his family, his friends and you.

Self-help

For how many of their problems, can people care for themselves? How much outside help is required? Are people ready to generate resources and cooperative to solve their problems? Do people work together to meet common needs? Do they share or help each other when needs are great. What are their opinions to make the village better and healthier place to live? Where might you and your people begin?

COMMUNITY PARTICIPATION IN HEALTH MANAGEMENT AND DEVELOPMENT[3–5]

Goal of 'health' cannot be achieved without community participation as the people are the most important resources for health and development. Community is the 'heart' of health system.

What is Community Participation?

"Community participation is a process by which individuals and families assume responsibility for their own health and welfare and for those of community and develop capacity to contribute to their and the community's development".

Types of Community Participation

i Community takes the responsibility to manage health services at village level, e.g. management of sub-centres by village *Panchayat* (women members of PRIs).

ii Community generates its own resources to maintain the building of a sub-centre and construction of sub-centres and schools.

iii Community itself plans or determines their health needs and priorities and work hard to meet these needs.

iv Community organises the programme and implements the programme with their own resources plus resources provided by the government.

v Community monitors the government run programmes and provides feedback to the system.

vi Community evaluates the health programmes and gives its report card to government for necessary corrective actions.

Rogi Kalyan Samiti at PHC, CHC, *Mahila Arogya Samitis* in urban health centres, village and Urban health sanitation and nutrition committee and Mahila Mandals at village level have been constituted to enhance community participation in health and development.

Competency addressed: The student should be able to:
CM 2.2: Describe family types, its role in health and disease.

How?

Student interacts with family regularly and follows it longitudinally.

TYPES OF FAMILY AND ITS ROLE IN HEALTH AND DISEASE

Family is a universal institution in all the cultures. In India, family occupies a pivotal position and is a significant system in the social fabric. The family thus is a biological unit, or a social unit and a universal institution in every society.

Several definitions of family have been given from time to time; some of these are being reproduced:

- McLver defines family as "a group defined by a sex relationship, sufficiently precise and enduring to provide for the procreation and upbringing of children".
- According to Burgess and Locke, a family is "a group of persons united by ties of marriage, blood or adoption, constituting a single household, interacting and inter-communicating with each other in their respective social roles of husband and wife, mother and father, son and daughter, brother and sister, creating a common culture".
- Ninkoff defines a family as "a more or less a durable association of husband and wife with or without children or a man or woman along with children".
- Elliot and Merrill define family as "the biological social unit composed of husband, wife and children".
- The definition given by Bureau of Census (USA) is easier. According to Bureau, the family is "a group of two or more persons related by blood, marriage or adoption and residing together."

Household

The term family differs from household, in that, all members of household may not be blood related, e.g. servants.

House and Household[6]

The term 'house' means a structure with a single roof, where one or more than one family may be residing during the enumeration of population.

The number of households in a house is determined according to number of kitchens (*Chulahs*) in a house. For examples, if there are four families living in a house and their food is being cooked in three kitchens, the total number of households will be three. In a house, there may be more than one household and each should be assigned a separate identity number.

Definition (NFHS-5): A person or group of related or unrelated persons who live together in the same dwelling unit (S), who acknowledge one adult male or female as the head of the household, who share the same housekeeping arrangements, and who are considered as single unit.

Characteristics of Family

Out of these definitions, the following characteristic can be summed-up:

- ***A mating relationship:*** The family comes into existence when a man and woman establish mating relationship between them. The relation may be of shorter duration or lifelong. When a marital relation breaks down, the family disintegrates.
- ***A form of marriage:*** Mating relationship is established through the institution of marriage, it may take one of the several forms, monogamous or polygamous, partners may be selected by the parents or elderly persons in the family in arranged marriages or an individual himself/herself may select the partner.
- ***A common habitation:*** Family lives in home or household for child bearing and rearing.
- ***System of nomenclature:*** Every family is known by name and it has its own system of reckoning and descent. The descent may be reckoned through the male line or through the female line. Usually the wife goes and joins her husband's relatives but sometimes husband also may go and join his wife's relatives (in North-east India).
- ***An economic provision:*** There is some source of income to sustain economic needs of the family. Head of the family performs certain vocation to earn money.

Types or Forms of Families

The families can be classified on the basis of authority or else on the basis of structure.

On the basis of authority vested the families can be either:

- *Patriarchal:* Where male member as head of family is authority in decision-making and controlling the family affairs and the female is subordinate. Patriarchy defines life patterns and culture and even way men and women think about one another. The descent is recokned through the male line.
- *Matriarchal:* The authority is vested in female head of the family. Now 18% of households are headed by women.

On the basis of marriage pattern, the family may be classified as:

- *Monogamous* in which one man marries one woman. Only such a marriage where there is only one regular trusted sexual partner and both are free from HIV infection have no chance of acquiring sexually transmitted infections like HIV and other STDs.
- *Polygamous family:* Husband has more than one wife or multiple sexual partners, such a marriage relationship in these families involves the greater risk of transmission of STDs and HIV infections.
- *Polyandrous family:* In this kind of family, one woman marries many men and lives with all of them or with each of them alternatively. This also involves the risk of multiple sexual partnership. If it is regular partnership the risk of HIV transmission is somewhat less but certainly it carries more risk if the partnership is irregular and involves multiple sexual partnership behaviour.

Similarly, the family could belong to various groups as per sanctions of marriage.

An endogamous family is one which sanctions marriage only within members of in-groups. **Consanguineous marriages**, i.e. marriages amongst cousins have more risk of transmission of genetic disorders.

An exogamous family is one which sanctions or allows marriages of in-groups with members of an out-group. Such a marriage carries low risk of transmission of genetic disorders.

On the basis of the structure, the family has been classified as nuclear, joint or extended family.

Nuclear Family Socio-cultural Factors

Nuclear family is one which consists of the husband, wife and their children who stay together. These types of families are common in urban settings when the male adult members get married, they leave their parental home and start their life as an independent unit. Compelling reasons for development of nuclear family are—the male member getting an employment in urban settings far away from parental house or the newly married couples wish to stay away from their parental house. Industrialization, urbanization and employment pattern are some of the compelling reasons for development of nuclear family. In a nuclear family, both the parents may be employed for the job or work for wages, children are left under the care of some agency or at home under the care of servant.

The strain and stress of bringing up children (feeding and care) is real in nuclear family. If the wife is housewife, the worry of care of child gets reduced. The development of children in such families is a challenge. The extra-familial institutions, such as creches, child care centres, balwadi centres or nurseries are utilised for the care and development of young children by most nuclear families.

Joint or Extended Family

The culture of joint family is widely prevalent in rural India and even in urban areas. Married couple/couples live with their parents. The children of these couples are looked after by the grandparents as the men and women are away for field work or are in the job. The joint family shares the common kitchen. All the property is held in common; including land. To save the land from division or fragmentation, joint families played their pivotal role. The authority is vested in the eldest member who is the head of the family/household. Joint family is characterised by large size, common residence, common purse, common kitchen and common land and there is great degree of inter-dependency.

The merits of joint family are—it provides social and economic security to all its members—working, non-working, old age people and young children, sick people, widows and handicapped/disabled. The widow's re-marriage is common and it is a kind of rehabilitation to save the property in the name of joint family.

Apart from merits, there are several demerits of joint family, such as it hinders the development of personality, privacy to couple is least, and it leads to uncontrolled births. Merits overweigh demerits.

Three Generation Family

It is also a joint family but it denotes that three generations stay together and share common house and kitchen. Grandparents, their married sons and their offsprings are an example of three generation family.

Functions of Family/Roles in Health and Disease

Biological Function

The basic/essential function of family is to bear children and propagate its progeny. Bearing and rearing children is to preserve its species. In the process of bearing children, there may be too many children, which add to the size of family and in some states like Bihar, Rajasthan, Uttar Pradesh and Madhya Pradesh, the family size tends to be large and acceptance of contraception may be low. Biological function should have emphasis on quality of life.

The total fertility rate has declined from 6.0 (1951) to 2.0 in 2021, which is below the replacement level of fertility of 2.1. Interruption of biological function by contraception adds on, the essential responsibility of ensuring the survival of the children born as also adequate quality of life by health services.

Rear Children

Rearing children is another essential or obligatory function. Rearing children means nurturing; transmitting values and culture till such period the children attain adulthood and become independent. Rearing practices vary from culture to culture and family to family. Child learns moral values and develops 'lifestyle' within the family as family and parents are eternal and first school of learning for a young child. The basic values and practices are transmitted from parents and family members to their children/offsprings. In this process, the parents and other family members have to be good role models for their children.

Child may acquire the habit of smoking from parents or grandparents, habit of use of toilet, brushing teeth, washing hands and personal hygiene is acquired in the family. Family needs to be supported in this function by all other social institutions like *Anganwadi* centres, creches, *Balwadis* and formal system of schools. The total child development and growth is family-based but conditioned by the environments. Seeds of NCDs are sown during childhood period.

Culture Transmission

The family is an institution that transmits traditional values, ideals, beliefs, practices and traditions. The child who is born in the family is a 'clean slate' and he imbibes and learns the values, beliefs, practices from his family. Some of the things which cannot be taught by any other institution are best learnt within the family.

Security

Family provides social and income security to its members. It provides shelter, food, clothing and other necessities of life to dependent members. Similarly, family provides security to old age person, to sick and disabled person. Mentally retarded and other disabled are best cared for in the family. Old age homes are homes away from home and do not provide family environments hence family in Indian set-up is the best institution for care of the elderly people. All efforts should be directed to sustain and maintain the institution of family.

Shaping Personality and Lifestyles of an Individual

Family takes pride in shaping of personality of an individual. Behaviour pattern of a person, obedience, respectfulness, cooperativeness, truthfulness, discipline, self-reliance, ability to stand against stress, gender respect, develops in the milieu of family. Children learn by imitation and this learning can be further enhanced by extra-familial institutions like non-formal education imparted through ICDS *Anganwadi* workers and continued through the formal education system of school.

Thus, family is sheet anchor for sustaining and providing social and economic security, developing life styles, personality traits and transmission of values and culture to its members.

Family Size

In general, the family size means total number of persons in a family, however demographically it means the number of children a woman has born at a point in time. The total fertility rate (TFR) means the average number of children born to a woman during her lifetime or else the number of children that would be born per woman if she was to live to the end of her child-bearing years (15–49 years) and bear children at each age in accordance with prevailing age-specific fertility rate (see measures of fertility).

$$\text{TFR} = \frac{5 \sum_{15-19}^{15-49} \text{Age-specific fertility rate}}{1000}$$

During the year 1951, the TFR was 6.0. The current level of TFR is 2 (2019–21), which is below the replacement level of 2.1, this in other words means two child norm. In states like Bihar, Meghalya, UP, Jhharkhand and Rajasthan it is still higher than national level.

The large size of the families in these states is attributable to early marriages, lack of practice of contraception due to illiteracy, ignorance and poverty, unfavourable attitudes and disbelief in contraception. These states are very **high focus states** for Family Planning Programme.

Large-sized family means where the number of children are more than average of the nation, these families are high risk families.

Broken Family

These are those families where the parents have separated or divorced due to disharmony or else one or both parents have died and the children become orphans. Such a situation profoundly affects the physical, social and mental development of children since the family support is lost or it is partial. Children of such families may drift to abnormal development and likely to develop behavioural problems. *Orphanages* provide support to such children.

Broken homes are due to inter- and intra-family quarrels and is the bed rock on which personality and psychological breakdown starts in children.

Problem Families or High-risk Families

Such families like large-sized families, families below poverty line, broken families, addiction in husband, and long illness of child or in any other member are called

problem families and these families need to be targeted as priority families for healthcare, social development and poverty alleviation. Children in these families run the risk of poor health, development problems and social problems.

Role of Family in Health and Disease—Gender Inequities

The family would be referred and quoted in all 'lifestyle diseases', 'chronic non-communicable diseases' and 'behavioural problems' because all have their origin at the place of living and in the family and the natural history of disease can be traced to the setting of family. The first response to an illness of young children or any other falling ill comes from family. It is the family response which matters most in child survival may it be initiation of breastfeeding, exclusive breastfeeding, infant and young child feeding practices, administration of home available fluids (HAF) in diarrhoea, continuing feeding during diarrhoea, smokeless kitchen, supplementary feeding, spacing and limitation of births, home delivery/institutional delivery, seeking antenatal care, immunisation services and treatment of tuberculosis, the decisions of family are critical. Therefore, the families need to be empowered and well informed and supported by all the primary health centres, sub-centres, ICDS system, education and development department. How this support comes is a matter of national, state, district and local policy of village Panchayat. Disparity between boys and girls and adverse sex ratio (gender discrimination) is ultimately family or at the most a community choice.

Food availability at the household level is seldom a problem for children between the ages of 6 and 24 months, the amounts required are small, the issue is proper care and attention to child's need and attitudes of the family which deliberately denies food (cereals) to children, due to wrong beliefs.

Social attitudes at the family level are at heart of environmental concerns. Much of the hygiene and sanitation is in the mind, rooted in conceptions of purity, pollution, and dignity of labour. Family level storage of drinking water and its use, protection from contamination by use of clean hands are decisions of the family. Safe disposal of garbage, refuse, waste water and excreta disposal are ultimately the decisions of the family. Sanitation costs nothing when people cooperate and take it by themselves. People's programme on sanitation succeed but government programmes on sanitation quite often fail. Sanitation and hygiene is essentially a way of life deep rooted in the cultural practices and only determined efforts of families can make it successful.

What people do with their lives and those of their children affect their health far more than anything that governments do but what they can do is determined, to a great extent, by their income and knowledge—factors that are not completely within their control.

Poverty reduction programmes and universal elementary education and education for all especially for girls (*Sarva Shikhsha Abhiyan*) by the government if pursued and implemented vigorously can change the scenario. Similarly, primary healthcare for all can make the difference.

Competency addressed: The student should be able to:
CM 2.1: Describe the steps and perform clinico-social cultural and demographic assessment of the individual, family and community.

Objective

The main objective of this competency is to assess community health needs, cultural and demographic profile of community and its implications on health

How?

The student uses household survey register data and village/urban ward information to assess clinico-social, cultural and demographic profile of individual, family and community.

Steps in Assessment of Clinico-social Cultural and Demographic Profile of Individual, Family and Community

Household Surveys (HHS) and Village Health Survey

The primary healthcare is reaching families through network of Sub-centres, PHCs, CHCs, *Anganwadis* and ASHAs. This appears to be the major means of reaching families. It is mandatory for health workers female, ASHA and *Anganwadi* workers to maintain family records of each household. This **household survey register** (family register) connects families to the system of sub-centres and *Anganwadis* under ICDS. Household register is updated once every year and it forms the basis of formulation of village and sub-centre action plan and **community health needs assessment.** The health needs and health practices of each family and family member are assessed by the health workers by establishing contacts with each family. The household survey register provides wealth of information relevant to the health and action to be initiated/undertaken by the worker. The objectives of household survey are:

i To assess community health services needs

ii To assess the clinico-social, cultural and demographic profile and health status of each individual in the household and its environment and for identifying beneficiaries for initiating relevant healthcare activities/services.

iii To identify high risk households or families. The information of household survey register consists of—**household information** and **individual information**.

The household information consists of:

Household no. Resident/ migrant	*House no.*	*Family type*	*Nuclear/ joint*
Religion	Caste	Source of drinking water	Storage practices
Monthly income	Above poverty line	Below poverty line	Type of latrine used
Type of house	Katcha–pucca–semi-pucca	Ownership of house	Own/ rented
Number of rooms	Separate kitchen	Type of fuel used	Electricity
Assets	TV–radio	Other assets	Motor vehicle, tractor
Breeding places of mosquitoes and flies	Land holding	Cattle wealth	Garbage and waste water disposal

- The information on individual is given in Table 2.3.

Village Health Register/Census Ward Register

Household surveys are carried out village wise by health team. This generates information on socio-cultural and demographic profile of each village. Village Health Sanitation and Nutrition Committee is responsible for preparation of Village Health Action Plan based on village health register data/information. Essentially village health register provides information on demography—total population, agewise population structure, total number of households and families, eligible couples,, infants, pregnant and lactating mothers, sources of drinking water and sanitation facilities, health facilities, health teams (ANMs AWW, ASHA, male worker) formal and informal leaders, schools, village practitioners, major health problems, health behaviour/practices and health seeking behaviour, of community besides births and death data. Urban ASHAs and AWWs prepare census ward register under the supervision of urban health centre ANMs and supervisors.

Armed with this information the health workers, *Anganwadi* workers and ASHAs are required to visit 10 families per day and to cover the entire area within 3 months period. The priority houses where visit is required are chosen and priority includes:

- Eligible couples. Large-sized families.
- Pregnant women—unregistered.
- Registered pregnancy with any complications or not turning-up for second dose of tetanus toxoid/or IFA tablets.
- Postnatal case not seen after delivery.
- A low birth weight neonate.
- A new acceptor of oral pill/IUD.
- Child with suspected pneumonia.
- Child with diarrhoea with some dehydration.
- Child with vitamin A deficiency not turning up for second therapeutic dose.
- An infant not turning up for immunisation.
- Follow-up after tubectomy and follow-up of referred to PHC/CHC/hospital by you.
- A person acutely and seriously ill.
- A child who has had an adverse reaction to any immunisation.
- Maternal, neonate or child death.
- A recent case of acute flaccid paralysis.
- Severely malnourished child.
- Follow-up patients of diabetes and hypertension.

In summary, it includes priority houses of 'scheduled caste, below poverty line families or landless families', and families having either infant or pregnant woman.

Before making home visits, the workers are required to look into the relevant individual mother and child protection card, immunisation card, or family record and note the urgency of the health needs. The workers review any procedures to be carried out, specific advice to be given or demonstration to be done. Workers carry the required articles and records with them and visit the priority houses/ families.

Expected outcomes: The student analyses the household survey data and prepares demographic profile of community/family. He/she enlists observed way of life such as garbage and excreta disposal, cooking fuel used, water storage practices and food distribution within the family, literacy, occupation, income and common illnesses suffered in the last one month and healthcare utilized.

Competency addressed: The student should be able to:
CM 2.2: Demonstrate in simulated environment the correct assessment of socio-economic status.

Table 2.3: Individual information at household level (demographic and socio-cultural assessment)

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Name of head of house-hold	Name of members of house-hold	Age in years DOB	Sex	Relation to head of house-hold	Marital status	Occupation and literacy	Immunization status of children (under 2 years)	Illness in last 1 month	Disability if any	Marriages, pregnancy, births, deaths in the last year	Health-care utilization and expenditure

Objective

The objective of this competency is to identify the deprived households/families and vulnerable populations and priority groups for health services.

Correct Methods of Assessment of Socio-economic Status (SES) of Individual and Family

How?

The socio-economic status of family can be determined by the student on the basis of *education*, *occupation* and *income* level. Based on these variables, socio-economic status has been measured by following methods.

Kuppuswami's Method (for Urban Area)

Kuppuswami's method takes into consideration the education, occupation and monthly income of family to classify or determine socio-economic status. Each component is given a weighted score and then the total score is summed-up and the individual/family can be classified into a socio-economic class I, II, III, IV and V as illustrated in Table 2.4. The level of income is generally updated on the basis of consumer price index (CPI).

Udai Pareek's Method (for Rural Areas)

Pareek has evolved to determine socio-economic scale and class for rural area. It takes into consideration—caste, occupation, education, land holding, social participation, family size, housing and farm power and material possession. Each of these components is given weighted score and by summing-up all the components the SES can be determined and categorised into several classes, as given in Table 2.5.

This way individuals and families can be classified into a socio-economic class. Income may be concealed and it may not be easy to determine. To determine the level of poverty, these criteria can be adopted to classify the family as below poverty line (BPL) or above poverty line (APL).

Prasad's Method (1961) Modified in 2018[8]

Socio-economic status of family can also be known by criteria proposed by BG Prasad in 1961, which includes per capita monthly income of an individual as given in Table 2.6.

Standard of living index (SLI) based on household amenities and possession of some selected household items, the SLI can be developed by allocating scores to items. The total of scores may vary from lowest of 0 to maximum of 40. On the basis of total score, households are divided into three categories as:

a. Low—if total score is less than or equal to 9.
b. Medium—if total score is greater than 9 but less than or equal to 19.
c. High—if the score is greater than 19.

These three categories of SLI have been used in district level household surveys and NFHS in India (Table 2.7).

Socio-economic criteria determine the level of 'well-being', lifestyles, and utilization of services apart from social status and recognition and position in the society. Wealth does not ensure or guarantee good health as wealthy may adopt unhealthy lifestyles. Poor may spend money on alcohol or tobacco and wealthy persons may smoke, drink and consume unhealthy diets (more saturated animal fats, animal food, etc.). Income level or socio-economic status of families can be assessed by rapid observation methods in community and family can be described as economically well-off or economically weaker or middle class family. Middle class income families in India are under transition and obesity, hypertension, coronary heart disease and diabetes (all lifestyle diseases) are emerging in this socio-economic class, while poor families bear the brunt of malnutrition, repeated infections due to diarrhoeal diseases, acute respiratory infections, TB and worm infestation, due to overcrowding, poor housing and insanitary conditions.

Table 2.4: Revised Kuppuswami's method of social classification of an individual (urban areas), updated Jan 2018[7]

Components	*Weighted score*	*Components*	*Weighted score*
(A) Completed educational qualification of head		**(C) Monthly income of family (2018)**	
• Professional or honors	7	• >1,26,360	12
• Graduate or postgraduate	6	• 63,182–1,26,356	10
• Intermediate/post high school diploma	5	• 47,266–63,178	6
• High school certificate	4	• 31,591–47,262	4
• Middle school certificate	3	• 18,953–31,589	3
• Primary school certificate	2	• 6,327–18,419	2
• Illiterate	1	• ≤6,323	1
(B) Occupation of head		**Calculation**	
• Legislators, senior officials and managers	10	***Total score = A+B+C***	***Social class****
• Professionals	9	• 26–29 Upper class	I
• Technicians and associate professionals	8	• 16–25 Upper middle class	II
• Clerks	7	• 11–15 Lower middle class	III
• Skilled workers and shop and market sales workers	6	• 5–10 Upper lower class	IV
• Skilled agricultural and fishery workers	5	• Below 5 Lower class	V
• Craft and related trade workers	4		
• Plant and machine operators and assemblers	3		
• Elementary occupation	2		
• Unemployed	1		

*Class I is the highest socio-economic class; while class V is the lowest economic class.

Table 2.5: Pareek's method of socio-economic classification (rural areas)

Components	*Weighted score*	*Components*	*Weighted score*
(A) Caste		**(F) Family members**	
• Scheduled caste	1	• Up to 5	1
• Lower caste	2	• Above 5	2
• Artisan caste	3	**(G) House**	
• Agriculture caste	4	• No house	1
• Prestige caste	5	• Katcha house	2
• Dominant caste	6	• Mixed house	3
(B) Occupation		• Pucca house	4
• None	0	• Mansion	6
• Labourer	1	**(H) Farm power**	
• Caste occupation	2	• No draught* (buffalo/cows) animal	1
• Business	3	• 1–2 draught animals	2
• Independent profession	4	• 3–4 draught animals	3
• Cultivation	5	• 5–6 draught animals or tractor	6
• Service	6	**(I) Material possession**	
(C) Education		• Bullock cart	1
• Illiterate	0	• Cycle	1
• Can read only	1	• Radio	1
• Can read and write	2	• Chairs	1
• Primary	3	• Improved agriculture equipment	2
• Middle	4	• None	0
• High school	5	**Socio-economic class**	
• Graduate and above	6	***Total score***	***Grading***
(D) Land		Score more than 43	I
• No land	0	Score 33–42	II
• Less than 1 acre	1	Score 24–32	III
• 1–5 acre	2	Score 13–23	IV
• 5–10 acre	3	Score less than 13	V
• 10–15 acre	4		
• 15–20 acre	5		
• 20 and above	6		
(E) Social participation			
• None	0		
• Member of one organization (like Panchayat member, Nambardar, etc.)	1		
• Member of more than one organization	2		
• Office holder in such organization	3		
• Wider public leader	6		

*Draught animal—animal used for pulling heavy load.

Table 2.6: Modified Prasad's social classification[8] for may 2021

Social class	*Per capita monthly income limits (₹)*	
	Prasad's classification 1961	*Modified classification* for may 2021*
I	100 and above	≥7863
II	50–99	3931–7862
III	30–49	2359–3930
IV	15–29	1179–2358
V	Below 15	<1179

*Majhi MM, Bhatnagar N. updated BG Prasad's classification for the year 2021: Consideration for new base year 2016. J. Family med prim care 2021; 10:4318–9

Socio-economic and Caste Census (SECC)

SECC-2011 is a study of socio-economic status of rural and urban households through a comprehensive door-to-door enumeration across 640 districts of India. **SECC** provides an automatic exclusion on the basis of 14 parameters, automatic inclusion on the basis of five parameters, and grading of deprivation on the basis of seven criteria for the households.

Rural areas—Automatically included households (based on fulfilling any of the 5 parameters of inclusion): Households without shelter, destitute living on alms, manual scavengers, primitive tribal groups and legally released bonded labourer. Rest of households are identified as poor on the basis of standard deprivation parameters to which they are subjected to. Seven deprivation factors are: D1—the households, which have only one room with

Table 2.7: Standard of living index (SLI)

Sr. No.	*Variables*	*Categories*	*Scores*
1	Source of drinking water	i Tap (own)	3
		ii Tap shared	2
		iii Hand-pump + well	1
		iv Others	0
2	Type of house	i Pucca	4
		ii Semi-pucca	2
		iii Katcha	0
3	Source of lighting	i Electricity	2
		ii Kerosene	1
		iii Others	0
4	Fuel for cooking	i LPG	2
		ii Kerosene	1
		iii Others	0
5	Toilet facility	i Own flush toilet	4
		ii Own pit toilet	2
		iii Shared toilet	2
		iv No toilet	0
6	Ownership of items	i Fan	2
		ii Radio/transistor	2
		iii Sewing machine	2
		iv Television	3
		v Telephone	3
		vi Bicycle	2
		vii Motor cycle/scooter	3
		viii Car	4
		ix Tractor	4

katcha walls and katcha roof; D2—there is no adult member in the household between 16 to 59 age; D3—female headed households with no adult male member between age 16 to 59; D4—households with disabled member without able bodied adult members, D5—SC/ST households; D7—landless households earning via only manual causal labour. On the basis of deprivation score, the order of priority for inclusion of households in the BPL list is the largest number of deprivations to the smallest number of deprivations in rural areas.

For urban area, after automatic exclusion criteria, households facing various kinds of deprivations and vulnerabilities, viz. residential, social and occupational vulnerabilities would be automatically included.

Eleven defined occupational categories entitled under the scheme are: (i) Rag picker, (ii) beggar, (iii) domestic worker, (iv) street vendor/cobbler/hawker, (v) construction worker/plumber/mason/painter/welder, (vi) sweeper/sanitation worker/mali, (vii) home based worker/artisan, tailor, handicraft worker, (viii) transport worker/driver/conductor, rickshaw puller, (ix) shopkeeper/peon, (x) electrician/mechanic and (xi) washerman/chowkider and families covered in erstwhile Rashtriya Swasthya Bima Yojana.

Household Consumer Expenditures

National Sample Survey Organization (NSSO) conducts survey on household consumer expenditures on a thin sample of households and a quinquennial survey (every 5 years) on a large sample of households. Household consumer expenditure is the sum total of monetary values of all the items (i.e. goods and services) consumed by the household on domestic account during the reference period.

Social Mobility

The socio-economic status of an individual/family can change or advance over a time period with attainment of literacy, better occupation and enhanced income. Person/family of low socio-economic status may move to upward scale (higher socio-economic status) or from higher status to poor economic status. This phenomenon is known as social mobility. Stories of rags to riches are most common.

Expected outcomes

The student collects information on literacy, occupation and income and assets of allotted family/families and categorizes the family as above/below poverty line or class to which family belongs as per SES for implications on health and development.

Family-retained Household Records

Home-based pregnant mother and child protection card (MCPC) is powerful tool to educate family as also to motivate them to complete all the health actions up to 3 years of age (mother and child protection card prepared by Ministry of Women and Child Development GOI and Ministry of Health of Family Welfare). This is a ready-made tool to

evaluate the services and outcome thereof by the family itself. Simplified records (with pictorial and action photographs) of this kind are quite valuable and helpful to both, the family and the healthcare system to evaluate their performance and to quickly know, what remains to be done. Apart from this, it generates demand for maternal and child health services and is a useful tool for referral centres, as well as to monitor the progress of these services (Fig. 2.1). The revised card includes information on what the child does by a specific age, what the parents should do to simulate the child for early childhood development.

Expected outcomes: Based on SES data the student identifies priority households and BPL families in need of healthcare services.

Family Medicine[9]

'Family medicine' is an academic discipline and a speciality recognized by National Board of Examination and the Medical Council of India leading to degree awarded called Diplomat of National Board (DNB), on par with other postgraduate degrees. However, the universities and medical colleges have not set-up the departments of family medicine so far. Only a few MBBS doctors in practice or government service have acquired DNB.

There is need for creating awareness in the public about family medicine as an independent speciality. Family physician is the first level contact for the patient and his family. In a country with large population spread over to vast rural and urban areas, the need for adequately trained, properly qualified, competent general practitioners is acutely felt. National board is a unique body which conducts postgraduate degree examinations in family medicine to the award of Diplomat of National Board (family medicine).

'Family' being the basic unit of community is a well-defined entity and fundamental unit of clinico-epidemiology. 'Family' being a recognized unit of both development and

PART OF MOTHER AND CHILD PROTECTION CARD (MCPC)

NATIONAL HEALTH MISSION
राष्ट्रीय स्वास्थ्य मिशन

सत्यमेव जयते

- Get pregnancy registered in the first trimester. Get pregnancy tested by pregnancy testing kit (PTK).
- Have at least 4 ANC check-ups.
- Have BP checked and blood and urine examined at each visit.
- Have weight check-up at each visit.
- Gain at least 9–11 kg during pregnancy, gain at least 2 kg every month during the last 6 months of pregnancy.
- Td two injections at 4 weeks interval. Have one dose of Td if previously vaccinated within 3 years.
- Take one tablet of IFA a day for at least 6 months after first trimester, take at least 180 tablets.
- Take two tablets of calcium per day for at least 6 months after first trimester.
- Take single dose of tablet albendazole 400 mg after first trimester.
- Eat one extrameal, consume variety of foods, use iodized salt only and 2 hours of rest.



IMMUNIZATION ESSENTIALS

Vaccine Name	Birth	1½ months	2½ months	3½ months	9 months
BCG Prevents tuberculosis	√				
HepB Prevents liver disease	√				
OPV Prevents polio	√	√	√	√	
Penta Prevents whooping cough, diphtheria tetanus, meningitis, and more		√	√	√	
PCV Prevents pneumonia		√		√	√
Rota Prevents diarrhoea		√	√	√	
MR Prevents measles, rubella					√
JE Fights brain fever					√

Fig. 2.1: Family-based/retained mother and child protection card

social growth, it is a unit of living as well as unit of illness. Individual reacts on the family and the family reacts on the individual and as such illness is a family event.

The practitioner of 'family medicine' is a basic doctor or physician who has to concern himself with the promotive, preventive, curative and rehabilitative family-oriented approach in health and disease. Thus, the concept of family medicine endeavours comprehensive and **continuity of care** covering the total life cycle (all phases of life). In essence, 'family medicine' is total medicine, for total family in its total environment and it goes far beyond the concept of general practice. Family medicine emphasizes attention to responsibility for total healthcare for sick and healthy both. Family doctor who combines preventive with curative medicine, with the full background of total environment is able to see persons in the *prepathogenic period*, as well as *pathogenic period* of disease and he is able to study all the elements that produce disease or make the family healthy.

After obtaining DNB such a doctor should be able to render health services to the community by providing primary healthcare to all members irrespective of age, sex, culture and socio-economic background. He should be able to decide for appropriate referral in order to provide secondary/tertiary health services when necessary. He should be clinically competent and should be able to take personal responsibility for rendering comprehensive and continuing care of his patients in their own setting. He should be able to institute immediate resuscitatory and first-aid measures in different emergencies apart from taking administrative responsibility of health centre and training of medical and paramedical staff.

Family physician should think epidemiologically and act socially. Accepting the responsibility of family in health and disease becomes the cardinal skill. Ability to assess the health problems in the assigned families in a geographical area and ensuring adequate and appropriate response is the major task which is similar to community diagnosis and treatment of community (families).

Practice of family medicine has almost disappeared due to advances in medicine and development of specialities and super-specialities, but we certainly need general practitioners. MG Institute of Medical Sciences and Research at Sewagram (Wardha) is a unique example in the country which took a lead in developing the concept of 'general practice' in the system of medical education.

Research in Family Medicine

'Family' is a unique biological unit where one can undertake applied and operational research. Research is really attitude of mind. The process consists of making observations which are objective and verifiable by others. The opportunities for research in family medicine lie essentially in the area of primary healthcare improvement.

There are opportunities for family medicine practitioner to undertake clinical, epidemiological, behavioural and educational researches. Most important method of research available with family practitioners is *clinical* and *observational methods*. Careful documentation of observed events and health behaviours provide valuable cues as to what is actually occurring. The participant observation techniques where researcher lives with community for some time is the best way to study socio-cultural patterns, customs and behaviour of community. It also discovers gap between knowledge and actual practice. He may use simple tests; out of his observations arise a problem and he develops a hypothesis and begins to test it. *Epidemiological research* provides special opportunities in the work of family medicine practitioner. It identifies *risk factors* rather than specific agents, it requires no complex technology except the field data processing and so much has come out of these researches. The diseases can be related to **behaviour, lifestyles,** to environment, lack of nutrition, income, **health services**. The *case study* method is most appropriate for family practitioner. It is a detailed study of a single and well-defined social life or a case in its natural environment. In depth, exploration of case leads on to several evidences which can be verified further. The case study is associated with qualitative approach in particular with ***anthropological*** and ***ethnographic research.*** (Scientific description of people and culture with respect to their customs and characteristics.)

The information is gathered by interviews, observations, reviews of various records, reports and tests. A notebook and a pencil are considered very important instruments. This kind of research provides answer to leading causes of morbidity, death, who dies most often, what is **economic burden of ill health**, what are feeding habits, outlook of people (attitudes) and various practices and how these influence the health of children and mothers. Many of the answers to big problems have come through simple observations of this kind. John Snow observed deaths due to contaminated water which provided the basis of cholera control and control of water-borne diseases. Observations serve as very important epidemiological tool to explain *natural history of disease* and build appropriate intervention.

Family Adoption Programme and Yoga Meditation

Family studies and family health services leading to learning of social and cultural factors, social psychology, community behaviours and community relationship and their impact on health and disease: It is a matter of routine that undergraduates and postgraduates in community medicine are given family studies in urban slums or rural areas depending upon the resources. Each medical college has adopted some urban or rural area in their vicinity for the purpose of family studies and some institutions go on changing the area after 1 or 2 years. Very few institutions have taken the total responsibility of villages or geographical area for *provision* of *primary healthcare services* on *continuous basis* especially *maternal* and *child* health *services*, and services for national health

programmes. Further very few institutions have established linkages with the urban health authorities and municipal corporations to avoid duplication and to enhance coordination for health services. The essential requirements for meaningful family studies include having an urban health centre (UHC) or health posts established in urban slum, take responsibility for essential services on continuous basis (at least national health programmes) and have adequate staff for urban health centre as per revised new curriculum by NMC effective from Feb-March 2022 wherein MBBS students will/adopt a village as part of community medicine course and yoga.[10] Lastly establish linkage and submit a progress report of performance to district health authority or municipal corporation every month and attend the review and planning meeting with the authorities and involve them in teaching and training programmes of undergraduates and postgraduates, since they are the real practitioners of public health/community medicine. This way competency-based learning in community medicine gets integrated into healthcare delivery system.

What is the Purpose?

The major purpose of family study is to offer educational experiences with focus on 'learning' the natural history of disease, the levels of prevention apart from assessing health needs of family/community. Family is allotted in first professional year and students follow it longitudinally for four years till their summative assessment.

Demography, medical sociology, behavioural sciences, art of **interview** and **communication**, vital statistic and biostatistics, epidemiology, healthcare delivery system, health management, health information system and national health programmes can be the focus of family studies. In brief, family studies help learning most aspects of community medicine. The art and science of community medicine can be seen, perceived and learnt best in families or in community. There is no exaggeration if we say that the whole subject of community medicine can be best learned and practiced in the families and community, hence (80%) or most of the teaching and training should be based in the community. The system of ASHAs ICDS (*Anganwadis*) in urban or rural setting should be linked with family studies to the maximum, as it (ICDS) is community-based and family-linked and it creates positive influence on the minds of over 91927 MBBS students admitted every year.

In our experience, the following aspects or exercises can be easily covered in planned manner to achieve the stated objectives:

- Composition of family—age and sex composition (demographic profile) age at marriage, childbirth and birth interval, large-sized and problematic families, and their unmet health needs.
- Health, nutrition, education and communication needs.
- Most vulnerables in the family.
- Gender issues (inequality) and practices in the family.
- Socio-economic profile (literacy, occupation and income). Below poverty line, and above poverty line families.
- Benefits reaching below poverty line families.
- Vital events, disabilities and registration of events (marriages, pregnancy, birth and deaths).
- Social factors related to health and disease.
- Environments—sources of drinking water, water storage practices, garbage and excreta disposal, problem of over-crowding and indoor air pollution.
- Health beliefs, attitudes and practices—reproductive health behaviour, gender biases, gender analysis contraception practices and beliefs.
- Food distribution within the family.
- Infant and young child feeding practices.
- Interaction and inter-relation between family members, and addiction/substance abuse in family.
- Dietary surveys (qualitative and quantitative methods).
- Growth monitoring of young children.
- Supplementary nutrition—therapeutic nutrition.
- Health check-up of family members for communicable and non-communicable diseases and care of elderly.
- Outreach session on immunization.
- Motivation exercises.
- Healthcare seeking behaviour/utilization.
- Common illnesses and management of these by family (tuberculosis, malaria, filaria, addiction).
- Community-based rehabilitation.
- Cost of illness (health economics).
- Mosquito breeding and fly breeding and collection of larvae and adult mosquitoes.
- Existing healthcare delivery system for these families.
- National health programmes (malaria surveillance, immunization, control of anaemia, directly observed treatment, short course chemotherapy, leprosy, and filaria, elimination, etc.).
- Health records and family-based health records.
- Organized primary healthcare/reproductive child healthcare.
- Functioning of NGOs ASHAs and ICDS in slum areas.
- Working of NGOs—their role and positive contribution besides village and urban health and sanitation committee.
- Practitioners in the area and their involvement in health programmes.
- Observe meeting of *Mahila Mandal*s/woman groups.

These are indicative areas, much more can be added and these can be enriched by advance preparation. The family exercises done by the students can be compiled and the data thus generated can be pooled and used for learning of health statistics, behavioural sciences, managerial sciences and epidemiology. Similarly, case studies or caselets, problem-based learning and clinical-social case-review exercises can be generated out of these.

Much will depend on the teachers and preceptors of the students and **their orientation, attitudes** and preparedness. Spot exercises like testing of residual chlorine at home and iodized salt testing or simple test of food adulteration can be quite impressive and effective. Similarly, collection of sample of water, stool, blood smear, blood, and throat swabs, etc. can be the starting point in surveillance of disease or evaluation of a programme. **Practice and art of interview** and how to observe and what to observe are essential elements in family studies. *Listening* to people is the hallmark. *Counselling* can be most rewarding. These exercises require a great element of creativity and programming. **Each learning exercise** must have **learning objectives, methods of learning, the observations** made and **inferences drawn** and key health needs of family are to be documented in Logbook by all students. Mere collection of data from families could be a frustrating experience. Minimum *service* component is essential to develop confidence and sustain the interest. Demonstrations can be organized by the faculty members or postgraduates and return demonstration to be done by students or family members, e.g. preparation of ORS solution, preparation of blood smears, staining and examination. At family level, emphasis is on 'action' or 'activities' and no time is wasted on theory or lecture. A small act is better than tonnes of advice or lecture, 'actions' speak louder than 'words' for competency-based learning.[11]

PROTOCOLS OF LEARNING

Most institutions have temptation to introduce family folders containing varieties of household registers, maternal and child health card, immunization card, growth charts, etc. which are much different from the one's used under the national health programmes and ICDS system. In our experience use of same household survey register, records and cards as being used in NRHM, RCH and ICDS programmes are much more meaningful. That makes more sense as it gives an opportunity to update the local records, identification of beneficiaries as also follow-up services. The observations can be cross-matched with those of health workers and ASHAs, and gaps can be discovered for rectification. This mechanism reinforces the system and helps the system.

RELATIONSHIP OF BEHAVIOURAL SCIENCES AND HUMANITIES TO HEALTH AND ILLNESS

Health has been defined as "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Therefore, one of the dimensions of health is 'social well-being' or 'social health'. To understand the social component of health, knowledge of social and behavioural sciences is essential.

Humanities: Learning concerned with human culture. Humanities incorporates body of social sciences to understand humans' in holistic and humane manner.

The Foundations of Health in all Policies—19th Century

Medicine is a social science, and politics is nothing else but medicine on a large scale. Medicine, as a social science, as the science of **human beings**, has the obligation to point out problems and to attempt their theoretical solution: The politician, the practical anthropologist, must find the means for their actual solution (Rudolf Virchow, 1821–1902).

Social sciences: It is the study of people in society and how individuals relate to one another and to the group. This discipline consists of *sociology*, *psychology*, *economics, political science*, and *history* or *anthropology*. Sociology, social psychology, social and cultural anthropology are known as ***behavioural sciences***.

Sociology is one of the human biosocial or behavioural sciences. It deals with social relationships of man with his fellow human beings. Sociology means study of society or group of people. The word sociology is derived from Latin, *Socio* (for society) and Greek, *logos* (study). The word society is derived from the associated words: *Socius* (individual) and *societas* (group). Men around man (groups and individuals) both interact and inter-relate and influence each other. The pattern of relationship could be in terms of economic, cultural, political, religious, familial or social groups and caste groups. Medical sociology aims at study of individual, family, groups and their relationships and group dynamics and their behaviour. In essence, the sociology involves study of structure and functions of group life or community life.

Areas of Medical Sociology

Definition: Cockerham and Scambler define medical sociology as "the study of social causes and consequences of health and illness".

This includes structure and **functions** of society (age and sex composition, caste, class, power structure and size of group), family life, customs, and habits, population movements and trends (birth rate, death rate and growth rate), urbanization, industrialization, income structure (economic status), occupations, structure of family and community, leadership in community, community organization and development, **housing conditions**, water sources, human and animal waste disposal, what integrates the society and what disintegrates the society, etc.

Medical sociology essentially includes the structure and functions of community, community organization, community power structure, groups, leadership, resources and economics of community, responsibilities of community for health and development, lifestyles, ways of life and practices in relation to health and disease, healthcare delivery in the community, community participation in health programmes and **doctor–community relationship and liasion**. Communities grow their food, manage drinking water, dig wells and tube wells, manage waste water, garbage and solid waste, promote latrines, generate resources, undertake, development works, build schools,

community centers, health centres (donate land), support the efforts of government and participate in planning and development process, and determine their health needs.

Competency addressed: The student should be able to:
CM 2.2: Describe **social and cultural factors in health**, disease and disability.

SOCIAL AND CULTURAL FACTORS IN HEALTH, DISEASE AND DISABILITY

The various social factors, such as **age, sex, literacy** levels, **income, occupation, habits, marital** status, **and** health **seeking behaviour,** way **of** life, **aggregation** and **dispersal** of **population, migration, urbanization, industrialization, globalization** and **geographical** area play an important role in initiating, perpetuating and distribution of a disease in the process of natural history of disease.

The total development of society, its economics and health development, development of women and women groups and organizations, industrial and agriculture development, equity and social justice remain cherished goals. Most of the health problems are as much sociological as biological.

Study and understanding of **humanities** (behavioural sciences) is essential to understand an individual, group/society or community structure, function, **inter-relationship** of man with his fellow-men and their ways of life. Behavioural sciences enhance the skills and competence of students, to elicit correct history, inculcates the art and skill of interview and communication, to assess the communication needs, and to formulate health education programmes. The knowledge of **humanities** is also essential to understand the role of socio-economic factors in the *natural history of disease* as also to enhance client satisfaction and doctor–patient relationship. Integrated bio-behavioural survey (IBBS) and behavioural surveillance survey data have been extensively used in national programme on HIV/AIDS epidemic in India for behaviour change communication.

Research: The application of behavioural sciences helps in qualitative methods of research-health system and human behaviour research to plan, implement, monitor and evaluate health programmes.

Social diagnosis and social therapy: Social diagnosis of an illness needs the application of behavioural sciences to arrive at community diagnosis and accordingly the therapy is social therapy in the form of education, legislations, individual and group counselling and motivation and team building apart from providing health services on equity basis without any discrimination with priority focused on economically weaker sections of the society.

Social Health Problems

A disease is called a social problem and its social relevance becomes high:

- When it has predominant behavioural component in its causation, e.g. lifestyles.
- When it is widespread over to large geographical area and it affects many people (incidence and prevalence is very high).
- When it is severe and mortality is very high.
- When it leads to permanent disability or crippling.
- When it leads to discrimination and ostracism.
- When it disrupts the trade, and affects the economy of the nation.
- When it affects the economically productive population most and leads to poverty.
- When it threatens the growth and development of young children.
- When the treatment is beyond the reach of many.
- When the disease is incurable.

Examples

Almost all diseases have some or the other element of social and cultural factors but some of these are major social problems, related to wide spread unhealthy behaviours/practices (Table 2.8).

The **social therapy** is directed towards treating the underlying cause or changing behaviour through education, individual and group counselling, motivation, involvement of community and by legislation to curb the bad practice or else to provide the missing health services.

Socio-cultural Factors

Socio-cultural factors with social problems and their behavioural components are listed in Table 2.8.

Specific social factors and behavioural components in relation to diseases, reproduction, child rearing, environmental health, health management and health services utilization, gender-related issues have been discussed in relevant chapters and 'case studies or caselets' have been cited to enhance learning of behavioural sciences. Case studies have been highlighted in the chapters on **community** and **community diagnosis**.

Expected outcomes: The students are able to describe the role of social and cultural factors as determinants of health and disease (social determinants-causes of causes) and multifactoral causes of disease and programmes for social determinants.

Competency addressed: The student should be able to:
CM 2.4: Describe social psychology, **community behaviour** and community relationship and their impact on health and disease.

How: Student interacts with community, families and patients to elicit healthy and unhealthy behaviours/practices.

Table 2.8: Socio-cultural factors with social problems and their behavioural components

	Social problems	*Behavioural components/practices*
1	(a) Population explosion	High fertility, early marriages, non-acceptance of contraceptive or no belief in contraceptives
	(b) Adverse sex ratio and falling child sex ratio	Female foeticides, infanticide and gender biases/disparity
2	Smoking or tobacco and alcohol use	Habit of smoking in the family and peer groups, socially acceptable practice in the society—a status symbol
3	Accidents and suicides	High speed driving and not obeying the traffic rules or driving under the influence of drugs or alcohol and stress
4	Drug abuse (substance use)	Drug trafficking, illicit drug use by adolescents and youths sharing of needles and syringes
5	HIV/AIDS and STDs	Pre-marital, extra-marital sexual relationships, unprotected sex with multiple sex partners
6	Prostitution	Economic compulsions, poverty and exploitation of young girls and women
7	Mental disorders and behavioural problems in children	Broken families, problem families, unable to cope with stress and adjustment problems
8	Insanitary environments, wide-spread filthy conditions	Habit of open field defecation, non-acceptance of latrines and belief that excreta of children is harmless and poor personal hygiene practices
9	Unsafe water	Poor water storage practices and drawing of water from pot or pitcher by dipping hands and non-acceptance of chlorination as also non-use of piped water supply for drinking purposes
10	Leprosy, tuberculosis, mental disorders and HIV	Social stigma, hiding disease, fear of loosing job, and non-utilization of treatment facilities, thought to be incurable and disabiling and fatalistic attitudes, besides loss of wages
11	Poor utilization of health services (antenatal care, immunization, vitamin A prophylaxis, etc.	Lack of knowledge, no belief in facility, non-accessibility (because of distance), non-affordability and non-acceptance due to cultural reasons/barriers, besides loss of wages
12	Poor management of health services	Lack of motivation, poor leadership, lack of interaction and involvement of community, lack of coordination
13	Illiteracy, poverty, unemployment and urban slums	Rising population, large-sized families, prolonged and recurring illness, addiction in the family, lack of facilities of schooling for girls, migration and industrialization.
14	Diabetes, hypertension cancer, CVD and strokes	Lifestyles—physical inactivity, faulty diet, tobacco and use of alcohol

Social Psychology and Community Behaviour

Psychology: Psychology is study of mind and human behaviour.

Social psychology studies the behaviour of individual and group. Essentially, it provides understanding of processes involved in **thinking, perception, motivation, learning, attitudes** and o**pinions** among individuals and groups.

Community Behaviour or Practices and their Impact on Health and Disease

Households and community are where healthcare **practices** and care-seeking behaviours are learned and supported. Health promotion and prevention typically requires behaviour change that starts in the **household** and can gain support through the **community**.

Improvement in nutrition, for example, are often the result of better infant and young child feeding practices by mothers or other care-givers, whether through breastfeeding or, later, by providing diversified complementary feeding at home. Such practices must be learned by an individual at home and reinforced by community. Wells, hand pumps, water posts, and toilets are important for good hygiene. But their effectiveness depends upon community primed to maintain them and use them. Children must learn to wash their hands and practice good hygiene, habits that are cultivated in the home, in school and among neighbours and friends. Healthy food habits, healthy lifestyles (physical exercise, weight control, avoiding use of tobacco, etc.) are inculcated at home by family and supported by community can go a long way in primordial and primary prevention of non-communicable diseases. When infant and children or any person become sick, it is their families, especially parents and other care-givers who form the first line of care. Household members, particularly mothers, undertake the primary diagnosis of illness, assess the severity and probable outcomes, select treatment and care options—including home treatment for diarrhoea, cough and fast breathing—and procure and administer drugs and other remedies. Family and care-givers make decision to seek formal healthcare for pregnant women and children who have fallen ill. Gender roles are determined in the family.

Community behaviour and practices: Promote **best practices** such as breastfeeding, acceptance of immunization, spacing births at least 3 years apart, limiting family size and healthy lifestyles. Change behaviours/practices which are **harmful** to health (tobacco use, physical inactivity, use of alcohol, junk foods, excess of saturated fats, sugar and salt) by behaviour change communication (BCC).

Learning outcomes: Student observes and interprets the dynamics of community behaviour at household and community level.

Competency addressed: The student should be able to:
CM 2.4: Describe social psychology, community behaviour and **community relationship** and their impact on health and disease.

Community Relationship and its Impact on Health and Disease

The way in which providers of health services are **connected** with community they serve is known as community relationship.

Poor quality of relationship with the communities leads to client dissatisfaction and poor use of public health services.

The behaviour of health providers at household level, at community level and at health facility level will determine the client satisfaction and service utilization.

Connecting care giving between households, communities, and health facilities—primary and referral care in a dynamic primary healthcare system is essential for continuum of services.

Linkage of households and communities to health systems (between places of care-giving in a dynamic health system) ensures continuity of services and enhances access and quality of services.

Good relations with communities promote access and quality of services. Quality of healthcare depends not only on the contacts between client and providers taking place, but also on being frequent enough and long enough to establish a relationship of trust and confidence and to sustain changes in health behaviour, once initiated.

Community relationships—contacts/linkages between clients (community) can be enhanced by several ways such as:

National rural health mission introduced key component of ASHAs as **community health worker programme** to increase household access to health services. Over 10.72 lakh ASHAs are there at community level. ASHAs are part of community and resident of same village/ward in urban set-up. One ASHA for 1000 population in rural and 2500 in urban area forms a bridge/link between community and formal health system.

Over 13 lakh *Anganwadi* workers and over 214820 ANMs are available at community level for community contacts.

Connectivity of ASHAs, AWWs and ANMs (3 As) with Community

*A*SHAs, *A*WWs and *A*NMs (3 As) stay connected with community by:

- **Regular home visits**—for **sustained contacts**, i.e. routine home visits for up to 2 hours per day. They spend more time with priority households/families having pregnant women, newborn, child below 2 years of age, or a malnourished child, young eligible couples between 20 and 29 years, poorest families or with a TB case and chronic non-communicable diseases. These households are being visited once a month. Six to seven visits for newborn child and postnatal mother, for home-based neonatal, postnatal and young child care.
- Attends village health sanitation and nutrition day once a month at *Anganwadi*.
- Once a month visit to schools for adolescent and school health.
- Meeting with formal and informal women/men groups/self-help groups/NGOs on regular basis.
- Empanelment of families—linking every family/household with primary healthcare facility for package of services anywhere in the country under NHP, 2017.
- Annual Households survey and **surveillance** of births/deaths and target diseases.
- Outbreak investigations and control in community.
- Friendly visits in other families/households.
- Meeting with men and women at gathering places such as Chaupals, community centre and *Panchayat* meeting.
- **Listening** to clients for assessing their health needs and providing them with information they need to **make informed** choices.
- Tailoring local plans and information, education and communication strategies to local needs.
- By involving local communities in village/sub-centre, action planning, monitoring, decision making and evaluation process.

Right now the community relationships and contacts in a dynamic health system are limited as only 24% of health workers ever talked to female non-users of contraceptives. All-out efforts must be made to promote good community relationship and their full participation to increase utilization of public health services from current levels of 28 to 50% by 2025.

To understand community behaviour and relationship we need to study:

Anthropology

It studies the physical, social and cultural history of man. Anthropology is a science or study of human evolution. Anthropology has been divided into five divisions:

1. ***Biological anthropology*** is study of races and evolution of mankind, by physical measurement of skulls and skeleton and inherent racial characteristics.
2. ***Social anthropology*** deals with the institutions, organizations, social groups and human relationship of the past and present.
3. ***Cultural anthropology*** which studies the 'way of life' or development of social and cultural life of people, and cultural variations.
4. ***Archeological anthropology*****:** Covers earlier human civilizations and societies based on their physical remains by excavations.
5. ***Linguistic anthropology*****:** It studies languages and their influence on social life.
6. ***Applied anthropology*****:** Studies management and business, medical, forensic and education anthropology.

CULTURE is 'way of life' or sum total of customs, beliefs, attitudes, practices, values, goals, laws, traditions and moral codes of people, as also the language they speak, dress they wear, rearing of children, services utilizations and dietary patterns.

Acculturation

It means diffusion of culture between groups and communities. 'Way of life' is influenced by contacts. Indian migrants acquire the culture of Western countries and change their 'lifestyles' dietary practices, smoking and alcohol consumption or Western people may adopt Indian culture and may become vegetarian and adopt Indian diet and *Yoga* or meditation. The culture diffusion or acculturation occurs, because of migration, urbanization, industrialization, and social mobility (education, trade, globalization, and information technology).

The knowledge of social sciences is essential to assess the community health needs, and community diagnosis. Understanding the culture of people is essential to implement a programme or to get a service or programme accepted by people. Acceptance of family planning programme necessitates thorough understanding of reproductive behaviour of people, their knowledge, beliefs, attitudes and practices in relation to reproduction.

Impact on Health and Disease

Launching a programme of health education or behaviour change communication (BCC) strategies and their implementation requires thorough understanding of community and its 'way of life'. The knowledge of epidemiology and social sciences is also essential in the areas of:

- Organization of health services.
- Strategy of **effective communication** with patient/client/community on health matters.
- Policy for allowing visits of relatives and near ones in hospitals.
- To develop good interpersonal relationships between staff and teamleader or health team and community members.
- **Motivating people** and identification of priority groups.
- Community needs assessment.
- To understand role of social factors in health and disease and diagnosis of social-medical problem.
- Helps to understand the natural history of disease process or epidemiological triad of disease/health.
- To enhance people or **community participation** in health programmes.
- To enhance the compliance of treatment and follow-up of instructions.
- To develop user-friendly health services.
- To tailor the health services according to the felt-needs of the people.
- For effective organization and **management of health services**, especially to understand, to predict and control the behaviour of people in an organisation and to marshal resources of the community.
- To enhance patient or client satisfaction.
- To enhance **utilization of services** (health seeking behaviour) and to create demand for services.

Expected outcomes: Students interact with community/patients/families to learn healthy/unhealthy behaviours and practices and various risk factors for diseases (CCDs and NCDs).

Competency addressed: The student should be able to:
CM 2.3: Describe and demonstrate in a simulated environment, the assessment of barriers to good health and health-seeking behaviour.

Objective: The objective of this competency is to identify barriers to good health and healthcare utilization.

How?

By interacting and listening to community and allotted families and households.

Barriers to Good Health and Health-seeking Behaviour

What people do with their lives and those of their children affects their health far more than anything that governments do. The households and communities are places where health and health-seeking behaviours/practices are learned and supported. Hence, household and community must be linked with dynamic health system. Common barriers in health and health-seeking behaviours in the community are:

i Poverty: People may not be able to afford health services cost (economic barrier).
ii Illiteracy: Lack of information and knowledge of services and unable to recognize when sick person needs service outside home. Lack of **health literacy** is widely prevalent in India to the extent of 90%. Universal health literacy is a must to achieve universal health coverage.
iii Cultural barriers: Poor acceptability due to wrong beliefs, attitudes and practices.
iv Access to healthcare services: Poor access, distance, lack of transport, roads, and inaccessible health services.
v Poor quality of health services and negative experience from contacts with health services providers.
vi Timing may be unsuitable.
vii Gender biases and discrimination for service use.
viii Decision makers in household/family for treatment.
ix Lack of community partnership/involvement. Poor demand and lack of ownership of services.
x Stigma associated with disease/illness like leprosy, TB mental illness may become barrier to use services.
xi Treatment schedule, frequent clinic attendance that costs in time, travel expenses or wage loss can dissuade families from seeking care.
xii Lack of confidentiality.
xiii Lock of empathy and poor communication skills of providers
xiv Lack of faith and trust in the system.
xv Fatalistic attitudes

Health Seeking Behaviours

Nearly 70% of people in India donot seek curative healthcare from government sector. Higher inclination towards allopathy treatment was prevalent in both rural and urban sectors for over 95% of ailments treatment was sought from allopathy providers, 4.8% sought from AYUSH and remaining 0.2% from other sources. Over 68% in rural and 74% in the urban areas the spells of ailments were treated in private sector (consisting of private doctors nursing homes, private hospitals and charitable institutions). Only 32% rural and 26% urban spells of ailments were treated at government facilities (subcentre, PHC, CHC and hospitals). Thus, private sector was most important single source of treatment in urban and rural areas alike. People have more faith and trust in private sector, due to its easy accessibility, timings, good behaviour, etc. (NSS 75th Round). For preventive services over 90% of people used government health services, since these are not profitable to private sector. Identification of causes of care seeking of outpatient clinic visits or hospitalization gives a picture of disease burden.

How to Overcome these Barriers?

- By education—universal health literacy.
- User-friendly health services.
- Healthy public policies and
- Community participation.
- Strategic information education and communication plan of SNA is in place to promote health seeking behaviour.

Swasthya Nagric Abhiyan (SNA)

The main objective of SNA is to generate demand for health services and to promote health seeking behaviour. The SNA strategy aims to create awareness and disseminate information about the health seeking behaviour, and about benefits available under various programmes.

Strategic Information Education Communication (IEC) Plan

Strategic framework for targeted IEC activities using 360 degree communication approach is in place. It uses all possible means of communication such as mass media, mid media, social media interpersonal communication to disseminate information. The year long IEC plan focuses on "health days" and health themes, besides week and month long plans. These activities are centered around Ayushman Bharat, integrated diarrhoea control fortnight, Breast feeding week, national nutrition month Tobacco control and seasonal diseases—dengue and malaria month, etc. Recently, all efforts were directed on Covid-19 appropriate behaviours—wearing mask, social distancing and hand hygiene. It was a pan India massive campaign to roll out of a pre-caller tune on Covid-19 amplifying do's and don'ts.

Expected outcome: The student interacts and contacts allotted family/families or urban/rural community and collects information on health seeking behaviour on specific disease/common health problem.

Competency addressed: The student should be able to:
CM 2.5: Describe poverty and social security measures and its relationship to health and disease.

Poverty: It is a situation in which a person is unable to get minimum basic necessities, i.e. food, clothing and shelter for his/her sustenance or inability to attain a minimum standard of living. Extreme poverty is living on less than $ 1.9 a day.

Covid pandemic plunged 77 million more people into extreme poverty. According to UN 812 million people lived in extreme poverty—on US $ 1.90 per day or less in 2019, and by 2021 amid covid pandemic the number has risen to 889 million.

How?

Student meets BPL families in urban slums or rural areas to elicit benefits reaching to them (food, housing, free education sanitary latrines, etc.)

POVERTY AND SOCIAL SECURITY MEASURES AND ITS RELATIONSHIP TO HEALTH AND DISEASE

In 75% of 179 million rural households in India monthly income of the highest earning member was less than ₹ 5000 per month. About 106 million households (60%) being deprived households (socio-economic and caste census 2011).

Sustainable development goal 1 states: "End poverty in all its forms everywhere". Target is to halve between 2015 and 2030, the proportion of people whose income is less than $ 1.25 per day. At the current rate of progress it may take 41 years to eradicate poverty in India. For inclusive development the centre and states focus more on handouts to the poor than spending on water, nutrition, affordable houses, education, health and employment generation. Population below international/poverty line living on less than US$ 1.90 per day in India (2009–2013) was 21% (UNICEF 2016) and 16.4% were multidimensionally poor in India in 2021 (UNDP).

Below Poverty Line (BPL) Families

Poverty itself is a **disease** which cripples access to and success in school/college. Poor health comes in the way of working harder and longer and reduce productivity and income and thus sets a vicious cycle of poverty and disease burden. (People are poor because of sickness and sick because of poverty.)

Poverty line: Poverty estimates in our country are derived from household consumer expenditure data collected by National Sample Survey Organization (NSSO) every fifth year. The poverty line has been calculated

for 2009–10 to be ₹672.8 per month per capita in Rural India and ₹859.6 per month per capita in Urban India (according to Tendulkar Committee report).

Before 2005, the official measure of poverty line was based primarily on **food security.** It was defined by planning commission of India as the per capita expenditure needed for a person to consume enough calories—2400 calories per person in rural and 2100 in urban area and be able to pay for associated essentials to survive. Since 2005, the government adopted Tendulkar methodology which moved away from calories anchor to a basket of goods. Using the Tendulkar methodology based on per capita monthly consumption expenditure of less than ₹1640 in rural and ₹2500 in urban areas at current prices (2014), Niti Aayog estimates that during the year 2011–12, close to 25.7% of population in rural and 13.7% in urban areas lived below poverty line. Overall 21.9% of people were below poverty line in India in 2011–12. Population below poverty line has declined from 28.5% in 2004–05 to 21.9% in 2011–12; however population below poverty line varies from state to state. Close to 40% of population in Chhattisgarh, 37% in Jharkhand, 37% in Manipur, 34.7% in Arunachal Pradesh, 33.7% in Bihar, 32.6% in Odisha, 32% in Assam, 31.6% in MP and 29.4% in UP is below poverty line. Kerala, Punjab, Haryana, Tamil Nadu and Andhra are the richest states in India. Poverty is a significant disease in itself and is an important determinant of illness and health, malnutrition, high birth rate, high infant and maternal mortality rate and high burden of all infectious and communicable diseases.

Multidemensional Poverty Index (MPI)

A Progress Story

In 2005–06, the population in India living in multi-dimensional poverty stood at 645 million and this has reduced to 230 million in 2019–21. Thus, India lifted 415 million people out of poverty between 2006 and 2021 as per United Nations report of 2022. India's MPI value reduced from 0.283 in 2005–06 to 0.69 in 2019–21. The country significantly reduced deprivations in all indicators. In India, 16.4% of people were multi-dimensionally poor in 2022.

About 400 million people working in informal economy in India are at risk of falling deeper into poverty due to COVID-19 crisis (ILO) which is having catastrophic consequences.

Multidimensional Poverty Index (MPI) means deprivations suffered by individuals in 3 dimensions: **Health**, **education** and **standard** of **living**. The health dimension is based on nutrition and child mortality. The education dimension is based on school attendance and mean years of schooling. Standard of Living Index is based on six indications: Cooking fuel, sanitation, drinking water, electricity, housing and assets. Income poverty (people living below US $ 1.90 per day) tells only part of story. MPI of 27.9% is 5.4% points higher than income below poverty line of 22.5% in India. This complies that individual living above income poverty line may still suffer deprivations in health, education and/or standard of living.

Social security measures (poverty reduction policies): Government of India has initiated several schemes to reduce poverty in India. Examples—employment guarantee scheme, health protection scheme (*Ayushman Bharat*) for 500 million people, free and Compulsory Elementary Education, Food Security Act to provide subsidized food to poors at affordable cost to 820 million, **PM Grib Kalyan** Ann **Yojna** (Free food grains to poor 5 kg per person per month) apart from housing scheme for poor to name a few.[12] *Pradhan Mantri Jan Dhan Yojna* is yet another social security measure.

India has eliminated extreme poverty and achieved less than 1% of extreme poverty for the last 3 successive years (2019–2021,—as per IMF report study.

Expected outcome: Student enumerates poverty reduction programmes.

PRINCIPLES OF HEALTH ECONOMICS

The health has a price and the sickness costs. Resources are always scarce or limited and these have to be allocated to priority health problems. Health economics studies the allocation of scarce resources to different areas of health sector to achieve the results. Hard choices have to be made.

Table 2.9: Pattern of investment in health and family welfare (central budgetary allocations percentage to total outlay)

Sector	*Investment as percentage of total plan investment*									
	IInd plan	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*
Health	3.01	2.63	2.13	1.93	1.87	1.88	1.75	2.31	2.09	6.50
Family welfare	0.11	0.29	1.76	1.25	1.04	1.81	1.50	1.76	1.83	

	Total health expenditure as percentage of GDP												
	1961	*1971*	*1981*	*1986*	*1991*	*1995*	*1996*	*1998*	*2000*	*2003*	*2005*	*2009*	*2018*
Public	0.71	0.84	1.05	1.19	0.92	0.95	0.91	0.81	0.87	1.00	1.0	1.10	3.31
Private	2.25	2.60	4.06	3.61	2.88	3.04	3.07	3.30	4.76	5.60	4.0	4.13	

Economics is most famously defined as "the science which studies human behaviour as a relationship between ends and scarce means which have alternate uses". Health economics is concerned with the choices over how best to spend limited resources available for healthcare.

1. In absolute terms, the plan outlay spent on healthcare has been falling from plan to plan and from 2002 to 2007. During tenth plan period, it increased to 2.09% of the total outlay (Table 2.9) for health and 1.83% for family planning and during eleventh plan it further increased to 6.50%.
2. The aggregate expenditure in the health sector was 5.23% of the GDP (year 2009) which has decreased to 3.31% of GDP. Out of this 40.8% of the aggregate expenditure is public health spending and rest 59.2% being private.

India ranks low among developed countries in per capita health expenditure, despite the relatively developed and wide-spread infrastructure. A significant feature of health in India is its maldistribution in favour of urban, upper and middle classes and biased against the rural poor.

To meet the objectives of reducing various types of inequities and imbalances—inter-regional; across the rural-urban divide and between economic classes—the most cost-effective method would be to increase the sectoral outlay in the primary health sector. Such outlets afford access to a vast number of individuals, and also facilitate preventive and early stage curative initiative, which are cost-effective. In recognition of this public health principle, National Health Policy 2002 and 2017 sets out an increased allocation of 67% or more of the total public health investment for the primary health sector, the secondary and tertiary health sectors being targeted for the rest of 33%.

The cost of secondary and tertiary care is going up day-by-day and it is enormous in government teaching hospital. A hospital bed may cost ₹ 50,000–75,000 per annum. Most of this cost goes to salaries of staff (75%) and maintenance cost (water-electricity) which is around 20%.

Economic Impact of Tuberculosis in India

The burden of suffering caused by tuberculosis in India is enormous. TB is one of the India's biggest health and social problem—a problem that India can ill afford.

Man Days Lost due to Tuberculosis

Indian worker with tuberculosis lost an average of 83 work days because of disease. Considering that 2 million new cases are reported annually in India, the national loss per year works out to 166 million lost work days, at a cost of about $ 200 million (₹ 694 crore). In addition, the debts incurred by patients because of tuberculosis amounted to $ 120 million (₹ 416 crore).

If we add indirect cost, it is estimated that TB costs India ₹ 12,000 crores annually. Other non-disease cost due to tuberculosis are 300,000 school dropouts due to parental TB. The costs to the patient for diagnosis and successful treatment averages US$ 100–150, more than half of the annual income of daily wage labourer.

Thus, TB leads to poverty and poverty leads to tuberculosis and it exerts an enormous social and economic toll on India. More than 300,000 children leave school as a result of parental TB. More than 100,000 women are rejected by their families on account of TB. More than 89% of cases are in the **economically productive** age group (15–59 years), the economic and social costs to them and to their families are enormous.

Cost of Tobacco Use

Tobacco is also an economic burden for the government. According to ICMR the cost of treating tobacco-related disorders like chronic obstructive pulmonary disease (COPD); coronary artery disease (CAD) and cancers in 2002–03 was ₹ 308.33 billion, which more than offsets all the benefits accruing in the form of revenue and employment generated (₹ 81.6 billion) by the tobacco industry.

Economic costs of tobacco use, which causes serious diseases was ₹ 104500 crores in 2011 for users aged 35–69 years, which translates into 1.16% of the GDP, which is 12% more than the annual budget on health.

Macroeconomic impact of non-communicable diseases in India accounts for an economic burden in the range of 5–10% of GDP, which affects development. Similarly, disease burden has marked effect at *household* and *family level* in terms of loss of wages and out of pocket expenses of illness (*microeconomics*).

Definition of cost: Economist defines cost as the value of resources used to produce something; including a specific health service or set of services (as in health programmes).

Customer wants 'value for the money' spent on health intervention.

Knowing the cost-effectiveness of a health intervention—the net gain in health (compared with doing nothing) divided by the cost can be extremely useful for both public and private decision.

What is benefit: In economic language 'benefits' strictly speaking refers only to '*outcomes*' that can be measured in terms of money. Outcomes are: Products and services (*output*), improved knowledge attitudes and practices (*effects*) and improvement in health status; reduction of morbidity and mortality and fertility, improvement of nutritional status (*impact*). *Effectiveness* or *effects* are outcomes in natural way that are not expressed in financial terms, such as number of lives saved by a health intervention or life years gained as a result of intervention or quality adjusted life years (QALY) gained or number of heart attacks prevented or number of cases due to a disease prevented or births averted.

Classification of Cost by Inputs

Costs are divided into direct and indirect. *Direct costs* are the resources used-up in an intervention, such as drugs,

hospitalization, transport, etc. *Indirect costs* are the reduction in productive potential because of an intervention, such as value of time used in seeking care (wage loss).

There are two important categories of resources, those that are used-up in the course of a year and are usually purchased regularly (i.e. **recurrent costs**) and those that last longer than 1 year, such as buildings, vehicles and equipment (i.e. **capital cost**).

Capital Cost

- *Vehicles:* Bicycles, motorcycles, trucks.
- *Equipments:* Refrigerators, sterilizers, manufacturing machinery, scales and other equipment with a unit price of ₹ 5000 or more.
- *Buildings:* Space, health centres, hospitals, training schools administrative office and storage facilities.
- *Training:* Non-recurrent training activities for health personnel that occur only once or rarely.
- *Social mobilization:* Non-recurrent social mobilization activities, e.g. promotion publicity campaigns, that occur only once or rarely.

Recurrent Cost

- *Personnel (all types):* Salaries of supervisors, health workers, administrators, consultants, casual labour.
- *Supplies:* Drugs, vaccines, syringes, small equipment (unit cost less than ₹ 5000).
- *Vehicle operation and maintenance:* Petrol, diesel, lubricants, tyres, spare parts, registration and insurance.
- *Building operation and maintenance:* Electricity, water, heating, fuel, telephone, telex, insurance, cleaning, painting, repairs of electrical supply, appliances, plumbing, roofing, etc.
- Training recurrent (e.g. short in service courses).
- *Social mobilization:* Operation costs.
- Other operating costs not included above.

Costs

Opportunity Cost

Opportunity cost is a central notion in economic analysis. Simplest concept of opportunity cost is—rupee spent on 'A' is rupee denied to 'B'. It can be used to explain the consequences of choosing between two alternatives. If we have a choice of two effective treatments, A and B, but we have enough money for one of them. If the treatment A is funded rather than treatment B, the opportunity cost of funding A is the benefits we forgo in not choosing B, the next best alternative use of resources. Consider for example two possible interventions: A cancer screening programme (intervention A) and the next best alternative, a smoking cessation programme (intervention B). Only one of these interventions can be funded within the available budget. The opportunity cost of funding A can be thought of as the number of life years that would have been gained through smoking cessation programme. Opportunity cost reflects the fact that choices have to be made between interventions because of scarcity of resources.

Average Cost

It is the total cost for the intervention divided by the total number of units provided for the treatment, e.g. average cost of OPD treatment at PHC per patient per day.

Incremental Cost

Incremental cost is the difference in cost found between two interventions (i.e. the intervention and its comparator).

Marginal Cost

Marginal cost is an additional cost or extra cost of producing one unit of output or expanding a programme, e.g. additional cost of adding hepatitis B vaccine in universal immunization programme or increasing the length of stay in hospital by 1 day.

Methods of Economic Evaluation

Economic evaluations always consider benefits as well as costs. There are four main methods of economic evaluations:

i Cost minimization analysis (CMA)
ii Cost-effectiveness analysis (CEA)
iii Cost utility analysis (CUA)
iv Cost benefit analysis (CBA)

I. Cost Minimization Analysis (CMA)

CMA compares the costs of different interventions that are assumed to provide equivalent benefits. A good example would be a comparison between a generic drug and a branded equivalent. If the assumption of equal effectiveness is established, the decision hinges on finding the least expensive way of obtaining that health benefit.

Here only the costs are compared and not the benefits. The cheaper intervention will provide the best value for the money, however, it is rare for two healthcare interventions to provide exactly the same benefits.

II. Cost-effectiveness Analysis (CEA)

Cost effectiveness in healthcare: The net gain in health or reduction in disease burden from a health intervention in relation to cost. It is measured in dollars per disability adjusted life year (DALY).

In cost-effectiveness analysis (CEA), benefits are measured in 'natural' units. For examples, these could be heart attacks avoided, or life years gained (i.e. the number of years by which life is extended as a result of intervention). Quality adjusted life years (QALY) gained is also used which is most comprehensive indicator of CEA.

The results of CEA are usually presented in the form of ratio (e.g. cost per life year gained or lives saved).

$$\text{Cost effective ratio (CER)} = \frac{\text{Cost}}{\text{Number of lives saved}}$$

Effectiveness is an expression of the desired effect of a programme, service or institution or support activity in reducing a health problem or improving the unsatisfactory health situation. Thus, effectiveness measures the degree of attainment of predetermined objectives and targets of the programme, service or institution. The assessment of effectiveness is aimed at improving programme formulation or function and structure of health services and institutions through analysis of extent of attainment of their objectives.

Population-based services like immunization, nutrition, fertility, tobacco and other drugs, the household and external environments (indoor air pollution safe water and sanitation, vector control) and HIV/AIDS are highly cost-effective. The public health package should include all these components.

III. Cost Utility Analysis (CUA)

While cost-effective analysis is useful for healthcare technologies that impact on a 'single' outcome dimension (e.g. length of life), it is often the case that treatments impact both on quality and quantity of life (i.e. multi-dimensional). Cost utility analysis can be used to compare the costs and benefits of health technologies where this is the case. 'Utility' as used by economist refers to happiness or pleasure.

In CUA, benefits are measured in healthy years, to which a value has been attached. Unlike CEA, CUA is multidimensional and incorporates considerations of quality of life as well as quantity of life using a common unit. The most widely used measure of benefit in CUA is quality adjusted life years (QALY) but other measures include disability adjusted life years (DALYs) and healthy year equivalent.

$$\text{CUA} = \frac{\text{Cost}}{\text{QALY gained or DALYs averted}}$$

The results of cost-effectiveness and cost utility analyses can be expressed by many ways. If the benefits of drug A and drug B are equivalent, then the analysis is CMA and intervention with drug of lowest cost should be chosen. If an intervention is both cheaper and more effective than its comparator, the intervention is said to be dominant and should be chosen. Since it would provide larger benefits at a lower cost than its comparator. However, most commonly an intervention will be found to be more effective but it will also be more costly than the comparator. In order to make a decision on which treatment to select, the incremental cost-effectiveness ratio (ICER) should be calculated.

$$\text{ICER} = \frac{\text{Cost of A} - \text{Cost of B}}{\text{Effectiveness of A} - \text{Effectiveness of B}}$$

IV. Cost Benefit Analysis (CBA)

In CBA, the benefits are measured in monetary terms. The final result is expressed as net monetary gain (or loss) or cost benefit ratio.

$$\text{CBA} = \frac{\text{Cost in monetary terms}}{\text{Benefits in monetary terms}}$$

There are two main methods to measure health gains for CBA: The human capital approach and the willingness to pay approach.

Efficiency

It is output–input ratio or efficiency is an expression of relationships between the results obtained from health programme or activity and the efforts expended in terms of human, financial and other resources, health processes and technology, and time. The assessment of efficiency is aimed at improving implementation.

QALY

Quality-adjusted life years (QALY): A quality-adjusted life year (QALY) is a common measure of a benefit that combines quantity and quality of life. It is calculated by estimating the total number of life years gained from treatment and weighing each year with a quality of life score (or utility) to reflect the quality of life in that year. For example, a patient living for 10 years, but with quality of life of say, 0.7 on a scale of 0–1 (with 0 as death and 1 as perfect health), would live for seven (0.7 × 10) QALYs.

How the Utility Score is Obtained?

Utility score is a number generally between zero (representing death) and one (perfect health), utilities can be measured by using direct method, such as the 'standard gamble' or 'time trade off'. Because these techniques are complex, simple method has been devised to obtain health state utilities. Generic health state questionnaire (e.g. EuroQol) asks respondent a number of simple health-related questions and then convert the results into utilities using pre-scaled responses obtained by 'standard gamble' or 'time trade off' from a relevant reference group.

The standard gamble is a technique widely used in economics. It is based on the idea that something is only of value if we are prepared to give another thing up in order to get it. The respondent is asked to make a trade-off between the certainty of having a chronic disease for a period (t) and a gamble that has two possible alternatives: Staying in good health for the same period or death. Finding the point where the respondent is indifferent between being in the chronic condition and the gamble provides us with a value that reflects the quality of life that the respondent attaches to chronic condition.

Time trade off (TTO) techniques are based on concepts similar to the standard gamble. The respondent is asked how many years of life in a health state with a disease, he or she would be willing to give-up to be in full health but

for a shorter period. For example, the respondent may be asked if he or she would prefer to live 5 years in health state, with a specified chronic condition or 3 years in perfect health. The process goes on until the point, at which the respondent is indifferent between the two health states, is found.

Quality-adjusted Life Years

EQ-5D (developed by EuroQol Group, 1990) used multiattribute utility scales. The EQ-5D uses five dimensions—mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension has three levels of severity, thus enabling the EQ-5D to define 243 (3^5) different health states. Two extra health states, unconscious and dead have been added to have 245 possible health states descriptions to assess quality-adjusted life years (QALYs) (Table 2.10).

This is administered in the form of self completed questionnaire. Subjects are asked to define of their own.

Disability-adjusted Life Years (DALYs)

Given a common currency for measuring cost and a unit for measuring health effects, different interventions can be compared by what it costs to achieve additional year of healthy life. Outcomes are measured in the same unit of disability-adjusted life years (DALYs) used to estimate disease burden. DALYs is another indicator similar to QALYs, developed by World Bank and WHO to quantify the global burden of disease. Like a QALY, it incorporates both quantity and quality of life in a common measure. The main difference is that it measures losses of healthy life rather than life years gained. One DALY can be interpreted as equalling 1 year of healthy life lost.

Table 2.10: Dimension of EuroQol EQ-5D[13]

Mobility
- I have no problem in walking about
- I have some problem in walking about
- I am confined to bed

Self-care
- I have no problem with self-care
- I have some problems in washing or dressing myself
- I am unable to wash or dress myself

Usual activities
(*Examples:* Work, study, housework, family or leisure activities)
- I have no problems with performing my usual activities
- I have some problems with performing my usual activities
- I am unable to perform my usual activities

Pain/discomfort
- I have no pain or discomfort
- I have moderate pain or discomfort
- I have extreme pain or discomfort

Anxiety/depression
- I am not anxious or depressed
- I am moderately anxious or depressed
- I am extremely anxious or depressed

For example, a person who is expected to live up to 70 years but suffered an incapacitating stroke at age 65 years, has lost 5 DALYs.

DALYs combine (a) losses from premature death which is defined as the difference between actual age at death and life expectancy at that age and (b) loss of healthy life resulting from disability. For disability-number of years of healthy life lost was obtained by multiplying duration of disability by its severity weight.

DALY is thus a unit used for measuring both the global burden of disease and the effectiveness of health interventions, as indicated by reductions in the disease burden.

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CHAPTER

3

Environmental Health Problems

"Environment is major determinant of health and disease in population/community"
"Air, water and soil pollution, by plastic, human and animal excreta and carbon emission are leading to global warming and climate crisis' threatning life and livelihood"



Swachh Bharat Abhiyan and Jal Shakti Abhiyan
World Water Day—22nd March Every Year
"Ground water—making the invisible visible" 2022

Competency addressed: The student should be able to:
CM 3.2: Describe the concept of safe and wholesome water, and sanitary sources of water.

CONCEPT OF SAFE AND WHOLESOME WATER

Safe water is one that is free from pathogenic organisms, harmful chemical substances, excessive amounts of minerals which could produce undesirable physiological effects. It does not harm the consumer when consumed over prolonged period.

Potable/wholesome water: It is safe water which is pleasant to taste, odourless, cool and colourless and does not stain clothes or utensils.

Water can be made safe and potable through time-tested technologies and natural process to diminish organic and inorganic suspended particles.

Environment is most important *determinant* of health—"achieve universal and equitable access to safe drinking water and sanitation and hygiene for all and end open defecation by 2030". It is one of the goals of UNs sustainable development (Goal 6).[1]

Water is literally, the source of life on our planet (the earth). The human body is 70% water. Close to 6% of DALYs lost in developing countries are attributed to unsafe water, sanitation and hygiene. Water is essential for all metabolic functions of life. The availability of fresh and safe water is a challenge in view of increasing population, industrial and agricultural activities. About 2.2 billion people globally are living without access to safe water.

"Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life and human dignity. It is pre-requisite to the realization of all other human rights". Everyone should have access to safe water and secure drinking water and sanitation facilities.

The framework for safe drinking water and recommended approach for regulations, policies and programmes are based on Stockholm Framework (1999).

As indicated in Chapter 18 of "Agenda 21" of United Nations Conference on Environment and Development (UNCED), "…. An estimated 80% of all diseases and over one-third of deaths in developing countries are caused by the consumption of contaminated water and on an average as much as one-tenth of each person's productive time is sacrificed to water-related diseases".

In view of the International Conference on Primary Healthcare, jointly organized by WHO and UNICEF in Alma-Ata USSR in September 1978, it was enunciated that "adequate supply of safe water and basic sanitation" would be one of the essential components of primary healthcare to attain minimum level of health for all citizens of the world by 2000 AD.

NITI Aayog[2]

75% houses lack, 84% of households do not have piped water access, besides 70% of fresh water sources are contaminated and 600 million people face high to extreme water stress. On water quality index India is currently ranked 120 among 122 countries (2018), i.e. bottom three of 122 countries.

The composite water management index (CWMI) released by *NITI Aayog* in June 2018 projects that water stressed population is likely to double by 2030 from

current level of 600 million people who face high to extreme water crisis.

Daily Requirement for Drinking Purposes

Average daily consumption for drinking water varies in view of variations in climate, temperature and physical activity. On an average, two litres of water are required per day per adult person for drinking purposes alone, and child requires 1 litre per day.

Water Requirement Norms for Rural Areas

Different norms/standards have been adopted by developing and developed countries. In India, standard of 40 lpcd (litres per capita per day) has been adopted and considered to be necessary minimum to meet the needs of drinking and sanitation. The stipulated norms of supply of 40 lpcd of safe water within a walking distance of 1.6 km or elevation differences of 100 metres in hilly areas, can be relaxed as per field conditions applicable to arid, semi-arid and hilly areas.[3]

At least one hand pump/spot source for every 250 persons and additional water of 30 litres in desert development programme (DDP) for cattle, based on the cattle population is to be provided. The water requirements for cattle need not necessarily be met through piped water supply and could be made through rainwater harvesting structure/spot sources.

In the states, where 40 lpcd has been achieved in all habitations, the next step is to raise the level of availability to 55 lpcd. Population/distance/elevation norms may also be liberalized for states which have achieved full coverage as per existing norms subject to the cost sharing by the beneficiaries.

Norms of Water Supply for Urban Areas

The manual on water supply and treatment published in May 1999 by Central Public Health Environmental Engineering Organization (CPHEEO), Ministry of Urban Development and poverty alleviation specifies the norms and standards of municipal water supply for domestic and non-domestic needs such as institutional, commercial, fire-fighting and industrial requirements. The requirements/norms are as under.

1. Towns with piped water supply but without sewerage system: 70 litres per capita per day (lpcd).
2. Cities with piped water supply and existing or planned sewerage system: 135 lpcd.
3. Metropolitan and megacities with piped water supply and sewerage: 150 lpcd.
4. Public stand post–40 lpcd.

The above figures exclude unaccounted for water (UFW), which should be limited to 15%.

With the level and scale of development of an area, the norms will be scaled up and periodically these norms are reviewed. These norms have hardly been met in most cities though these norms are the bare minimum and not the ceiling or limit fixed. The eighth plan specified one source for 150 persons with maximum walking distance of 100 metres.[3]

Fresh Water Availability and Use

Only 3% of all water on earth is fresh water and rest 97% is in oceans. Most of the fresh water is locked away in icecaps and glaciers or deep underground aquifers and only 1% is considered easily accessible through lakes, rivers and shallow aquifers (underground levels shallow enough to be tapped by an affordable cost). Only this amount is regularly renewed by rain and snowfall and thus available on sustainable basis.

Usage

The major use of fresh water is in the area of **agriculture** (production of food and rearing of animals). Worldwide over 69% of all annual water withdrawal is for agriculture, 23% for **industry** and 8% for **domestic** use. India uses 70–90% of all water for agriculture purposes with just 7% for industry and 3% for domestic use.

SANITARY SOURCES OF WATER

Drinking water comes from various sources such as groundwater, surface water (lakes, ponds, rivers, etc.) and rainwater.

Groundwater

Groundwater is available in different layers of earth. Aquifer is a layer or section of earth or rock that contains fresh water known as groundwater (any water that is stored naturally underground or that flows through rock or soil supplying springs and wells). Groundwater is dependable source of water supply. Groundwater in aquifers if recharged periodically by adequate rainfall or from riverbeds is called a *renewable* water resource. Water in aquifers and other natural reservoirs that is not recharged by the hydrological cycle or is recharged so slowly that significant withdrawal for human use causes depletion are thus *non-renewable* water sources.

Qualities

Groundwater is somewhat dependable source of water supply and accounts for 40% of water supply.

In most situations, it is available at affordable cost but in rocky areas access is difficult.

It is less liable to be polluted if source is adequately protected.

Disadvantages

It is highly mineralized and hardness varies from place to place. Sometimes, groundwater may contain excess of fluorides and arsenic which are harmful for human beings. Excess of iron causes taste problem.

Groundwater is susceptible to pollution through industrial chemical wastes and agriculture pesticides and

insecticides. Excessive withdrawal of groundwater by ever increasing population poses several problems.

Shallow Open Wells

These wells draw water from superficial water table above the impervious layer. These wells are located intentionally near the ponds or canals or river beds from where these are charged continuously and provide sweet water of acceptable taste. Rural population depends on such wells. These wells over the times have dried up and are no longer dependable source of water supply.

- Often these wells are contaminated by human activities as also through seepage and poor maintenance of parapet around the well. Unclean buckets and washings often pollute these wells.
- People love the taste of well water and are adapted to it. Moreover, they believe that it is good for abdominal ailments, it quenches their thirst easily and is readily available. People prefer well water to piped water.

Deep Wells

These wells draw water from deep water table and water available between two aquifers. It is more dependable source and less liable to pollution but much depends upon the integrity of aquifer. If it is friable and broken there are more chances of contamination from surface water, industrial and agricultural activity. Deep wells have high mineral contents and the water is often hard.

Tube Wells

Water is drawn from the superficial or deep water table underground by boring into the ground. Accordingly, the tube wells are categorized as shallow and deep tube wells. With appropriate local technology, the hand pumps are widely used in rural areas. India mark II and mark III hand pumps are classical example of development of appropriate technology to draw underground water from rocky areas, and training local women and men for maintenance and upkeep of these pumps. Training of rural youth for self-Employment (TRYSEM) scheme was exploited for hand pump maintenance at local level and participation of youth was quite encouraging. UNICEF played pivotal role in advancement and popularization of India Mark II and Mark III hand pumps. About 50% of the households in rural area used hand pump as principal source of drinking water.

Surface Water

Surface water is available to us through lakes, rivers, and ponds. Around 11.6% of families in West Bengal in rural settings use ponds (*Dobas*) for drinking purposes. Ponds are heavily contaminated due to human activities such as ablution and washing of dirty linens as also animal bathing. These are unsafe sources of drinking water; but only means of drinking water to some families.

Rivers are the mainstay of surface water to urban areas. All big cities depend considerably on rivers for drinking water, therefore, it is necessary to keep the rivers clean. Unfortunately, all the 14 major rivers in India are heavily polluted because of discharge of raw sewage of municipality towns, industrial effluents and agriculture activities. Central and state pollution control boards are there to regulate river cleanliness, but these bodies are not effective to deal with the menace of river pollution.

Census 2011 data indicated that 43.5% of households in India used piped drinking water, while 33.5% drink water from hand pumps, 11% used well water, 8.5% drink from tube well/borewell and remaining 3.4% used surface water and other sources. In rural areas 43.6% of households drink water from hand pumps, 30.8% depend on tap water (piped water supply), 13.3% use wells, 8.3% use tube wells/borewells and remaining 4% use surface water or other sources. About 56% of persons in rural and 76% in urban areas used improved source of drinking water located in the household premises (NSS 78th round).

Competency addressed: The student should be able to:
CM 3.1: Describe health hazards of water pollution.

Water Pollution

Agriculture is the biggest polluter, even more so than industries and municipalities. Widespread use of insecticides and pesticides indiscriminately have led to contamination of groundwater aquifers and surface water. The water that goes back into rivers and streams after being used for irrigation is often severely degraded by excess nutrients, salinity and pathogens that render it unfit for any further use. India which depends on irrigated agriculture for food supplies, more than 4 million hectares of high quality land have been abandoned because of salinization and water-logging caused by too much irrigation.

Pollution through Industrial Activities

While agriculture remains the biggest source of water pollution, wastes from industries have increased tremendously in recent years. Industrial wastes generate between 200 and 400 major chemicals, which are directly dumped into waterways. Moreover, pollutants such as sulfur dioxide and oxides of nitrogen which combine in the atmosphere to form acid rain, have pervasive effects on both fresh water and land ecosystems. In the soil, acid can release heavy metals such as lead, mercury, and cadmium that can percolate into waterways. Further synthetic chemicals particularly persistent organic pollutants (POPs), which include hydrogenated hydrocarbons, dioxins, and organochlorides such as DDT are long-lived and highly toxic in the environment. These do not breakdown easily under natural processes and thus tend to accumulate up the biological food chain

until they pose risk to human health. Industrial chemicals have led to pollution of groundwater with arsenic (in West Bengal and Bangladesh) and consequently produced ill effects on human health in the form of **melanosis, keratosis** and **skin cancers.**

Industrial **fluorosis** in population living near industries, which release fluorides into water channels, is yet another example of toxicity through polluted groundwater. Near Agra, Yamuna river water is red due to heavy pollution with industrial dyes and chemicals. Total dissolved solids (TDS) in water exceed many times than the prescribed limit of 800 ppm.

Municipal Pollutants

Human and animal wastes are let into waterways. Raw sewage of towns and mega/cities finds its way into rivers. All of India's 14 major rivers are badly polluted. Together they transport 50 million cubic meters of untreated sewage into India's coastal waters every year. The city of New Delhi dumps 200 million litres of raw sewage and 20 million litres of industrial wastes into Yamuna river everyday as the river passes through the city on its way to Ganges.

Health Hazards of Water Pollution

Many waterborne outbreaks and epidemics have occurred on this account in the past in the city of Delhi. Outbreaks of viral hepatitis (hepatitis A and E) have become perpetual affair. During 1958, outbreak in Delhi 30,000 cases of viral hepatitis were reported; due to heavy pollution of River Yamuna with sewage near Wazirabad waterworks. Water and excreta borne disease (Cholera typhoid, hepatitis and diarrhoeal diseases are endemic in most cities of India). Outbreaks of these diseases are quite common.

Competency addressed: The student should be able to:
CM 3.3: Describe the aetiology and basis of waterborne disease (jaundice/hepatitis/diarrhoeal diseases).

Aetiology and Basis of Waterborne Diseases

About 2.3 billion people in the world suffer from diseases that are linked to water. In Bangladesh, e.g. an estimated 75% of all diseases are related to unsafe water and inadequate sanitation facilities. In Pakistan, one-quarter of all people attending hospitals are ill from water-related diseases. In India, too very high proportion of illnesses are water-related, about 62000 children die of diarrhoeal diseases every year. Diarrhoea (76.43%) and pneumonia (16%) were leading morbidities in children in OPDs as per HMIS analytical report 2021 and 2022.

Providing clean supplies of water and ensuring proper sanitation facilities can save million of lives by reducing the prevalence of water-related diseases.

Waterborne Diseases (WBD)

WBDs are dirty water diseases; those caused by water that has been contaminated by human, animal and chemical wastes. Waterborne diseases include diarrhoeal diseases, cholera, typhoid, dysentery, polio, hepatitis A and E. Diarrhoeal diseases kill over 62,000 of young children in India and produce malnutrition and disabilities in survivors. Improved water supply reduces diarrhoea morbidity by 6–25%. National Viral Hepatitis Control Programme has been launched to mitigate viral hepatitis besides control of endemic fluorosis and arsenicosis.

Water-based Diseases

Snails and cyclops live in water and act as intermediate hosts. Schistosomiasis is transmitted through snails. Infected faeces reach water, schistosome eggs hatch, embryo penetrate the snail where infective larvae develop, larvae leave snail and enter into water, when man comes in contact with such water these larvae penetrate through the skin of human body and cause schistosomiasis.

Infected cyclops when ingested produce guinea worm disease in man. Thus, cyclops act as intermediate host for guinea worm disease (dracunculiasis). Guinea worm disease has been successfully eradicated from India.

Water-related Vector-borne Diseases

Mosquitoes and tse-tse flies that breed and live in or near both polluted and unpolluted water can transmit diseases like malaria, yellow fever, dengue fever, dengue-haemorrhagic fever, chikungunia, sleeping sickness, filariasis and Japanese encephalitis (neglected tropical diseases).

Water Scarce Diseases (Water-washed Diseases)

Many diseases including trachoma, scabies, skin sepsis, lice infestation, conjunctivitis, bacillary and amoebic dysentery, salmonellosis and worm infestations are due to lack of water and personal hygiene. These diseases are also called 'water-washed' diseases. These diseases thrive because of scarcity of water and consequently poor hygienic practices.

***The Swachh Bharat Abhiyan*:** Clean India (Safe Water and Sanitation for all) drive has been launched in 2014 to reduce water and vector-borne diseases and improved solid waste management.

Competency addressed: The student should be able to:
CM 3.2: Describe water purification processes.

How to attain: Show various processes of purification of water.

WATER PURIFICATION PROCESSES

The aim of water purification is to make water safe, i.e. free from pathogens or disease-producing organisms.

NATURAL METHODS

A. Dilution

Controlling pollution by dilution is a natural way in rivers and stream water. Small amount of sewage or polluting

matter, which enters river or stream gets diluted so much that it loses its bad effect on human health. Dilution is an important means of purification.

B. Sedimentation

If water is allowed to stand or stored in a reservoir or tank, it is exposed to natural sunlight and air which leads to aeration and adds oxygen to water and oxidizes organic matter to a large extent.

Ultraviolet rays help to destroy the harmful organisms. The suspended organic matter (bacteria, protozoa) and inorganic matter settles down at the bottom, if the water is allowed to stand in reservoir tank for 24 hours or longer. This is the common method used in water purification for piped water supply system. Aquatic plants, which grow at the bottom of tank over a time period help oxidize the organic matter and trap harmful micro-organisms. Over 90% of suspended impurities settle down in 24 hours of sedimentation process. The raw water drawn from a source of canal/river is quite turbid because of suspended impurities. During the process of sedimentation, the turbidity gets reduced and water becomes clearer and most of the suspended matter settles down at the bottom. The storage and sedimentation therefore are natural purifiers of water and form the preliminary stage in purification of water in slow sand filters. Over the period after sedimentation, sludge accumulates at the bottom of the tank which has to be removed periodically.

PURIFICATION BY ARTIFICIAL MEANS

A. Filtration

The objective of filtration is to make water safe by removing pathogenic organisms. Over 98–99% of bacteria get removed by the process of filtration.

Slow Sand Filters

These filter beds are made with filter media:

- The surface layer or top layer consists of fine sand graded particles. The thickness of this layer varies from 3 to 5 feet.
- The second layer is of coarse sand 6–12 inches in thickness.
- The third layer is graded gravels or stones 6–12 inches.
- Bottom layer is made of two layers of bricks arranged in the form of drain over perforated pipes.
- The total depth of slow sand filter is 9–12 feet.
- The sizes of the slow sand filters vary depending upon the size of community to be served.

Function of Slow Sand Filter

- It acts as sedimentation tank as well as removes suspended organic and inorganic matters.
- It acts as strainer and removes suspended matter.
- Slimy layer develops on the top surface of the filter bed. It is vital layer of the filter which is called *zoogleal* or *biological layer*. It is also called schmutzdecke or dirty skin. It adsorbs the colloidal particles and bacteria. Real biological action is done by this layer and the process of nitrification also occurs at this layer.
- There occurs oxidation of organic matter in filter bed pores.

Limitations

- The filter occupies large space/land area.
- Rate of filtrations is low. It gets chocked frequently.

Efficiency

The efficiency of slow sand filter is maximum as it holds back 99% of bacteria.

Rapid Sand Filter (Mechanical Filter)

Mechanical or rapid sand filters have replaced slow sand filters. Speed or rate of filtration is quite rapid and these filters occupy less space. These filters are of two types:

1. Gravity type rapid filter
2. Pressure type rapid sand filter.

Gravity Type Rapid Filter

It is a water tight chamber containing 33 inches of sand and about 18 inches graded gravel underneath.

In this filter, the vital layer is artificially made by producing flocculent precipitate with which the colloidal silt settles on the surface of the sand. Aluminium hydroxide or 'alum floc' forms slimy layer over the sand bed of filter, which performs the functions of adsorbing bacteria from water. Oxidation of ammonia also occurs in the vital layer.

Coagulation: Process of coagulation is an essential step for rapid sand filtration. Coagulation is done by mixing aluminium hydroxide 5–40 mg/L or adjusted according to turbidity level of water. When alum is added to water it results into formation of white flocculent precipitate of aluminium hydroxide, which is allowed to settle in sedimentation tank. Clear water is then allowed to pass through filter bed.

Backwashing: Rapid sand filter gets clogged with excess of floccules of aluminium hydroxide and has to be washed by pressure periodically, it is called backwashing or backflushing.

Efficiency: Bacterial removing efficiency is to the extent of 90–95%.

Rapid Sand Filter (Pressure Type)

The filter media is placed in an entirely closed steel tank and operates under pressure higher than atmosphere pressure. The filter bed is same as that of rapid sand gravity filter. Strainers are provided at the bottom instead of perforated pipes. Raw water dosed with

aluminium hydroxide passes on the top of the sand and forms a gelatinous film without previous mixing. Consequently, the quality of effluent is inferior to that of gravity type filter. These filters are suitable for small installations.

Domestic Filters (Household Level)

Their action is purely mechanical. An effective domestic filter must keep back all germs and raw substances.

Usually, the filter media we use is infusorial earth, clay, porcelain or patent combination of porcelain or clay or animal charcoal.

Some of the Common Domestic Filters

i *Pasteur-Chamberland filter:* This consists of porous tubes or bougies of unglazed porcelain. These tubes can be screwed onto a tap. The action is purely mechanical. It can separate the suspended particles including bacteria. It is reliable filter but action is slow.

ii *The Berkefeld filter:* This consists of cylinder made of infusorial earth.

Domestic filters need frequent cleansing. Filtered water is not always above suspicion, sometimes these filters give us a false sense of security as they very often get clogged.

Meta Filters and Stellar Filters

These were extensively used in World War II. These are pressure filters of domestic use taking water directly from the tap. The actual filter bed consists Kieselgurh coated with silver and intermixed with aluminium hydrate, forms a layer over the metallic filter pack.

Modern techniques: Online filters, Aquaguard, Kent, Pureit, Philips-389 filters are available in the market. Besides mechanical filtration, the function of reverse osmosis and UV rays are built in these filters. Such systems help in removing bacteria, hardness, and excess of fluorides and arsenic.

B. Disinfection of Water

All water supplies need to be disinfected before consumption of water. Various methods of disinfection are as follows.

Boiling

Boiling is the best method to destroy all organisms and it makes the water sterile but this method is not practical. It can be practiced at individual, households and for high-risk individuals and during outbreak situation.

Ozone

It is a powerful sterilizing and oxidizing agent. It inactivates viruses very quickly. Ozonized air when brought into contact with water destroys the germs. 0.2–1.5 mg of ozone is required to purify 1 litre of water. It is somewhat expensive. There is no residual effect of ozone as it decomposes and disappears within a short time. A minimal dose of chlorine if added to ozonized water before distribution ensures residual free chlorine in water.

Ozonation is practiced in advanced countries.

Ultraviolet Rays/Solar Water Disinfection

Sterilization of water can be done by ultraviolet rays. It is being used in developed countries; and in domestic filters: Like Aquagard. Bacteria and viruses are killed by UV rays. Filled water bottles exposed to sunlight for 6 hours can disinfect water (solar water disinfection).

Chemical Methods

Terminal disinfection is essential for surface water treatment and for protected groundwater sources when *E. coli* or thermotolerant (faecal) coliforms are detected. For effective disinfection, there should be a residual concentration of free chlorine of ≥0.5 mg/L after at least 30 minutes contact time at pH <8.0. A chlorine residual should be maintained throughout the distribution system. At the point of delivery, the minimum residual concentration of free chlorine should be 0.2 mg/L. In emergencies, e.g. in refugee camps, during outbreak of potentially waterborne disease, or when faecal contamination of water supply is detected, the concentration of free chlorine should be increased to greater than 0.5 mg/L throughout the system.

1 ppm = 1 mg in 1000 ml of water.

Chlorine has been the mainstay of disinfection of water and is the most commonly used disinfectant worldwide. When chlorine is added to water it forms hydrochloric acid and hypochlorous acid.

$$Cl_2 + H_2O = HCl + HOCl$$

The hypochlorous acid (HOCl) further ionizes to $H^+ + OCl^-$ (hypochlorite ion). The disinfection action of chlorine is mainly due to hypochlorous acid and partly by hypochlorite ions. Hypochlorous acid is a strong oxidizing agent. Best action of chlorine is achieved when pH is around 7.0. Free chlorine can inactivate more than 99.9% of enteric pathogens.

Limitation

Normal doses of chlorine do not destroy hepatitis virus, protozoal cysts, spores, and helminth eggs. Higher doses or superchlorination is required to destroy these forms of pathogens. At least 0.5 mg/L of free residual chlorine throughout the system is required to kill these organisms.[3] Chemical disinfection of drinking water supply that is faecally contaminated will reduce the overall risk of diseases but may not necessarily make the supply safe. Chlorine disinfection has limitation against the pathogens—in particular *Cryptosporidium* and some viruses.

Methods of Chlorine Application

Chlorine gas: In big water purification plants, chlorine is used in gaseous form with the help of mechanical injector called 'chloronomes'. The compressed gas is cheaper and easier for application. The dosing machine carries out chlorination automatically to ensure 0.2 ppm of residual chlorine at consumer's end or household level. At the plant, itself the free chlorine of 0.5 ppm is ensured.

Water purification process is shown in Fig. 3.1.

Chloramination: Chloramine is produced by interaction of ammonia and chlorine. It imparts less chlorinous taste in water and ensures persistent type of residual chlorine, however, chloroamines are slower in action. Chloramination could be useful in large urban areas when water is to make very long journey through pipes.

Bleaching powder: It is also known as chlorinated lime. Bleaching powder decomposes in water into calcium hypochlorite and calcium chloride.

$$CaO + 2Cl \rightarrow CaOCl_2 \text{ (bleaching powder)}$$

$$2CaOCl_2 + H_2O \rightarrow Ca(OCl)_2 + CaCl_2 + H_2O$$

Bleaching powder of good quality should contain 33% of available chlorine. It is white amorphous powder, unstable with pungent smell. Moisture, light, air and CO_2 reduce the available chlorine content of bleaching powder.

Bleaching powder is by far the most used disinfectant for water supplies and ideally suited for small water supplies in rural areas. The potency of unstable bleaching powder lasts for 3 months with chlorine content of 25–30%. It should be stored in cool dry and dark place, once opened should be used on the same day so it is advisable to store in small containers.

Under proper and optimal storage conditions chlorine content of bleaching powder is expected to fall below 20% in the course of 1 year.

Stabilized bleach: The stabilized bleaching powder has higher chlorine content 50–70%. The life of stabilized bleaching powder is normally taken as 1 year for which period it retains its chlorine contents.

Water-sterilizing powder: Keeping qualities of bleaching powder can be considerably improved by addition of quicklime in the proportion of 80:20, when it is called water-sterilizing powder (WSP). The available chlorine in WSP is 25%. WSP is soluble in about twenty times its weight in water. Chlorine solution can maintain its strength for weeks if stored properly. For preparing stock solution of chlorine *see* guidelines of chapter on cholera control. To prepare 1% of solution we add 33 g of bleaching powder in 1 litre of water.

Chlorine Demand

"Chlorine demand is the amount of chlorine required to kill bacteria and to oxidize the organic matter and ammonical substances present in the water".

Dose of chlorine is chlorine demand plus the free residual chlorine of at least 0.5 ppm, is the correct dose of chlorine.

Contact time: Minimum contact time of 30 minutes of bleaching powder with water is required for disinfection. This can be determined by *ortho*-toluidine test. If chlorinated water shows positive *ortho*-toluidine test after half an hour it means residual chlorine of 0.5 ppm is present in that water.

Determination of Demands of Chlorine

The demand of chlorine and dose of bleaching powder is determined by Horrock's apparatus. The Horrock's outfit consists of 6 white cups of 200 ml capacity each and 1 black cup of 240 ml capacity, 2 metal scoops each capable of holding 2 g of bleaching powder/WSP when filled level with brim, a bottle of cadmium iodide starch solution, glass stirring rods and pipettes.

1. Prepare stock solution of bleaching powder or WSP. One level scoopful of fresh bleaching powder is put up into the black cup and made into thin paste with minimum quantity of water and thereafter more water is added up to the white mark. The mixture is stirred with glass rod. This is the stock solution.
2. Fill 6 white cups with clear water.

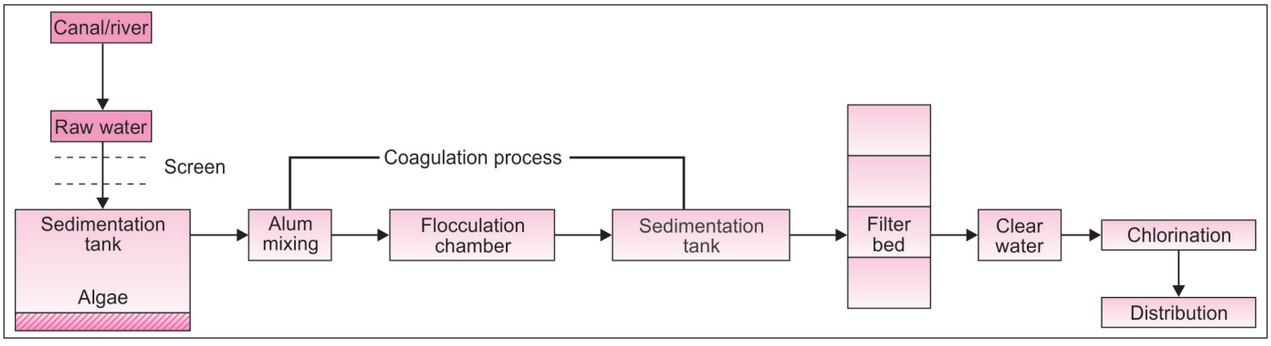


Fig. 3.1: Water purification processes

3 Drops of stock solution are added with pipette in each glass, 1 drop to first glass, 2 in second, 3 in third, 4 drops in fourth, 5 in fifth and 6 drops in the sixth cup. 1 drop represents 1 ppm (parts per million), i.e. one part of chlorine in a million parts of water.
4 Contents of each cup are stirred with glass rod and contact time of half an hour is allowed.
5 After contact time of half an hour, 3 drops of an indicator (cadmium starch solution) are added to each cup.
6 Serial number of first of the cup showing blue colour indicates number of scoopful of bleaching powder required to sterilize 500 litres of water with 1 ppm of residual chlorine after half an hour. If second cup shows blue colour, it means 4 g of bleaching powder is the demand and this much should be added in 500 litres of water.

If superchlorination is advised, one more scoopful of 2 g of bleaching powder in 500 litres of water is required to be added. This will give 2 ppm of free chlorine in water after 15 minutes of contact time.

Pot Chlorination

Chlorine tablets are available for pot chlorination at home. A safe dose of 2–3 mg/L of water is suggested this is equivalent to 1–2 drops of bleaching powder liquor with 3% available chlorine for each litre of water. Chlorine tablet of 0.5 G containing 25 mg of chlorine is added in 20 litres of water.

Chlorination in Practice

In rural settings, well chlorination and at small waterworks supplies the chlorination is not a routine or regular affair. It tends to be irregular or symbolic and resorted during outbreak or epidemic of waterborne diseases.

DISINFECTION OF OPEN WELLS

Around 11% of Indian rural households depend on wells to meet their need of drinking water. Well chlorination therefore deserves special attention. Chlorine demand and dose is determined by simple formula-5 D^2H, where D denotes the diameter of well in feet; H indicates the depth of water column in feet. The quantity of water is estimated in gallons (1 gallon = 4.55 litres). 2.5 g of fresh bleaching powder per 1000 litres of water is the rough estimate of demand of chlorine. Half an hour after adding bleaching powder; the well water is tested for residual free chlorine by *ortho*-toluidine test and if the test is positive it indicates successful chlorination. The health worker male keeps records of all wells in his area and ensures their chlorination, usually on demand basis.

Method

The calculated amount of bleaching powder is mixed with a small quantity of water in a bucket to make a thin paste; more water is added to get an even solution of chlorine. The sediments are discarded by pouring supernatant in another clean bucket. The bucket containing chlorine solution is lowered about 2-feet below the water level and mixing it by giving rotatory movements to the rope tied to the bucket and drawing it up and down several times below the water surface. The bottom of the well should not be agitated as it disturbs the organic matter and it increases the turbidity of water which can protect the organisms from the effect of disinfection, stimulate the growth of bacteria and gives rise to a significant chlorine demand.

Frequency of Well Chlorination

It is determined by *ortho*-toluidine test. Ideally it should be done daily in the evening by the village volunteers themselves. This ideal is seldom achieved.

Ortho-toluidine Test

This test is done at least half an hour after the water has been chlorinated. Objective of the test is to determine the **residual free chlorine** qualitatively and quantitatively. If the test is positive, it is inferred that residual chlorine of at least 0.5 ppm is present in the water.

The reagent consists of analytical grade of *ortho*-toluidine dissolved in 10% solution of hydrochloric acid. A sample of chlorinated water (5 ml) is taken in a test tube and 0.5 ml of *ortho*-toluidine (OT) is added and observe the colour of water. The yellow colour produced immediately after adding OT solution indicates free residual chlorine and a colour appearing after 20 minutes indicates both free and combined chlorine. The residual chlorine content of the water sample can be determined quantitatively with greater accuracy by matching the colour developed in the sample of water with standards contained in the sealed tubes using the chlorine comparator.

It may be noted that even if a trace of residual chlorine is present it gives a characteristic smell and taste. Villagers can smell or taste the water after half an hour to know if chlorine is present in the well water or pot water.

Successful stories of regular chlorination are very few. One experience is, however, worth quoting.

Intensive education to women was given in villages. Women groups took responsibility for home chlorination, inspired by young school children who were trained at school for chlorination. Chlorine tablets/bleaching powder packets were provided free of cost through *Anganwadi* workers and sub-centres. Women had a pride and at least in 10 villages they were emphatic and sure that they successfully kept away diarrhoea, drugs and doctors "because of regular pot chlorination; washing hands and improved water storage practices at home". However, civil surgeon of the district was annoyed with us as we were consuming half of the total supply of bleaching powder in just one block only. Demand for bleaching powder and chlorine tablets was generated in many villages but we could not meet this demand or sustain the supplies on regular basis. There was no local source of supply of bleaching powder.

Case study I: Young women of 10 villages were trained on chlorination of well and pot chlorination at home. One of the enthusiastic daughter-in-law of village Sehri carried the stock of chlorine tablets to her in-laws home. She chlorinated the pot. Mother-in-law got suspicious of the activity of her daughter-in-law, she suspected her daughter-in-law of adding poison in the water and consequently the daughter-in-law was beaten severely. The message went like wild fire in that village. A doctor was summoned from nearby primary health centre to testify the poison in the pot. Doctor verified and certified that tablets were not poison, but chlorine tablets meant to purify water. He was brave enough to consume one glass of chlorinated water in the presence of village crowd and stayed there for about half an hour and thus effectively demonstrated that nothing happened to him by consumption of that chlorinated water.

A woman adopted the practice of pot chlorination in her home. For the first 3 days, she would ask her husband every evening "Are you fit and fine?" Husband retorted back on the third day as to why do you ask me the same silly question every evening? What has happened to you? The wife disclosed that she was serving him the chlorinated water for the past 3 days and was really worried and feels concerned for his health and less any bad effect of chlorine.

Women, men and children draw water from pot by dipping their soiled hands and glass every time they feel the need of drinking water. Unwashed and dirty hands leave, lot of dirt and dust in pot. This was demonstrated to a group of women. Women were asked to wash their hands in steel bowl and the clean water in the bowl turned muddy (after dipping and rinsing hands in it). Women were asked to drink this water, they refused and appreciated that repeated dipping of dirty hands in pot spoils the drinking water we therefore advocated use of ladles to draw water from pot.

60 ladles were distributed free of cost under *Mahila Swasthya Sangh* group meetings in some villages to help some women to adopt healthy practices for drawal of drinking water from the pot. The left out women kept on waiting for arrival of free ladles and used to ask frequently when you will bring free supply of ladles? Lesson was learnt that free supply did not motivate the left out women to buy their own ladles to keep water clean.

Case study II: We advocated and demonstrated use of clean glass for drinking water, this was our belief and thinking that people would practice use of clean glass. We soon realized our mistake. People in this part of the country are habitual to drink water by cupping their hand/hands. They draw the water from pot by using a common glass but use their hands to drink water. Explanation and reasoning of this practice was very sound and simple that no one else could use their hands and it is a pure act limited for oneself. Use of glasses for drinking water is reserved for guests only. The focus of education was shifted soon and we promoted the practice of washing hands before drinking water. But, adoption of this practice meant more water and people want to conserve water for drinking.

All along these years the emphasis remained on achieving the target of 'coverage of rural population', thrust has been more on quantity of water (40 litres/day/person). The massive programme of rural water supply adopted 'provider's approach' and quality aspects of water supply and education of people has been neglected to a great extent all these years.

Due to alarming growth of population, there is mounting pressure on 'drinking water' which is becoming a scarce resource and widespread contamination due to human excreta and garbage continues. Due to widespread ignorance and illiteracy, the 'concept of safe water' eludes the common man. Consequently, the outbreak of water-borne diseases and several endemic diseases remain a great burden on the society.

Our experience and results of several studies reveal that over 80% of rural people in this part of the country depend on well or hand pump water. Well water is preferred and is the first priority whenever this is available. Hand pumps rank second in preference. Barely 20% of rural people use piped water system. Piped water supply is considered to be undependable, unsafe, taste is not liked by many (unpalatable), smell of chlorine is resented and according to many, it does not quench their thirst. Some people associate piped water with common cold and abdominal ailments. Most common and preferred use of piped water in this area consists of bathing, washing of clothes and utensils, cooking and preparing tea. People have experienced that soap works better on piped water and hence this water is good for washing clothes and hair.

Overall acceptance of piped water system tends to be low. Common villagers rate the piped water supply system as much inferior to that of well or hand pump water supply. Village people see their peers using raw water for ablution, lot of mud, dirt, dust and even dead animals and birds present in the storage system or raw water channels. How can I drink someone else's faeces? Is a common question asked by villagers? Concept of filtration and treatment system of waterworks is miles away from their imagination. Seeing is believing and the villagers have never seen the treatment process at waterworks. Women groups were taken to waterworks system and a demonstration was organized for them at the site, they got convinced and on return they demonstrated to fellow women and convinced other women in their village of the benefit of safe water supply.

The practice of chlorination and ensuring quality of water supply in rural setting more often than not, becomes a 'crisis response'. The practice of chlorination and

subjecting the water to laboratory testing assumes significance during outbreaks only or at best chlorination happens to be a seasonal activity. Routine and regular chlorination and testing of water samples are conspicuous by their absence. Chlorination of well water is resorted to as compliance to an order from higher formation and workers tend to adopt a line of 'all-or-none law' that is heavy chlorination of wells beyond the acceptable limits, forcing people to leave the regular source and switch over to alternate unsafe sources of water supply. They (workers) do this deliberately to show their presence to authorities. Further, the task of regular chlorination of sources is beyond the capacities of health workers. People must participate and take responsibility of chlorination and maintenance of water sources. Some of the operational research studies undertaken in field practice areas of Medical Colleges, Rohtak, paid rich dividends. School teachers undertook the responsibility of chlorinating the supply system in their schools, school children promoted the pot chlorination in their homes, women groups influenced women and built the practice of pot chlorination and took the responsibility of chlorination of village wells, they thus became self-reliant.

At home level, the storage practices and drawing water from the pot are deplorable. Water is stored in pitcher or metallic pots. Everyone dips hands to draw water from the pot, so water is liable to be contaminated. Storage of water in narrow mouthed pots (Surahi) can prevent contamination of water at home. Use of ladles to draw water from pot is a rare practice. People are habitual to drink water by cupping of their hand/hands and use of glass for drinking is reserved for guests only. Repeated demonstrations of clean water and unclean water were organized in schools and with women groups in the villages to inculcate practice of regular hand-washing and use of ladles to draw water. The success of inculcating the practice of handwashing in preschool children and school children was quite high and sustainable, but it meant more water and more burden on women, who fetch drinking water for family.

Competency addressed: The student should be able to:
CM 3.2: Describe water quality standards.

How? Demonstrate major indicators as on page 70 and *E. coli* count reports.

Water Quality Standards

WHO has developed guidelines for drinking water quality. The latest guidelines (published in the year 2017) are being reproduced in Table 3.1.

Microbiological Aspects

Indicator Organisms

Ideally drinking water should not contain any microorganism known to be pathogenic, capable of causing disease or any bacteria indicative of faecal pollution. The detection of *Escherichia coli* provides definite evidence of faecal contamination; in practice, the detection of thermotolerant coliform bacteria is an acceptable alternative. *Escherichia coli* is abundant in human and animal faeces, in fresh faeces it may attain concentration of 10^9 per gram. It is found in sewage, treated effluents and all natural water and soils recently contaminated with faecal matter. *E. coli* count should be zero and not detectable in any water sample meant for drinking purposes.[4]

Characters: *Escherichia coli* (*E. coli*) possesses enzymes β-galactosidase and β-glucuronidase. It grows at 44 to 45°C on complex media, ferments lactose and mannitol with production of acid and gas and produces indole and tryptophan.

However, increased attention has focused on the shortcomings of traditional indicators such as *E. coli*, as indicator organisms for enteric viruses and protozoa. Viruses and protozoa (*Cryptosporidium* oocysts, cysts of *Entamoeba* and *Giardia*) are more resistant to conventional environmental conditions or treatment technologies, including filtration and disinfection, may be present in treated drinking water in the absence of *E. coli*.

Table 3.1: Guideline values for verification of microbial quality[a] WHO 2017

Organisms	*Guideline value*
All water directly intended for drinking *E. coli* or thermotolerant coliform bacteria[b,c]	Must not be detectable in any 100 ml sample
Treated water entering the distribution system *E. coli* or thermotolerant coliform bacteria[b]	Must not be detectable in any 100 ml sample
Treated water in the distribution system *E. coli* or thermotolerant coliform bacteria[b]	Must not be detectable in any 100 ml sample

[a] Immediate investigative action must be taken if *E. coli* are detected.
[b] Although *E. coli* is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests must be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.
[c] It is recognized that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for the progressive improvement of water supplies.

Retrospective studies of waterborne diseases outbreaks have shown that complete reliance on assumptions surrounding the absence or presence of *E. coli* may not ensure safety. More resistant organisms such as bacteriophages and/or bacterial spores may be included as indicators of persistent microbial hazards under certain circumstances.

Thermotolerant Coliform Bacteria

These are coliform organisms that are able to ferment lactose at 44–45°C; the group includes the genus *Escherichia* and some species of *Klebsiella, Enterobacter* and *Citrobacter*. Thermotolerant coliform other than *E. coli* may also originate from industrial effluents or from decaying plant materials and soils. For this reason the term 'faecal' coliform though frequently employed, is not correct and its use should be discontinued.

Virological Aspects: Residual Chlorine

At least 0.5 mg/L free residual chlorine after a minimum contact of 30 minutes at a pH less than 8.0 is sufficient to inactivate enteric viruses. This level of free residual chlorine is to be insisted upon in all disinfected supplies in areas suspected of endemicity of infectious hepatitis. For emergency and outbreak situation, the level of chlorine should be increased to greater than 0.5 mg/L throughout the system. For other areas, free residual chlorine of 0.5 mg/L throughout the system is desirable. High level of turbidity can protect microorganisms from the effect of disinfection hence the turbidity should always be less than 5 nephelometric turbidity unit (NTU).

Major indicators of quality of drinking water

i Residual chlorine mg/L

ii *E. coli* or thermotolerant coliform bacteria count:
It should be zero.

iii Turbidity NTU—it should be less than 5 NTU:
Ideally should be below 1 NTU.

iv pH less than 8.0.

Further the drinking water should be colourless, tasteless, odourless and cool.

SAMPLING OF WATER

These are collected for:

- Physical and chemical examination.
- Bacteriological examination.

Physical examination consists of colour, turbidity, pH.

Chemical examination consists of determining the level of various chemicals (fluoride and arsenic).

Bacteriological examination: Water should be collected in sterilized or boiled bottles obtained from laboratory. People and health workers themselves can collect these samples. 200–250 ml of water is collected and labelled properly depicting date, time, source and place. These water samples should be transported in cold chain system or on ice to microbiological laboratory.

Frequency of Collection of Samples

In case of outbreaks, the bacteriological examination is to be done daily. Samples should be collected from different areas of distribution system. Periodicity of sampling depend on size of population.

Water Quality Control (WQC)

WQC is primarily responsibility of water supplying agency and it is aimed at meeting the water quality standards by regulatory authority. WQC can provide the water supplying agency valuable information:

- It indicates quality of source of water.
- It helps to assess efficiency of treatment and also indicates whether the water quality variables are within acceptable limits.
- It provides useful information on natural and seasonal variations.
- It identifies need for taking remedial action.

Operating Practices

The supplying agency should ensure suitable preventive maintenance, and exercise strict day-to-day control on water quality; collect routine water samples and test at various points including the source of water, conveyance, treatment and distribution, supplemented by sanitary inspection.

Water Quality Surveillance (WQS)

WQS is done by independent agency. Objective is to ensure safe water supply to community. This system investigates the activity and identifies the corrective or preventive measures and gives feedback to water supplying agency. Responsibility of WQS is entrusted to health department. Following must be ensured for effective surveillance.

- Regular testing of residual chlorine at consumer level.
- Supply of chlorine tablets
- Regular collection of water samples and testing of water samples for *E. coli* or thermotolerant coliform bacteria.
- Regular interaction with supplying agency.
- Monitor and surveillance of waterborne, water-related and water-associated diseases for early warning as part of integrated disease surveillance programme.
- Monitor outbreaks of waterborne diseases.
- Carry out sanitary inspection of water sources.
- Preparing and distribution of educational material to people on water management.
- Training of community members and *Panchayati Raj* Institutions (PRIs) for home and well chlorination besides education on safe water.

- Continuing education of health teams.
- Intersectoral coordination with ICDS, rural development and education, PRIs and non-governmental organizations.
- Combined analysis of sanitary inspection and water quality data can be used to identify the most important causes of and control measures for contamination.

Field Test Kits for Potable Water Quality Assurance

These kits have been developed for rapid surveillance of quality of drinking water. These can be carried to the field and can run on alternate source of power. These kits can test, essential physical, chemical and bacteriological parameters on the spot and during emergencies. These kits have been developed by:

- Defence Research Laboratory, Jodhpur
- National Environmental Engineering Research Institute (NEERI), Nagpur
- Industrial Toxicology Research Centre, Lucknow
- All India Institute of Hygiene and Public Health, Kolkata
- Central Scientific Instrument Organization, Chandigarh
- Other private organizations/entrepreneurs of national and international level.
- H_2S strip test for drinking water: This is used as rapid screening test for testing the microbiological quality of water. Cost is very low. Dry and sterile media are provided in screw capped bottle. Fill the water to be tested up to upper level of the label. Shake the bottle gently for 5 minutes. Keep the bottle at room temperature of 30–35°C or in incubator at 37°C for 18 hours. If none is available it can be kept in the pocket while sleeping in the night. If the medium turns black the water is considered to be unfit (KS Manja). This is purely a qualitative test. These kits have been supplied to health workers under NRHM.

ARSENIC CONTAMINATION

Problem

West Bengal, Bihar, Uttar Pradesh, Assam, Karnataka, Jharkhand, and Punjab are major states where arsenic contamination is prevalent in groundwater. Around 10.8 million people are at risk of arsenicosis (keratosis and melanosis). The number of habitations affected with excess of arsenic in 7 states across 75 districts were estimated to 15673 in the year 2019.

Arsenic contaminated habitations have been identified in 9 districts of West Bengal (North and South 24 Parganas, Murshidabad, Malda, Nadia, Howrah, Hugli, Bardhman and Uttar Dinajpur). Arsenic is released through industrial activities such as coal burning, copper smelters and industrial effluents which contaminate the groundwater and when waste from coal mines is dumped along river bed. Industries such as metallurgical industries, glassware, ceramic, dye and pesticide manufacturing units, petroleum refineries use arsenic in many of the processes.

Because of large scale overuse of groundwater due to rise in population and industrial activities led to groundwater pollution.

Permissible arsenic limit in drinking water by WHO standard is 0.01 mg/L. The range of arsenic content in drinking water in eight districts of West Bengal is 0.055–3.20 mg/L.[4]

Health Effects

Excess of arsenic in water produces arsenicosis. Skin pigmentation, arsenical dermatosis, mellanosis, excessive keratosis of skin and cancer of skin, hepatomegaly are the visible bad effects of arsenicosis.

Solutions

Providing safe water with arsenic level of acceptable limits. The Government of India introduced an arsenic sub-mission in 1994 under the Rajiv Gandhi National Drinking Water Mission to tackle the arsenic problem in West Bengal on 75:25 cost sharing basis.

Measures

1. Utilization of surface water from rivers, lakes, ponds, which are normally free from arsenic contamination.
2. Sanitary protected ring wells tapping shallow aquifers.
3. Tapping of deeper third layer beyond 100–150 metres below ground level, which is found to be arsenic free.
4. Adopting arsenic removal techniques through domestic filters, attached with hand pumps and arsenic removal plants in piped water schemes (by oxidation followed by coagulation and filtration, adsorption, osmosis, reverse osmosis and ion exchange).

ENDEMIC FLUOROSIS

Excess of fluoride in drinking water leads to endemic fluorosis. Fluorosis is endemic in 19 states of India.

Permissible Level of Fluoride in Water

The World Health Organization (WHO) has set the standard of fluoride in drinking water at 1.5 mg/L to be adopted by nations. WHO guidelines further state that climatic conditions, volume of water consumed and intake from other sources be considered while setting national standards. Because of widespread problem of fluorosis in India, the Bureau of Indian Standards (BIS) has fixed the upper limit of fluoride in drinking water at 1 mg/L. WHO

guidelines are under review and levels of 0.5 mg/L has been favoured in 2000 AD by International Workshop held in Chiang Mai, Thailand.

Geographical Distribution and Population Affected

In India, fluorosis is endemic in 275 districts of 19 states. Over 70–100% of districts are affected in the states of Rajasthan, Gujarat and Andhra Pradesh, where the problem is very severe. These are the states where drinking water problem is also very serious, people depend and draw underground water and suffer silently from fluorosis.

- 40–70% of districts are endemic in the state of Punjab, Haryana, Delhi, UP, Bihar, MP, Maharashtra, Karnataka and Tamil Nadu.
- 10–40% of districts are endemic in J&K, Assam, West Bengal, Odisha and Kerala. For the remaining states, the endemicity is not known precisely.

Fluoride mapping in the country has been done by Dental Council of India (2004). The evidence indicates that about 27% of households in India use water with fluoride levels of 1.5 ppm or more (Fig. 3.2).

While 40–50% of households in Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu and Haryana had used drinking water with fluoride level of 1.5 or more ppm. Fluoride content of water in Delhi, Puducherry and Chandigarh is low.

As per present data from Ministry of Drinking Water and Sanitation (Ministry of Jal Shakti) there were 8415 habitations as on April 2021 which are yet to be provided with safe drinking water. The population at risk in these habitations with high fluoride is over 60 Lakh. Fluorosis prevalence was earlier reported in 230 districts of 19 states.

Social and Economic Implications

Social and economic implications due to fluorosis in India are enormous because of widespread crippling effects, disability, dependence and decreased work capacity. Discoloration of teeth leads to social problems in children.

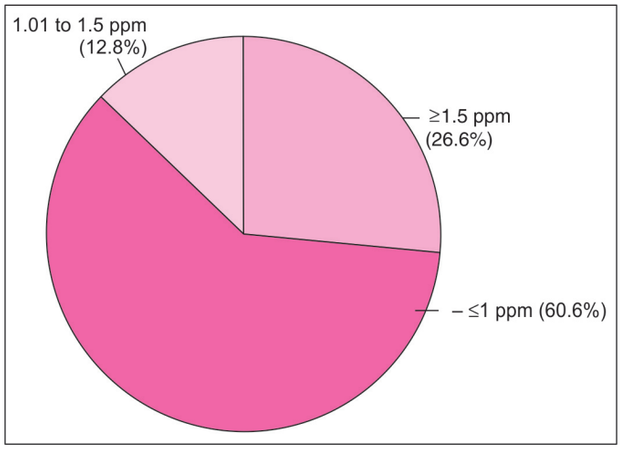


Fig. 3.2: Fluoride content of drinking water in India (households %)

Rural Urban Distribution

It is more in rural areas but in some parts, it is equally prevalent because of excess of fluoride in water.

Risk Factors

- A dramatic increase in population and industrialization and perpetual shortages of drinking water supply.
- Groundwater supply having excess of fluoride content.
- Lack of awareness.
- Undernutrition.
- Use of toothpastes having fluorides.
- Food habits of consumption of excess of black tea, supari, tobacco and black salt.
- Children and pregnant women and lactating mothers are most vulnerable.

Exposure Time

The prolonged consumption of water having excess of fluoride leads to fluorosis. Excess of fluoride in water does not change the colour of water or alters its taste, thus the consumer will not know unless frank stage of fluorosis is produced either in teeth or in bones.

Types of Fluorosis

Excess of fluorides affects all parts of body, predominantly it affects skeletal system (skeletal fluorosis) and teeth (dental fluorosis). Skeletal and dental fluorosis are irreversible conditions and not curable by any drug or medicine. Further skeletal and dental fluorosis produce crippling effects, permanent disability, loss of teeth and permanent discoloration of teeth.

Non-skeletal Fluorosis

Non-skeletal fluorosis affects soft tissues, red blood cells, muscles, ligaments, gastrointestinal system and it leads to development of vague signs and symptoms.

Dental Fluorosis

Dental fluorosis is an indicator of prevalence of fluorosis in the community, hence rapid survey of school children of 6–12 years of age can measure the extent of fluorosis in the community.

Mottling of teeth is one of the earliest and most easily recognizable sign of fluorosis. Dental fluorosis is not just a cosmetic problem, as generally perceived but also a window to what might happen to some of the vital organs of body. In mottled teeth, the enamel loses its lustre and becomes rough, opaque and chalky white. A yellow white discoloration appears which turns brown and presents itself in horizontal streaks. In late stages, the teeth become black, get pitted and perforated and may even get chipped off. There occurs premature loss of teeth. Dental fluorosis is irreversible and incurable. Children under 10 are most vulnerable.

Skeletal Fluorosis

Early symptoms of fluorosis include pain and stiffness in the neck, back and major joints. Entire spine may become one column of bone in late stage, manifesting a condition called **'pokers back'**. Finally, various ligaments of the spine become ossified. This spreads to other joints as well and produces deformities of hip, knee and other joints. Skeletal fluorosis leads to crippling in high endemic areas.

Hydrofluorosis

Waterborne fluorosis due to excess of fluoride in water is called hydrofluorosis and if food chain contains high fluoride, it results into food-borne fluorosis. It is well-established fact that consumption of fluoride contaminated water and/or food for a period of 6 months to 1 year is sufficient to have the ill effects on health.

Industrial Fluorosis

Industries which use fluoride in the manufacturing process produce lot of dust and fumes which pollute the environments, inhaling dust and fumes is as dangerous as fluoride-containing food or contaminated water with fluoride. The industrial workers and population nearby are the victims of fluoride toxicity or fluorosis. Such fluorosis is known as industrial fluorosis. The industries that use fluoride are: Aluminium, steel, enamel, pottery, glass and ceramics, bricks, phosphate, fertilizer, welding, refrigeration, rust removal, oil refinery, plastic, pharmaceutical, toothpaste, chemical industries and automobile industries, etc. Monitoring of levels of fluoride in such industries is essential to control the level of fluoride at the source.

Neighbourhood Fluorosis

Industries listed above may discharge the effluents into streams or rivers and pollute the groundwater or surface water. The people living nearby these industries who depend on groundwater may suffer the ill effects of fluorosis. Such fluorosis is known as neighbourhood fluorosis. Industrial town of Faridabad in Haryana bears the testimony. Underground water table of this town shows unacceptable high level of fluorides ranging from 5 to 20 mg/L.

NATIONAL PROGRAMME FOR PREVENTION AND CONTROL OF FLUOROSIS (NPPCF)

Since there is no cure of skeletal and dental fluorosis, prevention is the only means to tackle the problem of fluorosis. Fluoride once impregnated in tooth and bone stays there for lifetime. Government of India initiated preventive measures against fluorosis as a part of safe water supply.

Fluorosis is public health problem caused by excess intake of fluoride through drinking water, food products, and industrial polluants over a long period.

A 100% centrally sponsored new health initiative entitled 'National Programme for Prevention and Control of Fluorosis' was taken during the XIth Five-Year Plan in the year 2008 with a goal to prevent and control fluorosis in the country with the following objectives.

i To assess and use the base line survey data on fluorosis.
ii Comprehensive management of fluorosis in selected areas.
iii Capacity building for prevention, diagnosis and management of fluorosis cases.

Strategies

1 Surveillance of fluorosis in the community
2 Training to health personnel for preventive, health promotion, early diagnosis and prompt treatment/intervention, deformity correction, and rehabilitation, capacity building of district and medical college hospital for reconstructive surgery and rehabilitation.
3 Health education for prevention and control
4 Establishment of diagnostic facilities at district level. NPPCF has already been initiated in 6 districts, namely Nellore, Jamnagar, Ujjain, Nayagarh, Nagaur and Dharmapur in 2008–09. The programme has been expanded. The programme is being implemented in 163 districts of 19 states including one UT. 85 district level laboratories have been established for estimation of fluorides in water and urine by 2020–21.
5 Managing fluorosis cases by surgery and rehabilitation.

RAJIV GANDHI NATIONAL DRINKING WATER MISSION (RGNDWM)

Guidelines for Fluoride Control

Fluoride control was taken up as sub-mission of RGNDWM. Major guidelines are:

i To identify and label any potable source SAFE and educate the population to conserve/use the source for drinking and cooking only.
ii To tap safe low fluoride aquifers.
iii To arrange for blending of water from different sources to obtain adequate quantities of safe water, and to supply this potable, 'mixture' through designated 'safe' standposts.
iv To provide piped water supply schemes through distant sources.

Competency addressed: The student should be able to:
CM 3.2: Describe concept of water conservation and rainwater harvesting.

v **Concept of water conservation and rainwater harvesting:** Rainwater harvesting means collection and storage of rain water. The three major and widely prevalent problems in sustainable supply of drinking water—scarcity, brackishness and excess fluoride and arsenic content are manifested in low rainfall and high potential evaporation areas. This calls for integrated water and sanitation programme with emphasis on conservation of water, rainwater harvesting and groundwater recharging, storing of rainwater for harvesting and drinking—exploiting traditional sources of water and changing cropping pattern in drought hit areas.

Revive traditional methods for water conservation such as rainwater **collection** from roof top and ground catchment stored in reservoir—village ponds/*Dobas* step wells, earthen check dams, watersheds, field trenches apart from desilting or water bodies, and retaining walls around ponds. Honourable prime minister of India in his '*Mann ki Baat*' on 30-6-2019 and 27-3-22 gave a nation wide call on water conservation as an urgent task of *Jal Shakti Mantralya*. PM urged all village *panchayats* to conserve water by rainwater harvesting locally and it should become a people movement like '*Swachh Bharat Abhiyan*'. There should be rationalization of free electricity and free water to agriculture to save groundwater depletion, and promote intensified afforestation. Water conservation programme must be integrated with agriculture policy and other relevant policies. The first phase of *Jal Shakti* campaign in 256 water-stressed districts out of 766 in the country has commenced with effect from 15th july 2019 focusing on reviving water bodies, recycle water and reduce excessive ground-water use for agriculture, and save every drop for drinking water. The process of rainwater harvesting must begin at village level as meagre 8% of rainwater is being harvested currently. Revive step wells, ponds and traditional methods of water conservation in modern age. Catch the rain water when and where it falls.

vi **Rainwater harvesting techniques** (conserving rain water by several techniques for drinking) have been used to mitigate fluorosis and shortage of drinking water. Rainwater clean, pure, precious resource.

vii To provide community treatment plants to remove excess of fluoride.

Defluoridation of Water

Defluoridation is the removal of excess fluoride from water. It should be considered only if none of the above solutions work.

3

Defluoridation Methods

Precipitation and adsorption/ion exchange.

Precipitation method

These methods involve the addition of soluble chemical to water, which leads to precipitation and/or adsorption of fluoride on the precipitate formed.

1 *Lime treatment:* By adding lime excess of fluoride can be removed from water. This method is effective only for waters with a fluoride concentration in the range of 3–4 mg/L.

2 *Alum coagulation:* The addition of high doses of alum results in removal of fluoride from water. Large alum doses, however, can lead to the presence of high residual aluminium in the treated water.

3 *Nalgonda technique:* This method was developed in India in 1975 by the National Environmental Engineering Research Institute (NEERI) at Nagpur. It involves the addition in sequence, of lime, bleaching powder (optimal) and filter alum in fluoride rich water and rapid mixing, which results in the formation of alum flocs (coagulation). These flocs are allowed to settle (sedimentation) and the supernatant water which is free of excess fluoride is filtered. Fluoride removal is probably due to formation of polyhydroxy aluminium complexes with fluoride and their adsorption into polymeric aluminium hydroxides. Technology is simple and economical (cost of filter is ₹ 700 only) and is very popular in India. The dose of alum and lime varies from source to source depending upon alkalinity and fluoride level in raw water.

Adsorption/Ion Exchange Method

Activated Alumina

Defluoridation of drinking water by activated alumina (AA) is the method of choice in developed countries. The Indian Institute of Technology (IIT), Kanpur has developed defluoridation systems based on activated alumina technology including domestic defluoridation filter and a hand pump attachable defluoridation plant. Domestic filters using activated alumina have been accepted by users. Use of proper grade of AA is a must to obtain satisfactory result. Exhausted AA has to be regenerated after 4–5 months.

In India, Nalgonda technique has been used extensively in large scale water treatment but it appears to be cosmetic measure and cannot meet the requirements of affected community. Maintenance of plants has been a perpetual problem. At household level, both Nalgonda and AA-based domestic defluoridation units are in use.

Domestic Defluoridation by Nalgonda Technology

Defluoridation of water can be carried out at home level after training local women.

Example: 40 litres of raw water (3 ppm fluoride content and alkalinity 200 ppm is reduced to fluoride content of 1 ppm)

when mixed with 6 ml of lime solution (10 g of quicklime in 1 litre of water), 120 mg of bleaching powder mixed well and then 120 ml of alum solution (100 g of alum dissolved in 1 litre of water) is added and stirred slowly for 20 minutes and allowed settling for nearly one hour. The supernatant, which contains permissible amount of fluoride, is withdrawn for consumption. The settled sludge is discarded.

Nutritional Intervention

Non-skeletal fluorosis can be reversed by promoting intake of vitamins C, E, calcium and antioxidants. These help in the prevention and control of skeletal and non-skeletal fluorosis. In terms of diets promoting vitamin C rich foods such as *amla*, lemon, oranges, tomato, green leafy vegetables, carrots and *salads* help in reduction of fluoride levels.

Similarly, milk, green leafy vegetables and cereals are rich sources of calcium in diet.

Antioxidant foods such as garlic, turmeric, ginger, carrot, onion, green leafy vegetables, papaya and pumpkin should be encouraged.

Community Participation

Information education and communication on all aspects of fluorosis is vital to mitigate fluorosis problem. People in endemic and high endemic areas should be empowered for self-help to use safe and alternate sources of water in their village. Government alone cannot solve this problem. Fluorosis mitigation should be the concern of development agencies. Voluntary agencies and non-governmental organizations should take the lead.

International Organizations

UNICEF and DANIDA are working closely with Government of India and helping to strengthen the district water quality laboratories, development of activated alumina (AA)-based domestic defluoridation by IIT Kanpur, as also educational material and support to non-governmental organization. DANIDA is supporting rural drinking water supply and sanitation project (RDWSSP) in Karnataka.

NATIONAL RURAL DRINKING WATER SUPPLY AND SANITATION PROGRAMME

RAJIV GANDHI NATIONAL DRINKING WATER MISSION (RGNDWM)

Provision of safe drinking water in rural areas is the responsibility of states and funds have been provided in the budgets of the states right from the commencement of First Five-Year Plan. A national water supply and sanitation programme was started in the social welfare sector in the year 1954.

Taking into account the magnitude of the *problem villages*, the central government introduced the accelerated rural water supply programme (ARWSP) in 1972–73 to assist the states and union territories with 100% grants in aid to implement the scheme in such villages (problem villages).

Focus

The focus remained on problem villages. The programme of rural water supply in the country is based on identification of problem villages/habitations through surveys conducted in 1972, 80, 85 and 1991–94. India is a signatory to 1977 UN General Assembly Resolution on International Drinking Water Supply and Sanitation Decade (IDWSSD) (1981–90). Goal during the decade (1981–90) was to provide safe drinking water and adequate sanitation to all its citizens. Target was to cover 100% of rural and urban areas with safe water, i.e. *water for all.*

Problem Village/Habitations

- Water scarcity was the first consideration. Any village/hasbitation which do not have a safe source within 1.6 km with 15 meters depth in the plains and 100 meters elevation difference in the hills is called a problem village. The drinking water is considered *safe* if it is free from chemical contaminants (excess fluoride, arsenic, brackishness, iron and other toxic elements) or biological contamination (leading to diarrhoea, cholera, typhoid, hepatitis and worm infestations).
- Villages where cholera and dracunculiasis were endemic.
- Villages having excess of fluoride, iron and brackishness and excess of arsenic.

National Technology Mission on Drinking Water

New push: 'Water for all'

In 1986, the entire programme was given a mission approach to make intensive efforts to cover problem villages. The programme was named as Rajiv Gandhi National Drinking Water Mission (RGNDWM). Out of 5.75 lakh villages, 2.27 lakh (39%) were identified as problem villages' for water in 1987. The Mission specific objectives were:

- Cover 2.27 lakh residual problem villages by 1990, i.e. 39% of total villages.
- Supply potable water of 40 litres per capita/day (lpcd).
- Supply water in desert area at the rate of 40 lpcd for human beings and 30 lpcd for cattle.
- Evolve cost-effective technology mix to achieve above objectives.
- Take adequate measures for sustained water supply.

Targets in 12th Plan, 2012–17 and by 2024

- In the states, where 40 lpcd have been achieved the next step is to raise the level of availability to 55 litres.

- By 2017, at least 50% of rural population in the country (as against 35% today will have access to 40 lpcd piped water supply within their household premises or within 100 meters radius (and within 10 meters elevation in hilly areas) from their household.[5]
- At the end of April 2021 56% of rural households had water sources within premises, 26% near premises and 18% away form house. *Jal Shakti* Ministry has been formed to ensure piped water supply to every rural household (*Nal se Jal* scheme) by 2024. Jal Jeevan Mission Aims at—Potable water to every rural household—*Har Ghar Jal*. Nearly 16 lakh rural households have been supplied tap water by Sept 2022.

Decentralization of Rural Water Supply

Panchayati Raj Institutions (PRIs): Currently planning of rural water supply is made at the central and state levels. Water supply projects are designed and executed by implementing departments and handed over to the end users. The system is supply driven, people and PRIs are not involved. The installed supply system fails because of lack of maintenance. PRIs are unwilling to take responsibility for maintenance of rural water supplies.

People First

A paradigm shift from 'government-oriented supply driven approach' to 'People-oriented demand responsive approach' was adopted in 1999.

People and PRIs should be involved and consulted as to what system of supply suits them. Cost sharing by users and PRIs is essential. Presently a large number of private organizations in rural areas are operating and have given water connections to household level and charge at the rate of ₹ 100–200 per household per month and people pay willingly to private operators. These private organizations use source of groundwater, shallow or deep tube wells. Reverse osmosis plants in Punjab with the assistance of Government of India have been set up in many villages and safe water is being provided to rural people at subsidized/affordable rate (₹ 2 per 10 litres). Government piped water supply system in these villages is not accepted. Piped water is used for everything except for drinking (bathing, washing clothes, utensils and preparation of tea as it is soft water, soap, works well on it and milk in tea pot does not curdle). Consumer consultation is essential to decide the kind of supply they want. PRIs should be empowered for devolution of powers and responsibility and to meet out part of cost of water supply. PRIs should be strengthened and entrusted with all activities relating to water supplies, sanitation, hygiene and nutrition. The participatory approach has become a necessity to share project cost but major source of funding for rural water supply schemes has to be from budget of the state and central governments.

Operation Maintenance

As more than 3.5 million hand pumps and over 1,00,000 piped water schemes have been installed in the country under the rural water supply programme. The total maintenance cost would be around 2000 crores per year (10–15% of capital cost). A majority of schemes remain non-functional and many other become permanently defunct due to lack of proper maintenance and repairs for want of funds. Funds of minimum needs programme (MNP) and the accelerated rural water supply programme (ARWSP) are already available to meet some of the operational and maintenance cost. Community should share the responsibility of maintenance cost.

Water Quality Monitoring and Surveillance

This is minimal in rural water supply system. Regular monitoring of quality and surveillance though most desirable is lacking. It operates only during 'crisis' situations, such as outbreaks and epidemics. People only demand chlorination when they observe a large number of mosquitoes larvae in the water supply of wells or during outbreak situation. Monitoring and surveillance system needs to be strengthened to a great extent by developing district laboratories and local capacity to test minimum parameters, such as residual chlorine, coliform count and *E. coli* count. The Government of India launched *National Rural Drinking Water Quality Monitoring and Surveillance Programme in February 2006*. This seeks to ensure community participation for monitoring and surveillance of drinking water sources at the grass root level by village *Panchayats* and village water and sanitation committees with support of district laboratories. H_2S strips are supplied to ASHAs and ANMs to monitor Quality of water.

URBAN WATER SUPPLY SYSTEM

Responsibility

Around 34% of population of India is urban and this proportion is going to rise in coming years. Municipal bodies have the responsibility of providing civic amenities including drinking water. *Jal Shakti* Ministry has been formed after integrating ministry of water resources, River development, Ganga rejuvenation and ministry of drinking water and sanitation to provide piped water supply to every household by 2024.

Goal

Rainwater is harvested/collected from roof top and ground catchment and stored in tanks and containers for drinking and harvesting purposes. Eleventh Five-Year Plan envisaged 100% coverage of urban and rural population with safe drinking water and sanitation as per stipulated norms and standards.

Norms of Water Supply in Urban Areas

Towns with piped water supply but without sewerage; 70 lpcd and cities with existing or planned sewerage systems; 135 lpcd, metropolitan towns and megacities with piped water supply and sewerage; 150 lpcd and public standpost; 40 lpcd.

Present Status

Improved drinking water sources include: Piped water supply at household, plot or public tap and protected tube wells, bore wells springs and rainwater harvested from roof and ground catchment and stored in containers.

Over 96% of rural households and 98% of urban households have access to improved drinking water source (2011). According to 78th round of national sample survey (NSS), and Census 2011, an estimated 70% of urban households are being served by taps, 20% by tube wells or hand pumps. 76% of households had drinking source within their premises, while 32% had it within 0.2 km; and 59% shared the public post. 15% of households did not get sufficient water from their principal source.[6]

Coverage figures do not reveal many things. Sufficient quantities as per norms are available to 60% of households, quality of water supplies in urban areas is very difficult to ensure. Pressure of growing population and habitations is mounting and supplies always run short. Conditions in urban slums are deteriorating fast because of large influx of migration of population to towns and industrial development. Widespread insanitary conditions hold perpetual threat of water contamination and consequently outbreaks of diseases and high incidence of waterborne diseases.

Water Post

One post or source for 150 persons at a distance of 100 metres

Finances

The financial health of municipal bodies is poor and amount of user charges collected in urban area is insufficient to meet the norms and augment and maintain water supplies. State government and municipal bodies share the cost of urban water supply. The central government only provides assistance through central sponsored schemes of accelerated urban water supply (AUWS) programme.

Centrally Sponsored Accelerated Urban Water Supply Programme (AUWSP)

This was launched in 1993–94 to provide water supply in towns with population of less than 20,000 as many as 2151 towns qualified for this scheme. The project funding is shared equally between central and state governments with 5% contribution from beneficiary. The centre meets the entire cost in union territories. Priority is given to towns with special problems such as very low per capita supply, very distant and deep water source, drought prone area, excessive salinity, fluoride and iron content in water source and high incidence of waterborne diseases. The per capita cost is normally limited to ₹ 1000.

Sources

Urban area water supply depends upon surface water (canals) or underground water. The raw water undergoes through all processes of cleaning and making it safe for consumption. The raw water passes through sieving → storage tanks → sedimentation → coagulation → clarification → chlorination → distribution. Usually rapid sand filter system operates in urban areas (*see* Fig. 4.1). All said and done the quality and quantity of water supply in urban area is poor and water supply system is under pressure of ever increasing population and outbreaks of waterborne diseases are perpetual phenomenon. Viral hepatitis and other waterborne diseases have become endemic in many urban areas.

Competency addressed: The student should be able to:
CM 3.5: Describe the standards of housing and effect of housing on health.

Housing in Urban and Rural Areas and its Effect on Health

Housing in urban and rural areas: It is a big problem. Overcrowded houses with poor ventilation, poor drainage and sanitation lead to widespread diarrhoeal diseases and respiratory infection, TB, and vector-borne diseases.

Government is determined ot provide affordable houses to all by 2022.

WHO HOUSING AND HEALTH GUIDELINES

Improved housing conditions can save, prevent disease, increase quality of life, reduce poverty, help mitigate climate change and contribute to the achievement of the sustainable development goals (SDGs), including those addressing health (SDG 3) and sustainable cities (SDG 11). Housing is becoming increasingly important to health due to demographic and climate changes. The world's urban population is expected to double by 2050[a] and will require housing solutions. The world's population aged over 60 years of age, who tend to spend more time at home, will also double by 2050.[b] Changing weather patterns, associated with climate change, underline the importance of housing providing protection from cold, heat and other

[a] Habitat III. Revised zero draft of the New Urban Agenda. Quito: United Nations; 2016.
[b] World report on ageing and health. Geneva: World Health Organization; 2015

extreme weather events in order to promote resilient communities.

Housing can expose people to a number of health risks. As discussed in the WHO Housing and Health Guidelines (HHGL), structurally deficient housing increases the likelihood that people **slip or fall**, increasing the risk of injury. Poor accessibility to their house puts disabled and elderly people at risk of injury, stress and isolation. Housing that is insecure, sometimes due to affordability issues or weak security of tenure, is stressful. Housing that is difficult or expensive to heat contributes to **poor respiratory** and cardiovascular outcomes, while high indoor temperatures can cause heat-related **illnesses** and increase cardiovascular mortality. Indoor air pollution is connected to a wide range of non-communicable disease outcomes, harms respiratory and cardiovascular health, and may trigger allergic and irritant reactions, such as asthma. Crowded housing increases the risk of exposure to infectious disease like tuberculosis. Inadequate water supply and sanitation facilities affect food safety and personal hygiene, and, therefore, lead to the development of communicable diseases.

Policy on housing for poor addresses problems of crowding, indoor cold and insulation, indoor heat, home safety and injuries and accessibility.

Competency addressed: The student should be able to:
CM 3.4: Describe the concept of solid waste, human excreta and sewage disposal.

SOLID WASTE, HUMAN EXCRETA AND SEWAGE DISPOSAL

The WHO/UNICEF estimates that 2.5 billion people—40% of the world's population lack access to even basic sanitation. It stands as the most neglected millennium development goal.[1]

World Bank water and sanitation programme study reported that poor sanitation cost India $54 billion or 6.4% of GDP in 2006. There are losses in terms of education, productivity, time and tourism. Around 62000 children aged below 5, die of diarrhoea alone in India every year. It may be under-reporting as 76% of morbidities in young children were due to diarrhoea in 2022.

India tops the list of countries where people defecate in open, exposing them to soil and waterborne infections.

'Sanitation is a way of life', it should be people's programme.

Sewage is raw water or waste water or human and animal excreta plus water; while sewer means network of pipes laid underground.

Definition: 'Sanitation' is collection, transport, treatment and disposal or reuse of human excreta, domestic waste water and solid waste, and associated hygiene promotion. The insanitary conditions were appalling in India. Sanitary conditions have improved in rural India. Now, 67% of rural households were using latrines and the rest 33% defecated in open, as revealed by UNICEF 2022 data; against 79% of urban households using latrines, while the national average being 71%. As per NFHS-4 (2019–21) about 81.5% of urban and 64.9% of rural households were using improved sanitation facilities such as—flush to piped sewer system, septic tank, pit latrine, ventilated improved pit/composting toilet which is not shared with any other household. Relative to the attention given to safe water, sanitation programme has had a very late start. There is now a distinct change in the strategy of 'promoting sanitation' by the Government. *Swachh Bharat Abhiyan* and open defecation free India and the *central rural sanitation programme* now promotes sanitation as a seven-component package.

1. Safe handling of drinking water.
2. Scientific disposal of waste water.
3. Safe disposal of human excreta including child excreta.
4. Disposal of garbage and animal excreta.
5. Home sanitation and food hygiene.
6. Improved personal hygiene.
7. Village sanitation.

Now the government intends to promote rural sanitation as a package as stated above.

The priorities for rural sanitation have been fixed as:

i. Preference will be given to the twin pit-model of water seal latrine. The successful model of Midnapur single pit latrine may also be adopted.
ii. School sanitation (providing toilets) should be given highest priority to inculcate safe hygiene habits among students.
iii. Village *Panchayats* should adopt building by-laws where dry latrines are not permissible only water seal type latrines are to be constructed.
iv. The state council proposed for urban sanitation sector should also have the mandate for rural sanitation.
v. Subsidy for low cost household toilets should only be given to rural below poverty line (BPL) families and it should be at par with subsidy for urban households. For the success of the scheme, a subsidy of 50% of the cost of unit inclusive of sub- and superstructures for the basic twin pit pour flush system appears to be necessary.
vi. In order to mobilize funds for rural sanitation, financial institutions/banks including Housing and Urban Development Corporation (HUDCO) and the National Bank of Agriculture and Rural Development (NABARD) should extend loan to states at lower rates of interest for provision of sanitation facilities.
vii. Private sector should be encouraged in setting-up of building centres and sanitary marts in rural areas to provide cost-effective sanitation technology.
viii. The recommendations made for urban low cost sanitation should also apply to rural areas as well.

ix Sanitation is a way of life. To change behaviour and adoption of sanitary practices, intensive, communication, education and appropriate information is necessary to be disseminated to women groups, PRIs and Village Health and Sanitation Committee through multiple channels. Participation of non-governmental organizations like *Safai Vidayala*, Ahmedabad, has made a real difference. Basic hygiene facilities are in place for 71% of population in India.

Social Factors Related to Excreta Disposal: 'Easing for Diseases'—A Case Study

Seventy to eighty per cent of illnesses are related to water contamination and poor sanitation. Because of age-old practice of indiscriminate open field defecation, widespread soil pollution occurs in villages as also in urban slums.

1 Human excreta which contains pathogenic organisms pollutes soil and drinking water by way of contamination because of human behaviour such as ablution, washing of dirty linen, hands and utensils at the source or nearby source. Soil in and around house get contaminated continuously because of human behaviour.

2 Excreta of children is considered to be harmless which is a wrong perception. Because of this perception children are allowed to defecate in and around home which leads to contamination of soil, food and drinking water at home; because children and adults may handle drinking water with soiled hands and fingers.

3 Open defecation is generally not seen as a health hazard by the community. Women folk defecate during dusk and dawn not very far from their dwellings, around village periphery near cow dung cake stores/heaps, in groups. Because of population explosion the defecating grounds are shrinking.

4 Men folk choose to defecate a bit away from village (about ½–1 km). They combine the act of defecation with morning walk and smoking with a firm belief that smoking helps the act of defecation, which has no scientific base.

5 Hands are used for the act of ablution and washing of hands after defecation is done with plain water or water and mud. Soap is seldom used.

6 People draw drinking water from pitcher/container by dipping their fingers and hands which are quite often soiled/unclean, this practice contaminates the stored water in the pitcher/containers and may act as risk factor for waterborne diseases.

7 Latrines are considered to be dirty places and nuisance of odour and flies.

8 Toilet built by the government or with subsidies of government are seldom used by people as these are considered as '*Sarkari* toilets' and often used as storage bins.

While improved quality of water resulted in one-sixth reduction in diarrhoea, however, improved excreta disposal resulted in one-third reduction in diarrhoea. By adopting a practice of excreta disposal to pit latrine or similar faecal disposal system along with improved water supply could reduce prevalence of diarrhoea to the extent of 44%. The highest rates of diarrhoea are found among slum children whose families did not have latrines.

Learning Personal Hygiene: Washing Hands

Practice of handwashing with soap before handling food, and water and after defecation can reduce the incidence of diarrhoeal diseases and worm infestation. This is a lifestyle and most important habit; must be developed in young children and should be practiced by every one to avoid diseases.

Recent studies have shown that personal hygiene practices like washing one's hands with soap and water after defecation and before eating could reduce diarrhoeal disease incidence and worm infestation by 43%. Practice of handwashing amongst young children should be inculcated by parents and family members, by *Anganwadi* workers in the *Anganwadis* before serving supplementary food, the young children should wash their hands. Large majority of *Anganwadi* workers have done it successfully. In our experience, once the young children develop the habit of washing their hands at *Anganwadi* centre, these children insist their parents to wash their hands before eating and some of the parents/mothers complained to *Anganwadi* workers that they have to bring now extra water to wash the hands of their children; and their water consumption has gone high.

School teachers should also inculcate habit of handwashing among their students by demonstration and becoming a good role model. Learning hygiene at school should be part of education and lifestyle. School sanitation programme has been chosen as priority area of rural sanitation programme as a part of *Swachh Bharat Abhiyan* and seven-component package as also component of TSC. However, only in 53% of schools basic hygiene services are in place.

Learning trimming nails and cleaning nailbeds prevents diseases. Similarly, eating clean food with clean hands and using clean utensils and clean water prevent waterborne diseases. These measures are measures of personal hygiene practices acquired in the family, at *Anganwadi* at school or at workplace.

Water Storage Practices

Storing clean water in clean utensil and keeping the water container covered was adopted by most families in rural areas, but positive effect of this practice was negated when people dipped their fingers and hands, while retrieving and using the water from pitcher/container. Storage of water in narrow mouthed pot (*Surahi*) prevents contamination.

Competency addressed: The student should be able to:
CM 3.4: Describe the concept of solid waste, human excreta and sewage disposal.

How? By demonstration and visits to establishments.

SAFE DISPOSAL OF HUMAN EXCRETA IN RURAL AREAS

Human excreta contains disease producing organisms and is the chief source of many diseases. Human excreta comes back to human mouth by contaminated water, dirty hands, flies, insects and eating raw and unwashed vegetables. Therefore, human excreta must be disposed off safely. nearly 29% of Indians defecated in open in 2021.

METHODS OF HUMAN EXCRETA DISPOSAL

Methods of human excreta disposal by use of sanitary latrines: Sanitary latrines should be acceptable, affordable and accessible. A sanitary latrine is one which does not contaminate the source of water, where excreta is out of bounds to flies and it does not produce objectionable odour and it is kept clean and acceptable to people. Some of the commonly used latrines in rural areas are as under.

Borehole Latrine

Digging a hole of 12″ to 16″ diameter with special instrument called 'auger' up to a depth of 10–20 feet underground. The concrete squatting plate with central hole is placed on the borehole. The excreta and ablution water directly falls into the hole and undergoes anaerobic digestion. The hole gets filled up in 1–2 years time. The hole can be lined with appropriate affordable material such as earthen rings, bamboo matting, etc.

Pit Latrine/Dug well Latrine

Pit latrines are used where the water is scarce and solid materials or minimum quantity of water are used for anal cleaning. This latrine is very simple to construct and cost is very low. A pit of 0.75 × 0.85 × 2.50 meters is dug and covered with a squatting slab having an opening. Excreta goes into the pit directly. The excreta may be covered with earth after defecation. The disadvantage of this type of latrine is that flies can come in direct contact with the excreta and moreover objectionable odour is a problem. Decomposition of excreta occurs by soil bacteria. Life of this latrine depends upon size of pit and number of users (Fig. 3.3). Pit can have water seal hand flush system (Midnapore design) to avoid fly breeding and bad smell.

After the outstanding action research contribution of The Planning and Research Action Institute (PRAI), Lucknow and Research-cum-Action (RCA) Project of ICMR and All India Institute of Hygiene and Public Health, Kolkata, RCA latrine (single pit or twin pit) design has been accepted and being promoted under Total Sanitation Campaign (TSC) in rural India.[7] Over 9% of Indians use pit latrines.

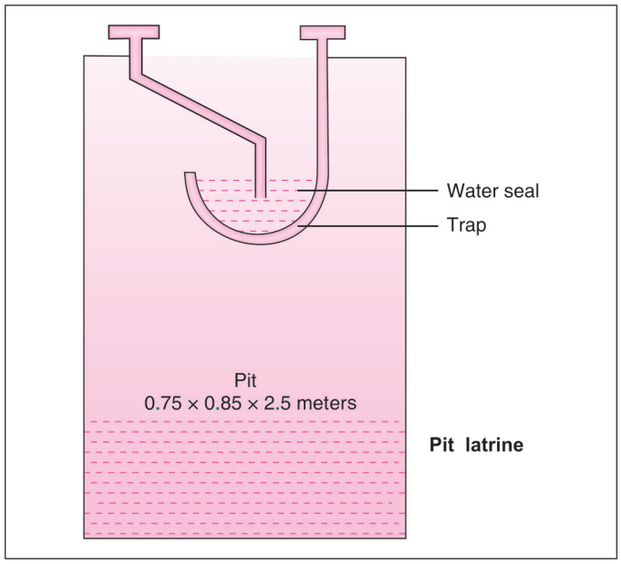


Fig. 3.3: Low cost hand flush single pit sanitary latrine (Midnapore design) for rural area

Flush Type Water Seal Latrine (Twin Pit Water Seal Latrine)

This type of latrine requires water for flushing usually hand flushed, requiring at least 2 litres of water per user. The essential feature of flush type is the 'water seal'—this is the amount of water which remains in the trap and prevents entry of flies/fly breeding and bad odour coming out of the pit (Figs 3.4 and 3.5).

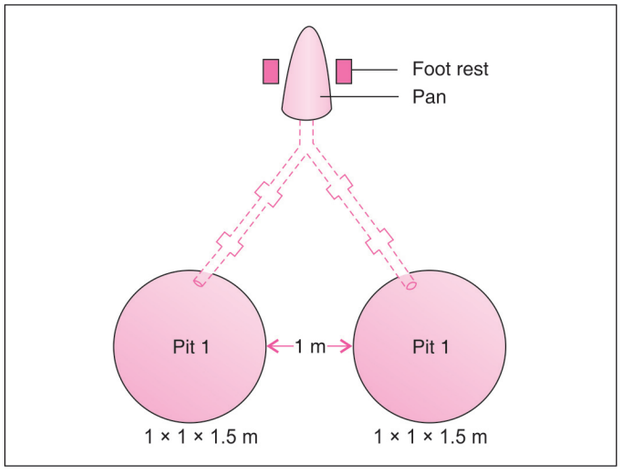


Fig. 3.4: Two pits water seal latrine for rural area for safe disposal of human excreta

Latrine pan/seat is connected to two pits by Y-shaped drain. Two pits of 1.5 meter deep and 1 meter diameter (circular or rectangular) are dug and connected through pipes to pan. One pit is put to use at a time. One pit can last for 3 years for 5 persons.

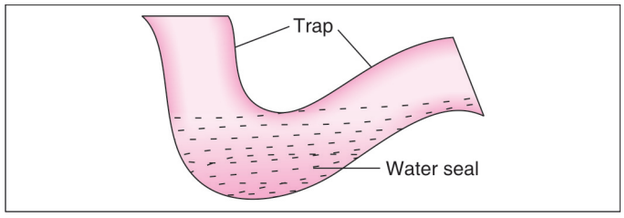


Fig. 3.5: Trap with water seal

Once the first pit is filled-up in about 3 years, the second pit is then used. The excreta in first pit is left undisturbed for a period of 2 years. After this much period the excreta gets self-digested by soil bacteria anaerobically and is rendered harmless. The contents of the pit can be removed/emptied safely and used as good manure, which is quite harmless. Hence, two pits are used alternately.

If only one pit is used to reduce the cost and space, it can be located directly under the slab incorporating the water seal unit. When the pit is filled-up, the contents have to be removed to second pit specially dug for this purpose, which is then covered with earth and left undisturbed for 2 years for decomposition of excreta. Alternately a new latrine can be constructed.

Ventilated Improved Pit Latrine (VIPL)

When a vent pipe is added to the pit to help escape of gases it helps in removing the bad smell. Fly screen is fitted at the top of vent pipe to act as trap for flies.

Location of Latrine

The flush latrine can be safely located 10 meters away from drinking water source; however, the safest distance is 15 meters.

Septic Tank

Septic tanks are in use in urban areas mainly and by some well to do households in rural areas. 22% of urban, 14.7% of rural households are using septic tank latrines.

This consists of a rectangular tank of 4½ × 3 × 3 feet deep below the water line, which is sufficient for a unit of six family members. It is a water-tight compartment, with inlet and outlet. The excreta from the pan and trap flows into tank and stays in the tank for considerable time. The excreta undergoes anaerobic decomposition in the tank.

The digested sludge at the bottom of the tank has to be removed periodically say once a year, which can be used for horticulture or agriculture purposes or manure. The effluent is usually let into drains but the effluent is as strong as city sewage and requires further treatment before it can be discharged on land or water courses. A large number of helminths eggs escape in effluent.

Promotion of latrine programmes in rural areas through the community development programmes initiated way back in 1952, through education department in schools and through *Anganwadi* workers in ICDS programme has not achieved much success. In some states like Gujarat, this programme has achieved some success. In some rural areas of Haryana (Distt. Sirsa), dug well latrine, is almost a universal practice in each home for women and children for security and privacy and it is their felt need. These latrines can be constructed with local technology and local resources with minimum cost. The cost was subsidized by the government for economically weaker sections and below poverty line families. One of the stated function of the primary health centre was 'environmental sanitation'. One sanitary inspector was posted at each primary health centre to promote environmental sanitation including latrine promotion programme as also ensuring regular chlorination of wells. Most of the tasks related to environmental sanitation have remained unaccomplished and it is too big a function to be performed by health centre. Seven components of rural sanitation as package need to be implemented through integrated efforts involving village *Panchayats*, VHSC, development functionaries, health; education and ICDS sector, women organization, voluntary and non-governmental organizations.

Case Study of a Dug Well Latrine

One of the police station in district Sirsa in Haryana had a dug well latrine which was used infrequently. In the past 6 months, the latrine was used only on a few occasions. One fine morning a police man had to use this latrine. Being a chronic smoker, he was habitual to smoke before the act of defecation. Most men in this part smoke before defecation with a firm belief that smoking facilitates the act of defecation. While squatting on the seat, this gentleman lighted a cigarette and burning matchstick was thrown in the pit of dug well latrine. Amazingly all of a sudden fire erupted in that pit and it caused perineal burns, before this man could escape from the site of latrine. Thus, the man was penalised for smoking by nature. Fire erupted because of accumulation of methane gas under the scum of human excreta which acted as partial seal. During the act of defecation on that day, the seal got disturbed and gave way to methane and burning matchstick led to fire flame in the pit.

Disposal of Waste Water at Household Level

Soakage pit can be constructed to dispose waste water or waste water can be discharged to kitchen garden. A soakage pit is a pit of 1×1×1 meter dug and filled with stones or rubbles, broken bricks and pebbles and the top of the pit is covered with layer of soil. Usually 10–15 cm rubbles or broken bricks are placed at the bottom of pit to fill up to one-third of the depth, followed by rubbles of 5–10 cm and 1 cm size respectively. Top of the pit is covered with gunny bag with 5 cm layer of soil on it. The waste water is

led to this pit and it is soaked by the earth. This avoids water collection and prevents mosquitoes breeding. Community can improve the drainage system at household level. Waste water of household can also be disposed in kitchen garden.

Competency addressed: The student should be able to:
CM 3.4: Describe the concept of solid waste, human excreta and sewage disposal.

SOLID WASTE MANAGEMENT

Towns and mega cities have drawn focused attention after the outbreak of plague in Surat in 1995. Solid waste consists of kitchen waste (garbage), waste papers, rags, glass pieces, metal pieces, dry leaves wood pieces, brick bats, plastics, etc. Solid waste is disposed of by trenching, **sanitary land fill** and by biomass or composting. Growing towns and slums, implementation of urban development and rise in population; pose serious problem to manage solid waste disposal. Plastic era has added to the problem of blocked sewers and non-biodegradable qualities of plastic material inhibit process of composting. Proper management of biomedical waste management is another problem.

Disposal of Garbage and Animal Excreta by Composting Method

Garbage is wet refuse (kitchen waste, vegetable and fruit peelings, left out vegetables, left out food) and if it is disposed indiscriminately or heaped-up around houses is a breeding ground for flies which can carry disease organisms and contaminate the food. Similarly, animal excreta is rich in organic matter, hence is most suitable for fly breeding. Garbage disposal and animal excreta disposal can be done in manure pits. Location of manure pits should be away from home. Every week a layer of soil 2 feet thickness is laid over levelled garbage to prevent fly breeding when the pit is filled it is covered with layer of firm soil and left undistributed. After 3 months, the contents of pit become good manure. A compact earth bank of 4 feet is raised around the pit to prevent flow of rainwater into pit. **Bangalore** method of composting night soil plus refuse in alternate layers by anaerobic method is quite simple and most popular method. **Indore** method of composting refuse and night soil by aerobic method is yet another method of safe disposal of refuse and night soil. Asia's biggest bio-CNG plant—the Gobar Dhan Plant with capacity to treat 550 tonnes of Garbage per day has been set up to Indore which is the cleanest city of India.

***Gobar* gas plant** is an appropriate technology, which can be used for safe disposal of animal excreta. Minimum quantity of 40–50 kg of *Gobar* (cow dung) per day is essential to feed the plant. This technology yields methane gas which can be used for cooking and the slurry or sludge formed after the process can be used as good manure. This requires keeping of 3–4 cattle and the cost may be unaffordable by below poverty line families, the maintenance of plant poses several problems, but these can be obviated by good training and upkeep of the plant.

Smokeless *Chullah* (Earthenware Stove)

Over 50–80% of houses in rural areas in India use unprocessed biomass fuel (firewood, crop wastes and cow dung cakes) which generate lot of smoke in the kitchen. More often than not the kitchens are ill-ventilated and the smoke generated by the fuel enters the respiratory system of women and children who are most susceptible. Indoor air pollution in rural homes is thus a widespread phenomenon. Its ill effects are acute as well as chronic respiratory diseases and also associated with long-term cardiovascular effects and increased risk to lung cancer in women and children. These ill effects can be avoided by improving the ventilation in the kitchen and by using smokeless *chullahs*. District rural development agencies are promoting the use of these *chullahs*. In addition, such *chullahs* offer the additional advantage of saving the fuel as these are fuel efficient, thus saving the energy and workload of women. *Mahila Mandals* have come forward to popularize these *chullahs*. In a nutshell, these *chullahs* are user-friendly and prevent indoor air pollution. PM UJWALLA YOJNA of free LPG connections and gas at subsidised rate to poor has reduced indoor air pollution.

Use of Solar Cookers

It is yet another technological advance and user-friendly device of non-conventional source of energy. Use of solar cookers in rural areas is becoming popular as it saves workload of women and it is environment-friendly, acceptable and affordable device.

Total Sanitation Campaign (TSC)[7]

As per Census 2011 data, nearly 50% of households used toilets. This percentage was lower in villages where only 33% used toilet. Total sanitation campaign is a sound beginning. Its objectives are to bring about improvement in general quality of life in rural areas, accelerate sanitation coverage and generate demand for toilets in all schools and *Anganwadis* in rural areas through awareness and education. TSC is presently being implemented in 572 districts. Components of TSC include IEC activities, rural sanitary marts, individual household toilets, women sanitary complex school sanitation programme and *Anganwadi* sanitation. *Nirmal Gram Puruskar*, a National Award under TSC has been launched in February 2005 by the government. Goal is to achieve open defecation free India by the year 2019 under *Swachh Bharat Abhiyan*. The 7th World Toilet Summit was held at India in Delhi on 19th November 2007 (world toilet day) wherein 40 countries participated, with focus on to meet the sanitation needs of people worldwide. The UN (United Nations) has declared

2008 as the International Year of Sanitation with an objective of providing toilet for all by 2030.

Sustainable Development Goal 6 of UN: Universal and equitable access to safe and affordable drinking water and sanitation for all by 2030 and end open defection paying special attention to the needs of women. United Nations has adopted a landmark resolution recognising the human right to 'Sanitation' along with the right to safe drinking water.

Swachh Bharat Abhiyan (SBA)/Mission

It was launched on 2nd October 2014 at New Delhi by Prime Minister of India. SBM has two sub-missions: *Swachh Bharat Abhiyan Gramin* which operates under Ministry of drinking water and sanitation and Swachh Bharat Abhiyan (SBA) (Urban) which operates under Ministry of Housing and Urban Affairs.

The objective: It aims at universal sanitation coverage. The objectives of SBA includes sanitation for all, eliminating open defecation through construction of household owned and community owned toilets and to establish an accountable mechanism of monitoring toilet use. The other objectives are solid and liquid waste management and safe drinking water for all.

The incentive amount provided under SBM (Gramin) to below poverty line households shall be up to ₹12,000 for construction of one unit of Individual Household Latrine (IHHL) and to provide for water availability including storage for handwashing and cleaning of toilet. Central and state government share is in the ratio of 60:40 and for North-East and special category states it is 90:10; *Gram Sabha*, municipal bodies actively participate in it. The crux of the SBA is to facilitate positive change in behaviour of people to undertake construction of toilets and use for themselves. **It is the biggest ever programme** for behaviour change communication (BCC) **Undertaken** by **GOI** on war footing. *Swachh Survekshan 2019* undertaken in 4237 cities indicates that 2900 urban local bodies are open defecation free (ODF) certified in 23 states, 1863 ULBs practice door to door garbage collection in more than 40% of wards. Indore is the cleanest city of India. Rural India was declared as "open defection free" on 2nd October 2019. Under SBM India was declared ODF in 2021. Over 100 million toilets have been constructed.

URBAN SANITATION

Problem

Census 2011 reported that 12.6% of households reported using no latrine, 38.2% reported using septic tank and 32.7% reported using sewerage system. This indicates that as many as 12.6% of households in urban areas had either no latrines or no connection to septic tank or sewerage and practice open field defecation. Overall 87.4% of urban households have latrine facility within the premises.

Out of 300 class I cities, about 70 have partially sewerage system and sewage treatment facilities. Levels of sewage treatment are reported to be very low. Nearly 72% of the liquid sewage generated daily by Indian cities flows into streams, rivers and sea untreated (Central Pollution Control Board). In 2020–21 cities produced around 72,368 million litres of waste water each day and India presently has the capacity to treat 20,236 million litres of waste water everyday (28%) but just 39% of treated waste meets the environment norms. Thus, the untreated and partially treated municipal waste water finds its way into water resources such as rivers, lakes and groundwater, causing water pollution. On the other hand, programme of low cost sanitation which offers an affordable alternative technology has made very little progress despite being linked to social problem of manual scavenging which is prohibited by law.

The poor sanitary conditions in urban slums are linked to outbreaks of cholera and gastroenteritis. Waterborne diseases are a major cause of mortality throughout India and impose a huge burden in terms of loss of lives and productivity.

Low-cost Sanitation (LCS)

The centrally sponsored scheme of urban low-cost sanitation for liberation of the scavengers started from 1980–81, initially through the Ministry of Home Affairs and later through Ministry of Welfare. From 1989–90 it came under the Ministry of Urban Development.

Objective

The main objective of LCS is to convert dry latrines into low cost pour flush latrines and provide alternate employment to the liberated scavengers.

Coverage

The scheme covers all the households which have dry latrines and households having no sanitation facilities including households in slums and squatter colonies.

NGO's Role: NGO Like *Sulabh* International

NGO's role: NGO like ***Sulabh*** **International** has played a key role in the construction and maintenance of 'pay and use' toilets for floating population or places such as bus stands, markets, parks and other places where people congregate.

Community Toilets

The scheme of LCS also includes community toilets. However, the experience of upkeep and maintenance of community toilets by municipality has been quite dismal, with the conditions turning so insanitary that the people prefer open air defecation to using public toilets. Public latrine are used by 3.2% of people.

Treatment of Urban Waste Water

Three-fourths of surface water resources are polluted and 80% of the pollution is due to sewage alone. Sewage is

rich manure apart from economic source of methane gas. Waste water or sewage treatment facilities are missing in most towns. Sewerage system is the answer for the problem but sewage treatment facilities needs to be geared up.

Scheme to Provide Sewerage for River Bank Towns

Urban waste both solids and liquids of towns located on the banks of river finds its way directly to river. The Ministry of Environment and Forest is implementing a massive programme of cleaning of rivers and lakes in the country. The programme which was started with Ganga Action Plan (GAP) in 1985 now extends to the polluted stretches of 27 major rivers with sewerage system works spread over to 149 towns in 16 states.

Sewage (Human Excreta) Treatment Processes

Sewage: It is human excreta, wash water and liquid waste. Sewage consists of more than 99% of waste water and solid content is less than 1%.

Sewage treatment facilities are available in metropolitan and mega cities only and missing in most other cities. Raw sewage or untreated sewage is used for agriculture and horticulture proposes (mainly as organic manure), this is risky practice and waste may come back to human beings through flies and raw vegetables and this pollutes the water sources of the city, if it is let into the river.

- **Primary treatment** of sewage consists of—screening → grit removal → primary sedimentation → sludge digestion.
- **Secondary treatment** consists of—biological treatment by → aeration, addition of activated sludge → final sedimentation followed by chlorination of effluent and sludge digestion → sludge drying (Fig. 3.6).

The biological process consists conventional techniques such as trickling filters, activated sludge process, extended aeration, aerated lagoons, oxidation ditches, up-flow anaerobic sludge blanket reactor, contact biological disk reactors, etc.

In most of the towns, only the primary treatment is done and secondary treatment facilities are not made available because of cost factor. Thus, most of sewage is partially treated and is not free from health risks.

Screening

Sewage is passed through a coarse screen or iron bars, this process holds back the floating objects in the sewage.

Grit Chamber or Detritus Tank

After screening when sewage is collected in small tanks, the heavy suspended material such as gravel, sand debris and ashes (inorganic material) settle down in this chamber.

Sedimentation

Sewage is allowed to stand for some period say half an hour to three hours in tanks, the suspended organic matter will settle down at the bottom is called 'sludge' when the process of sedimentation is applied to new sewage it is called primary sedimentation.

Screening, grit removal and **primary sedimentation** and **sludge digestion process** is called **primary treatment** of **sewage**.

Secondary Treatment

The secondary treatment of sewage consists of oxidation and aeration of sewage, percolation through trickling filter activated sludge mixing, oxidation ponds and oxidation lagoons.

Percolation or Trickling Filter

The effluent (liquid part of sewage) from primary sedimentation tank is sprinkled in spray form by perforated rotating pipes, over filter bed similar to slow sand filter described for water purification. The effluent trickles through filter

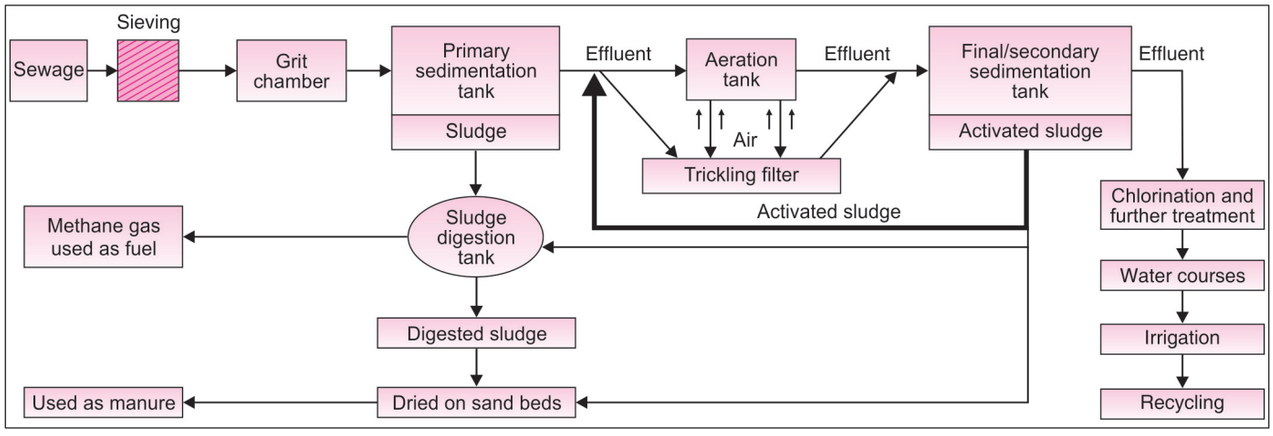


Fig. 3.6: Sewage treatment processes

and comes in contact with topmost vital layer or 'zoogleal layer' which removes bacteria, fungi and it is oxidized by atmospheric oxygen and the effluent after passing through filter bed gets clarified and it loses much of its venom. An efficient trickling filter would reduce the biochemical oxygen demand (BOD) of sewage to the extent of 85–95%.

Final Sedimentation or Secondary Sedimentation Process

The effluent from bottom of trickling filter is allowed to stay in secondary sedimentation tank. Aerated sludge or activated sludge settles at the bottom of the secondary sedimentation tank. The sludge is allowed to dry upon the drying beds of the ground and can be removed after drying and can be used as manure or mixed with soil as soil conditioner.

Activated Sludge Process

Part of the activated sludge from secondary sedimentation tank which contains the active aerobic bacteria is re-circulated and allowed to mix with effluent coming out of primary sedimentation tank, as also mixed with sludge of primary sedimentation tank. The sludge from primary sedimentation tank and active sludge is further aerated by diffusion of air in *aeration tank*. This process reduces the biochemical demand of oxygen and it reduces load on the system and improves the efficiency of the process. Oxidation of ammonia to nitrates and nitrites also gets faster with this process. This process is called biological **treatment of sewage**.

SLUDGE DIGESTION

Sludge which settles at the bottom of primary sedimentation tank and secondary sedimentation tank is led to sludge digestion tank, which is a closed tank. Here anaerobic digestion of sludge takes place and this process produces lot of methane gas and carbon dioxide. The methane thus generated can be used as fuel and power for various processes of sewage treatment. The digested sludge is removed from the digestion tank and dried on sand beds or taken to lagoon and allowed to dry up or else it is dried up by pressure filter process. The dried sludge serves as good manure.

OXIDATION POND

Here the sewage is exposed to sunshine and air in leak proof tanks, after the sedimentation (primary and secondary sedimentation). This process converts the organic matter of the sewage into harmless sludge which can be removed periodically or subjected to digestion by anaerobic or aerobic processes as described. The algae protozoa and fungi at the bottom of oxidation pond help and enhance the process of oxidation.

Oxidation Ditch/Aerated Lagoon

Here the sewage is mechanically aerated. It occupies less land area and efficiently oxidizes the suspended matter and dissolved organic matter by aerobic bacteria. The coliform organisms in sewage can be reduced by 90–95% by biological oxidation.

Tertiary Treatment of Sewage

When the water is scarce and the waste water is to be recycled for drinking purposes or recreational and industrial use, the effluent is further subjected to final treatment to make it absolutely harmless. Filtration and coagulation processes make the effluent more safe. Ozonization is most efficient method to destroy all sorts of pathogens, but it is quite costly. Superchlorination is another alternative to make effluent safe.

Disposal of Effluent (Fig. 3.6)

- The effluent after treatment (chlorination) is used for irrigation purposes. Sewage farming is common in many areas.
- The treated effluent can be disposed of in water courses such as rivers, streams, lakes, sea, ponds and canals.

Biochemical Oxygen Demand (BOD)

It is the amount of oxygen absorbed by the specified amount of sewage (one liter) at particular temperature (20°C) for specified period (5 days) for aerobic digestion of sewage. It measures the efficiency of treatment process as also the extent of strength of sewage. BOD of 300 mg/L (300 ppm) or above is called strong while that of 100 mg/L (100 ppm) is called weak.

The standard for biochemical oxygen demand (BOD), which represents the extent of organic pollution in a water body, is fixed at 10 mg/L in the country. This means any industry or infrastructure project or municipality has to treat sewage or effluent to a level of 10 mg/L prior to discharging the same to a water body. The standards in the developed countries are being revised and are now being based on the total maximum daily load (TMDL) calculation rather than a source based limit. In India, the level of BOD in source of drinking water has been fixed as BOD 2 mg/L or less.

Competency addressed: The student should be able to:
CM 3.1: Describe health hazards of soil pollution.

HEALTH HAZARDS OF SOIL POLLUTION (SP)

SDG: Reduce number of deaths and diseases due to soil pollution.

Soil—*Dharti Ma* (Mother Planet—The Earth) in India is respected and worshipped, but because of compulsive

life and exploding population this respect is diminishing fast. Soils are formed by the disintegration and decomposition of rocks, vegetation and animal fossils embedded in them. Decomposition and disintegration is brought about by action of rainwater, running streams, glaciers, wind, high and low temperatures, storms, volcanic activity, apart from action of soil organisms such as many soil bacteria, fungi, protozoa, earthworms, etc. and interaction of various chemicals. Soil structure and composition varies from region to region, district to district and state to state. It could be categorized as sandy soil, clay soil and loamy soil or alluvial, black, red, laterite, arid and desert, mountain and hilly, saline and alkaline, peaty and other organic soil.

Humus

Humus is decomposed vegetable matter dead roots, fruits, flowers, trunks, branches and leaves. It forms dark coloured surface layer on the ground. It is rich in nitrogen and can absorb lot of water. Humus is used for conditioning of soil, if it is added to sandy soil to improve its quality. Humus is an important seat for bacterial activity. Soil organisms and bacteria help decomposition of organic matter in the soil including human excreta. Pit latrines and trench latrine excreta gets decomposed by soil bacteria and organisms and over a period of time it gets converted to good manure for use in agriculture. Soil contains varieties of bacteria like nitrifying bacteria, nitrogen fixing bacteria, ammonifying bacteria, and sulphur bacteria. Lot of fungi and algae also help in decomposition of organic matter.

Human Population (Easing for Diseases)

Growing population and human excreta is enormous problem. Management of human excreta is uphill task in itself. Nearly 67% of villagers use sanitary latrines, while 33% defecate in open field. Similarly, 21% of urban slum dwellers have no facility of latrine and use all sorts of available grounds, open areas, railway tracks for indiscriminate defecation. Almost every big city has enormous problem of human faecal matter. Scene and obnoxious smell of excreta along railway tracks is awful in capital city of Delhi and other big cities.

Indiscriminate defecation by people in urban and rural areas leads to widespread soil pollution in India. Average faeces excreted per person per day defecting in open amounts to 0.3 kg per day × 30 days = 9 kg per month contaminates soil.

Sewage and Sewer

Sewage: It is raw water or waste water or human or animal excreta plus water.

Sewer: It means network of pipes laid underground to carry sewage.

Very few towns in India have complete facility of sewage treatment, sewage is collected through sewer system and disposed off untreated or partially treated outside town or led into water courses. Towns and cities along the river bank dispose off their raw sewage into rivers thus polluting drinking water sources. The sanitary disposal of night soil with effective control of foul smell and fly nuisance is therefore a serious problem all over the country.

Raw sewage and partially treated sewage as also sludge are used in farms, which is called *sewage farming*. This practice is hazardous. Vegetables grown on soil manured with untreated sewage and sludge is real danger to health. Human excreta comes back to human beings through vegetables and fruits (vegetables grown on such soils and consumed by human beings as unwashed, partially washed or uncooked). Taenia eggs can survive for long in soil and can survive many sewage treatment processes.

Garbage, Refuse and Solid Wastes

Garbage, refuse and solid collection and disposal in cities and rural areas leaves much to be desired. Quite often it is just heaped up on the outskirts of city and is not subjected to composting. Manure pits or trenches are seldom dug by municipal authorities. Garbage and refuse which is just dumped at outskirts of city poses several health problems. Biodegradable and non-biodegradable waste is dumped up together and no effort is made to segregate the waste. Plastic bags and plastic material hinders the process of composting. Rag pickers bring back the dirt to market and town population. Indiscriminate disposal of garbage, refuse and solid waste produces soil contamination and health hazards of several kinds (fly breeding and rodents apart from contamination of soil with plastic). Spores of *B. anthracis* remain viable in contaminated soil for many years. Rodents and cattle excrete large number of leptospires organisms in their urine and are thus responsible for the contamination of soil. The salinity of soil provides favourable environments for survival of leptospires.

Industrial Effluents and Soil Pollution

Urbanization and industrialization are inevitable for economic development, but uncontrolled industrialization has its own drawbacks. Many polluting and hazardous units are located in non-confirming areas (within the residential complexes). Dangerous and hazardous industrial wastes and effluents are dumped into the soil which leads to widespread soil pollution and air pollution. Most toxic wastes come from chemical industry but others including the metal, petroleum, transport electrical equipment, and leather tanning industries also produce significant quantities of hazardous waste. Sewage, sludge and hospital wastes are also hazardous. Indiscriminate disposal and dumping of industrial wastes have resulted in widespread soil pollution and underground water pollution, besides air pollution. The discharge of methyl mercury contaminated waste into river, resulting in hundreds of deaths

and thousands of cases of disablement at Minamata Bay in Japan (Minamata disease). Mercury contamination produced serious problems in many North American water bodies and has been noted in Alexandria, Bangkok, Bombay, Cartagena, Managua Perai and various Chinese cities. Significant build ups of mercury lead, arsenic, fluoride, cadmium, copper and chromium have been reported in recent years in almost every industrialized country in South East Asia. The Kalu river, which runs through two of Bombay's industrial suburbs received liquid effluents containing heavy metals from over 150 industrial units. This causes heavy levels of mercury and lead in the water of nearby villages. Heavy metals enter the food chain through cattle browsing on river bank vegetation. When contaminated water from industries is used for irrigation the heavy metals enter the food chain through vegetations and plants grown on such fields and when consumed by local population over long time produce toxic effects. These heavy metals become stock pollutant of the agriculture land. Radioactive substances from laboratories and industries, or atmospheric fall out from nuclear explosion can pollute soil and may enter the food chain through vegetation and plants.

Agriculture and Soil Pollution

Human exposure to persistent organic pollutants (POPs) occurs as pesticide residue. Indiscriminate use of pesticides on crops pollute soil. POPs are organic compounds and have long life in environment and undergo physical, chemical and biological changes over time. Through crops and foods, these pesticides climb the food chain and accumulate in tissues of animals and man and produce untowards hormonal effects in the long run. POPs can travel great distance in air or water.

Health Hazards of Soil Pollution

Soil-transmitted helminths like *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* and *Ancylostoma duodenale* (hookworm) are very common in India. High prevalence of soil transmitted helminthic (STH) infection in population has been observed, where open field defecation is practiced, due to soil pollution with human excreta. Excreta comes back to human from contaminated soil through dirty hands, by flies and contaminated water. Person with bare feet who walks or works on such soil or 241 million children who play on such soil are at risk of contracting helminthic infection and diarrhoeal diseases. DALYs lost due to STH have been estimated around 39 million against 34.1 million due to measles, 35.7 million due to malaria and 46.5 million due to tuberculosis.

Heavy metal poisoning (lead, mercury, arsenic) due to indiscriminate disposal of industrial wastes and carcinogenic effects of radioactive waste/material have been reported in many parts of the world. These substances either pollute groundwater or atmosphere and affect human beings.

Tetanus is transmitted through soil, which is contaminated by animal excreta. Tetanus spores are present in superficial layer of earth mostly in humus. Due to infection of wound by the spores of tetanus bacilli from polluted soil, street dust or dusty air, the danger of tetanus neonatorum and tetanus in adults persist in rural and urban slum areas. Road side accidents which contaminate the wound with dirt and dust can be risk factor for occurrence of tetanus.

Leptospirosis can be transmitted from contaminated soil.

Diarrhoeal disease, cholera, amoebic dysentery, typhoid fever, infective hepatitis may occur from infected or polluted soil indirectly through contaminated water, dust and flies. Outbreaks of diarrhoeal diseases, cholera and infective hepatitis may occur when large scale contamination occurs by rains, flood or sewage. Anthrax spores have been found in fields where infected animals are allowed to graze.

Prevention and Control of Soil Pollution

Good environmental health is a necessary pre-requisite for health of mankind. All efforts must be directed to prevent environmental pollution/soil pollution by:

- Controlling population.
- Promoting safe disposal of human excreta by sanitary latrines, sewerage system and treatment of sewage.
- Safe disposal of garbage and refuse, by composting in trenches or manure pits and solid waste management.
- Safe disposal of industrial wastes and effluents by adequate planning and enforcing the laws and by laws for polluting units.
- Regulating use of pesticides in agriculture.

Health Education

Improving Habits and Practices

The social attitudes are at the heart of environmental concern. Much of personal hygiene like washing hands, wearing of shoes and storing water clean at household level and open defecation are the mindsets of individual—families and community, these must be inculcated at all levels to prevent diseases, especially transmitted through soil pollution and water pollution. Families and schools as transmitter of values to next generation become central and so too does media in its role of shaping what is acceptable social behaviour.

Competency addressed: The student should be able to:
CM 3.1: Describe health hazards of air pollution.

HEALTH HAZARDS OF AIR POLLUTION (AP): A GLOBAL PUBLIC HEALTH EMERGENCY

SDG: Reduce number of deaths and diseases due to AP.

Case-study: Air, water and soil contamination has drawn the attention of all governments. Epidemiologists are

deeply concerned with deteriorating environments, as these determine the health status of individual, family and community. Air pollution is widespread in developed and developing countries, affecting urban and rural areas.

Over 90% of people were breathing poor quality of air in 2019. It is a **global public health emergency**. The main source of air pollution is combustion of solid fuels (coal, lignite, wood) and liquid fuel (from petroleum source). Due to population explosion, the need for more electricity has led to steep rise in power generation through coal (fossil fuel) as India has limited reserves of natural gas. Increased urbanization and economic activities have increased vehicular traffic using diesel and petrol both of which add to NOx and SOx emissions in cities. Heavy vehicles which use diesel as fuel, emit large quantities of RPM (respirable suspended particulate matter). Shortage of electric power has led to increased use of diesel generator sets in the commercial, household and agriculture sector. Air pollution was the 4th leading risk factor for premature deaths worldwide in 2019. Air pollution killed an estimated 6.67 million people in the year 2019 (about 12% of all deaths annually). 9 out of 10 deaths due to air pollution take place in the developing world where 82% of all people live. About 2.5 billion people almost all in developing countries suffer from high level of indoor air pollution. Indoor air pollution is due to burning wood, animal dung, crop residues and coal for cooking and heating. Most of the victims of indoor air pollution are women and girls who have the primary responsibility for cooking and tending the house. Outdoor air pollution harms more than 1.5 billion people mostly in cities. WHO estimates that about 7,00,000 deaths annually could be prevented in developing countries, if three major atmospheric pollutants—carbon monoxide, suspended particulate matter and lead were brought down to safer levels.

Composition of Air

It is composed of oxygen (20.94%), nitrogen (78.09%), carbon dioxide (0.03%), argon (0.93%), water vapour, ozone, krypton and other gases.

OUTDOOR AIR POLLUTION (AMBIENT AIR POLLUTION)

The air of large/mega cities is often polluted and unhealthy. Cities such as Mumbai (Bombay), Kolkata, Delhi, Chennai (Madras), Kanpur, Ahmedabad, Nagpur have severe air pollution problems with the annual mean levels of particulate matter 2.5 at least 5 to 18 folds as high as the revised WHO standards of 2021. Delhi being worst in the world, most polluted capital for 4th consecutive year. 35 of the 50 most polluted cities with worst air quality are in India.

Major Air Pollutants

The air pollutants are classified into two major categories:

1. Particulate matter (PM)
2. Gaseous

Particulate matter (PM): PM is common proxy indicator for air pollution. It affects more people than any other pollutant. The major chemical components of PM are sulfate, nitrates, sodium chloride, black carbon, mineral dust and water. It consists of complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air. While particles with diameter of 10 microns or less (≤ PM 10) can penetrate and lodge deep inside the lungs, the even more health damaging particles are those with a diameter of 2.5 microns or less (≤ PM2.5) can penetrate the lung barrier and enter the blood stream. There is close quantitative relationship between exposure to high concentrations of small particulates (PM 10 and PM2.5) and increased morbidity and mortality.

Gaseous: The gaseous pollutants include sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), hydrocarbon (HC) and photochemical oxidants (OX) and volatile organic compounds.

Sources of Outdoor Air Pollution

Fossil fuels (coal and petroleum products including diesel) are the largest sources of air and atmospheric pollution. Most industries, power plants and automobiles depend on fossil fuel. Fossil fuels account for nearly 90% of the world's commercial energy production. Use of Fassil fuels result in green house gas emissions that are driving climate change. While complete combustion of fossil fuels produces carbon dioxide and water together with some oxides of nitrogen generated by fixation of atmosphere nitrogen at high temperature. Post-harvesting burning stubble of paddy and wheat crops also leads to outdoor air pollution. It is widespread practice in Punjab, Haryana, UP and MP.

Suspended Particulate Matter (SPM)

The incomplete combustion of fossil fuels leads to black smoke which consists of finely divided particles of carbon or complex hydrocarbons. These particles of varying sizes constitute suspended particulate matter (SPM)—small particles floating in the air or atmosphere. The fine suspended particulate matters are called aerosols, which can enter the tracheobronchial tree. Finest particles can reach the alveoli of lung. Sulfur and nitrogen oxides emitted from fossil fuels in the atmosphere are converted to acids and eventually fall to the ground as acid rain or snow. Acid rain destroys many flora, fauna on earth apart from contaminating drinking water. PM2.5 includes pollutants like sulfate, nitrate, and black carbon which poses greatest risk to human health.

Sulfur Dioxide and Metals

Most of the sulfur present in the fossil fuels is emitted as sulfur dioxide and metals are emitted as vapour or present in ash or emitted in gases.

Ozone

At ground level ozone is powerful secondary pollutant formed due to photosynthesis of nitrous oxide gas released mostly from automobiles exhaust, industrial effluents, mass fuel burners, ultraviolet radiation from sun, thunderstorm and lightning discharge, photocopier machines, arc welding, and decay of potassium nitrate in agricultural fields during post-harvesting season. The ozone is major secondary pollutant formed within photochemical smog seen in big cities with mounting population of motor vehicles and automobiles. The problem was first recognized in Los Angeles as 'Los Angeles Smog', now it is widespread in many cities. Ozone is main component of smog. Another powerful secondary pollutant is acid rain, formed when SO_2 and oxides of nitrogen combine with water vapour of oxygen in the presence of sunlight to form a diluted 'soup' of sulfuric and nitric acids. They can fall as both wet (acid rain) or dry deposition.

Lead

Lead is used as an additive in petrol. Airborne lead from vehicles remains a big problem, further the lead is retained on the surface layer of soil and poses threat to human health and more severe effects are visible in young children.

Attributable Annual Deaths due to Outdoor and Household Air Pollution[8, 9] (Table 3.2)

Global Scenario (2019)

Air pollution was 4th leading risk factor for early deaths worldwide in 2019, surpassed only by high blood pressure, tobacco use and poor diet. Air pollution caused 6.67 million deaths worldover in 2019 (State of Global Air 2020).

Global Patterns in Outdoor and Household PM2.5 Exposure

In 2019, over 90% of the world population experienced annual average PM2.5 concentrations that exceeded the WHO 2005 Air Quality Guidelines of 10 µg/m^3. State of Global Air 2020 covered 4745 locations in 106 countries, estimated 4.14 million deaths caused by outdoor air pollution, and 2.31 million due to household air pollution; Air pollution accounted for nearly 6.67 million early deaths globally as per 2021 world air quality report which covered 6475 locations in 117 countries.

WHO recognises air pollution is critical risk factor for non-communicable diseases, causing adult deaths due to ischaemic heart disease, strokes, chronic obstructive pulmonary disease, pneumonia, lung cancer and neonatal deaths.[8] Air pollution is a risk factor for increased morbidity and mortality due to Covid-19.

Indian Scenario

Air pollution was the leading risk factor for premature deaths in India in 2019, accounting for nearly 18% of all deaths (more than 1.67 million).

Key statistics at a glance in India

- India was most polluted country in the world in 2019 with highest population weighted annual average PM2.5 exposure at 83.2 µg/m^3. No city in India met WHO air quality guidelines of 5 µg/m^3.
- 1.67 million deaths due to air pollution in 2019.
- About 1 million deaths attributable to exposure to outdoor PM2.5. (Lancet planetary health Journal).
- More than 6.1 Lakh deaths attributable to exposure to household air pollution.
- 61% of the population used solid fuels for cooking against 73% in 2010.
- Percentage of deaths (by cause) attributable to air pollution in India in 2019:
  - COPD 60%
  - Lower respiratory infection deaths 43%
  - Stroke deaths 39%
  - Ischaemic heart disease and lung cancer 32% each
  - Diabetes 24%
  - Neonatal deaths 21%

Good news: Deaths attributable to household air pollution (HAP) decreased by 26% since 2010. India released its National Clean Air Programme in 2019 with a view to reducing outdoor PM2.5 levels by 2024. In April

Table 3.2: PM2.5 attributable deaths (deaths by breath) and countries with highest exposure levels in 2019–21

Country	*Deaths (in million) 2019*	*Country*	*Average annual PM2.5 in µg/m^3*	
			2019	*2021*
China	1.84	India	83.2	58.1
India	1.67	Bangladesh	63.4	76.9
Pakistan	0.23	Pakistan	62.6	66.8
Bangladesh	0.17	Nepal	83.1	46.0
Indonesia	0.18	Chad	80.1	75.9
All other countries	2.58	Qatar	76.0	38.2
Global total	**6.67**	Nigeria	70.4	34

2020, the country initiated a switch to Bharat Stage VI (BSVI) emission standards.

Out of 50 world's most polluted cities in 2022 (PM2.5) 39 are in India (Bhiwadi, Ghaziabad, Delhi, Jaunpur, Noida, Bhavalpur, Bagpat, Hissar, Faridabad, G Noida, Rohtak and Lucknow .....).

Nearly, 480 million (40%) of population living in Indogangetic plains of North India are on course to lose 9 years of life if the levels of annual air quality pollution life index of 2019 persists. India is the most polluted country in the world.

INDOOR AIR POLLUTION (HOUSEHOLD AIR POLLUTION)

About 2.5 billion people, almost all in developing countries suffer from high levels of indoor air pollution. Indoor air pollution is common in rural areas as also poor people in urban slums. Some estimates suggest that worldwide urban and rural indoor air pollution kills prematurely about 2.31 million people annually. Indoor air pollution is a major health problem because worldwide almost 3 billion people rely on unprocessed biomass fuels—mostly firewood, charcoal, animal dung, logging wastes and saw dust, grass leaves, crop residues for household cooking and heating. WHO estimates that biomass fuels are used to meet the energy needs of nearly half of world's population. These are often burnt in open fires or inefficient stoves and poorly ventilated houses.

In China, India and Sub-Saharan Africa more than 86.5% of rural and 26.1% urban households use biomass fuel for cooking. These fuels do not burn cleanly and emit large amount of smoke, often directly inside dwellings with inadequate ventilation. The combustion of raw biomass fuels produce hundreds of chemical compounds including suspended particulate matter, carbon monoxide, oxides of nitrogen and sulfur, hydrocarbons, aldehydes, benzene, denol, cresol, toluene and more complex hydrocarbon compounds including polyaromatic hydrocarbons. Use of improved stoves with ventilation and exhaust chimneys can reduce the emission of suspended particulate matter by up to 60%; of carbon monoxide by up to 86%. While rural areas may lack access to modern stoves or clean fuels, the urban poor often cannot afford cleaner fuels such as kerosene, natural gas, or electricity. They have no choice but to use biomass fuels. Women and children suffer most from indoor air pollution because they spend many hours each day in their homes, where often the air is polluted.

Similarly, fossil fuels are widely used for space or water heating in the home or for cooking in many countries. Because of poor combustion conditions, coal fumes become major source of air pollution in homes. The production of sulfur dioxide from coal is inevitable besides carbon monoxide, which can reach lethal concentrations at times. The risk from oxides of nitrogen also remains because of poor combustion.

Effects on Health

Particulate matter of PM2.5 measurements can directly be linked to estimates of health risk and, therefore, are of particular interest.

Respiratory System

Air pollution is a potential risk and has led to an increase in respiratory problems/diseases in cities.

The most serious health risks of indoor air pollution are burns and smoke inhalation. Exposure to pollutants is 60 times higher in indoor environments in the rural area of developing countries than in urban areas of developed countries. The principal **Acute** adverse **effects** on health are respiratory and CO poisoning. Women working indoor on stoves have higher risks of inhaling total suspended particulate and benzo(a) pyrene. This creates risk of respiratory cancer. **Chronic effects** include inflammation of the respiratory tract caused by continued exposure to irritant gases and fumes. These may lead to development of emphysema and chronic obstructive pulmonary disease (COPD) and cor pulmonale. As women and girls tend the fires and do the cooking inhaling large concentration of pollutants over longer period and thereby increasing prevalence of chronic bronchitis by 100% in those chronically exposed to biomass fuels. Similarly, infants and children may be heavily exposed because they remain with their mother while fires are tended and cooking is done.

A protective layer of ozone is present in the region of 16–30 km above the earth's surface at a concentration of 1–10 parts per million (ppm). This is referred to as stratosphere that performs indispensable function of absorbing harmful ultraviolet radiation to shield the biosphere.

The stratospheric ozone layer is being damaged by the release into the atmosphere of various chemicals including **chlorofluorocarbons** (CFCs) used in refrigerant, air conditioning aerosols sprays, plastic foam blowers and other equipment, halogens used by firefighting services and various organic solvents.

Every year due to depletion of ozone layer, more and more people are being exposed to ultraviolet (UV) radiation from the sun thus causing 2–3 million new cases of non-malignant melanomas and more than 1,30,000 new melanoma skin cases worldwide. An estimated 66,000 deaths occur annually from melanoma and other skin cancers. The new educational materials were launched on the occasion of international day for the preservation of the ozone layer, which held its theme in 2003 as "Save our sky: There is a hole lot more to do for our children".[10]

Air Pollution and Sensory Irritation

The odour of airborne substances and irritation to the eyes, nose, skin and throat are most common and annoying aspects of air pollution. Ozone the component of

photochemical smog directly irritates the eyes, pharynx and trachea, causing a burning sensation in chest, chest discomfort, headache and various other symptoms in school children playing outdoor on 'Smog alert' days. Ozone can inflame and damage lung cells besides aggravating chronic lung diseases. Safe level of ozone is 64 parts per billion (ppb).

Carbon monoxide can alter human performance as well as cardiac function. Inhalation of lead can cause neurogenic disturbances and can adversely affect the central nervous system. Children are most susceptible to lead toxicity.

Greenhouse Gases (Global Warming)

Air pollution can build-up greenhouse gases (CO_2, methane, nitrous, oxide) in the atmosphere which is likely to lead to global warming and rise in sea level by melting of ice caps. Carbon dioxide and chlorofluorocarbons (CFCs) are mainly responsible for global warming effect. While CO_2, CH_4 and NO_2 are naturally present is atmosphere, the CFCs are product of industry and aerial activities.

Global warming has resulted in increase of mean surface temperature by 0.4 to 0.8°C during the last 100 years. 'UN on Global Warming' Intergovernmental panel on climate change—IGPCC in 2021 rings alarm bells. Ten thousand pages. The report says 'The world will cross 1.5° Celsius warming mark in 2030 earlier than past predictions. Nowhere to run, it will impact India much more. Indian ocean is getting warmer rapidly than others (IPCC-AR-6). Time running out to mitigate global warming.

Heat strokes and heat stress because of global warming can affect human population particularly old and young people. It may also lead to changes in rainfall, droughts, floods, storms, desertification, Over 70% of Europe is in grip of drought in 2022 depleting ground water and extreme weather patterns and agriculture may be affected seriously. There has been significant decrease in sunshine hours in most cities.

Stockholm conference of 2022 on world environment day on 5th May presented a grim environmental scenario "wellbeing is at risk".

PREVENTION AND CONTROL OF AIR POLLUTION

Outdoor Air Pollution (Ambient Air Pollution)

India released its National Clean Air Programme (NCAP) in 2019 with a view to reducing PM2.5 by 2024. Outdoor air pollution can be controlled and prevented by:

- Efficient public transport system and reduction of population of private vehicles.
- Use of lead free petrol.
- Reducing air pollution from fossil fuels use by appropriate technologies such as use of catalytic converters which can reduce the emission of oxides of nitrogen, carbon monoxide and volatile organic compounds from motor vehicles fuelled with lead-free petrol.
- Alternate fuel such as compressed natural gas (CNG) for automobiles instead of petrol and diesel. The landmark ruling of Honourable Supreme Court came on 5th April 2002, declaring that all public transport in Delhi will run on CNG. Similarly, it was mentioned that cities such as Lucknow, Pune and Jodhpur will also switch over to CNG for running their public transport. With this proclamation, the level of air pollution in Delhi has come down to a significant level.
- Green belts, plantation of trees to create a buffer zone between residential areas and industrial estates. These absorb CO_2 of the air. Hence, massive afforestation drives can improve earth's lung capacity.
- Creating seamless breathing spaces, e.g. The Mahim Nature Park Project has effectively demonstrated the effect of green spaces to clean-up Mumbai and decreasing pollution levels.[4]
- Plan industries away from residential areas and ensure regulation.
- Controlling emissions at source level in industrial set-up by use of electrostatic precipitators and bag filters can trap large amount of particulates (dust, ash and soot) in factories or power plant exhaust gases.
- Fitting power station with scrubbers can reduce sulfur dioxide emission by up to 95% and equipping them with catalytic converters can significantly reduce emissions of oxides of nitrogen.
- **Legislation to control air pollution:** The Air (prevention and control of pollution) Act, 1981 and Environment Act, 1986 forms the basis of monitoring and controlling air pollution in the country especially after Bhopal gas tragedy in 1984. Implement ban on burning of straw and other organic waste. Curtail the use of plastic.
- Development of alternate sources of energy such as biodiesel which is renewable energy source with properties of decreasing the emission of CO_2 and SO_2 and unburnt hydrocarbons during the combustion process is most welcome. Such a fuel could substitute fossil fuels.
- In April 2020, the country initiated a switch to Bharat Stage VI (BSVI) vehicle emission standards.
- Use of bio-decomposer for stubble.

The Lok Sabha passed a bill in 2022 to promote use of non fossil fuels to decabonise India.

Indoor Air Pollution

Sustainable development goal 7—access to affordable modern energy for all.

Indoor air pollution can be controlled and prevented by:

- Improved ventilation: Can reduce the levels of SO_2 and particulate matter.
- Use of improved and efficient stoves with exhaust chimneys. Fuel efficient stoves save lot of fuel and are better accepted by people.

- Use of modern fuels—like kerosene oil, electricity and liquefied petroleum gas (LPG). Free LPG connections at subsidised rates to 50 million women of below poverty line have been provided under Pradhan Mantri (PM) Ujwala Yojna. India targets to reach 80 million households by the end of 2020.
- The impact of Ujwala Yojna: It prevented 1.5 Lakh indoor air pollution related premature deaths in India apart from improved quality of life in 2019.
- Use of non-conventional source of energy such as solar cookers, wind energy, biogas plants—these are user-friendly and environmental friendly sources of energy and produce no air pollution or least air pollution.

Revised WHO Air Quality Guidelines Values Sept 2021

These guidelines are not legally binding (Table 3.3).

The WHO revised guidelines prescribe annual PM 2.5 at 5 µg/m^3, bringing it down from 2005 limits set at 10 µg/m^3. PM 10 annual average is now 15 µg/m^3 in comparison to earlier norms of 20 µg/m^3. NO_2 levels, which are presently attributable to vehicular emissions, have been revised to 10 µg/m^3 in comparison to 40 µg/m^3 in 2005. These new guidelines will have major implications for public health.

National Air Quality Monitoring Programme (NAMP)

Outdoor air pollution is a major environmental risk to health. By reducing air pollution levels we can reduce burden of disease from stroke, heart diseases, lung cancer and both **acute** and **chronic** respiratory diseases, including asthma.

National Air Quality Monitoring Programme[10, 11] for outdoor air (ambient air) has been launched in India. Central Pollution Control Board in collaboration with State Pollution Control Boards and committees and National Environmental Engineering Research Institute Nagpur (NEERI) monitors the quality of outdoor air through network of 793 stations covering 344 cities and towns in 28 states and 8 union territories. The objectives of the NAMP are to determine status and trends of ambient air quality. Four air pollutants viz. sulfur dioxide (SO_2), oxides of nitrogen as NO_2, respirable suspended particulate matter (RSPM–PM10) and fine particulate matter (PM2.5) are being monitored regularly.[9, 10]

At global level—global environmental monitoring system (GEMS) of WHO conducts regular periodical monitoring of air quality by satellite and ground level data and it has laid down acceptable standards.

Goal: Progressively, attain WHO standards of air quality in all major cities by 2024.

Achieving WHO Guidelines levels is not immediately feasible. For these reasons, incremental step goals of 10, 15, 25 and 35 µg/m^3 were recommended for use.

Indian Air Quality Index (IND AQI)

Indian national air quality standards (2009) for different pollutants have been laid down which provides a legal framework for air pollution control and rational for protecting public health. These standards are under revision.

Air quality index (AQI) is a tool for effective communication of air quality status to people. It transforms complex air quality data of various pollutants into a single number (index value), nomenclature and colour. National Clean Air Programme (NCAP) tracker was launched in 2019. NCAP has now set a new target of 40% reduction in the PM2.5 concentration by 2026. According to NCAP report of 2022 Delhi was most polluted city with average PM2.5 concentration of 99.71 followed by

Table 3.3: Recommended AQG Levels by WHO 2005 and 2021 and National Standards

Pollutant	*Averaging time*	*AQG level 2005*	*AQG level 2021*	*National* standards 2009*
PM2.5, µg/m^3	Annual	10	5	40
	24-hour[a]	25	15	60
PM_{10}, µg/m^3	Annual	20	15	60
	24-hour[a]	50	45	100
O_3, µg/m^3	Peak season[b]	60	60	–
	8-hour[a]	100	100	100
NO_2, µg/m^3	Annual	40	10	40
	24-hour[a]	200 (1 hour)	25	80
SO_2, µg/m^3	24-hour[a]	20	40	80
CO, µg/m^3	24-hour[a]	10 (8 hours)	4	02 (8 hours)

[a] 99th percentile (i.e. 3–4 exceedance days per year).

[b] Average of daily maximum 8-hour mean O_3 concentration in the six consecutive months with the highest 6-month running-average O_3 concentration.

* National standards have legal value and are under revision. In addition to guidelines values interim targets are given for each pollutant by WHO.

Table 3.4: National air quality index (AQI)

AQI	*Possible health impacts*
Good (0–50)	Minimal impact
Satisfactory (51–100)	Minor breathing discomfort to sensitive people
Moderate (101–200)	Breathing discomfort to the people with lung, heart disease, children and older adults
Poor (201–300)	Breathing discomfort to people on prolonged exposure
Very poor (301–400)	Respiratory illness to the people on prolonged exposure
Severe (>400)	Respiratory effects even on healthy people

Ref: Central Pollution Control Board, Ministry of Environments, Forest and Climate change. National air quality index of 153 cities at 362 locations, November 2015.

Faridabad at 95.64, Ghaziabad 91.25 and Srinagar was cleanest city with PM2.5 at 26.33 μg/m^3.

There are six AQI categories, namely good, satisfactory, moderately polluted, poor, very poor and severe. each of these categories are decided based on ambient concentration values of air pollutants and their likely health impacts (known as health breakpoints) (Table 3.4).

To combat climate change 197 nations agreed to phase out hydrofluorocarbons (HCF) use by 85% by 2045 as per Kigili Amendment to Montreal Protocol and freezing production and consumption of HCF by 2024.

Competency addressed: The student should be able to:
CM 3.1: Describe health hazards of noise pollution.

HEALTH HAZARDS OF NOISE POLLUTION

Noise is undesirable and annoying level of sound which affects human beings. Noise like any sound is defined in terms of its duration, frequency spectrum (measured in Hz) and intensity measured in sound pressure level (SPL) and expressed in decibels (dB). Noise may be continuous, intermittent, impulsive or explosive. Noise has been notified as pollutant under the Air (prevention and control of pollution) Act, 1981.

The unit of measurement: The unit of measurement of noise is decibel (dB) on a weighted scale.

SAFE LIMIT

The international organization for standardization (ISO) has considered the safe limit of exposure to noise as 90 dB. In India, ISO standards are followed. Noise induced hearing loss has been incorporated in the Factories Act, 1948 amended in 1976, as a notifiable disease and also made compensable. Way back, in UK in 1972 maximum level of noise exposure (equivalent continuous noise level—Leq) for an 8-hour working day were fixed at 90 dB.[12,13]

Noise Level in Industries

Sound pressure levels (SPLs) in many of the industries may be very high and beyond the acceptable limit of 90 dB. The example of industrial operations which produce lot of noise induced damages include:

- Blasting, drilling and loading operations, boiler makers and iron foundries.
- Air compressors, motors, blowers, generators, pumps and steam turbines.
- Sawing operation

Noise pollution in industries is an occupational hazard and workers who are exposed to the risk of high noise may suffer from various grades of hearing loss after prolonged exposure.

Community Exposure

The noise appears to be endemic in urban areas. The main causes in cities are traffic noise due to motors, trucks, buses and motorcycles and exhaust system of automobiles.

Railways, horns, whistles, aircraft, public address system, high-pitched pop music and personal cassette players and radio for entertainment are common sources of noise. Crackers on the eve of festival, produce intolerable noise and acute traumatic effect on eardrum besides air pollution. Otitic blast injuries are produced due to sudden explosive forces in bombs.

Effects on Health

Hearing Loss

The most intense and continued exposure to noise occurs at workplace, especially in industry. Workers manifest varying degree of noise induced hearing loss. Persistent exposure to high levels of noise can lead to hearing loss that is initially temporary, but can later become permanent.

- Industrial accidents on account of hearing impairment may result because of poor communication and disturbance of sound.
- Fatigue and tiredness may set early.

People who are exposed to the risk of surface rail noise, underground rail noise, road traffic noise and aircraft noise run a risk of hearing loss, which may be temporary or permanent.[14]

Non-auditory Effects

Behavioural effects are more than auditory effects. It creates annoyance, disturbed sleep (insomnia) and fatigueness and decreases intellectual and work performance. Cognitive and psychomotor functions are altered and noise can alter neurosensory coordination, psychological reactions and psychological responses.

PREVENTION AND CONTROL

Engineering Control Mechanisms

Using efficient machinery and soundproofing and isolation of noisy machinery in industrial set-up has been adopted to reduce the noise.

Legislation

Enforcing legislation, i.e. implementation of Factory Act (1976 modified) in industrial set-up. Regular monitoring of noise is essential.

Personal Protection

Use of hearing protectors (earmuffs and headphones and helmets) and periodic audiometric monitoring by periodic health check-up of exposed workers to ensure that damage is reduced to minimum.

- See also National Programme for Prevention and Control of Deafness.
- Health hazards of radiation pollution: *See* Chapter 11 on occupational health.

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Competency addressed: The student should be able to:
CM 3.6: Describe the role of vectors in transmission/causation of diseases.

ROLE OF VECTORS IN TRANSMISSION OF DISEASES AND INTEGRATED VECTOR MANAGEMENT

Medical entomology deals with insects of medical importance. These insects are responsible for transmission of several diseases. Major vectorborne diseases and commonly used insecticides have been discussed in Chapter 8. Role of other vectors in disease transmission is being discussed in this chapter.

ANOPHELES MOSQUITOES

Life History

The mosquito passes through four distinct stages, i.e. egg, larva, pupa and adult, the first three being aquatic (Fig. 3.7).

Egg

Eggs are small dark bodies and are just visible to naked eye. These are laid on water, leaves and stems of aquatic plants, mud and even on wet grounds. Anopheline eggs are always laid singly and separately; they float on the surface of water. These are usually boat-shaped. These are laid in clear water, and can withstand considerable amount of desiccation, but large majority of eggs die when kept away from water for some time. The egg stage lasts for 2 days under the most favourable conditions.

Larva

The eggshell hatches and larva is released. The larva is very active and shows swift movements. *Anopheles* larvae are exclusively surface feeder and float just below the surface of water. Larva subsists on bacteria and organisms floating on the surface of water. The breathing apparatus consists of parallel air tubes on the body of larva at the tail end. Every species of *Anopheles* has preference for breeding places like collection of rain water, irrigation channels, and open cisterns. Usually, it prefers clear water. *Anopheles sundaicus* prefers brackish water. Larval stage develops to pupa in 5 days. *Gambusia affinis* feeds on larvae and can be used as biological method to control larvae of mosquitoes. Similarly, Paris green and mosquito larvicidal oil (MLO) can be used as larvicidal material.

Pupa

Pupa is also an active swimmer. It is a comma-shaped structure and sees with its eyes but cannot feed as the mouth parts are entirely suppressed. Pupal stage lasts for

24–48 hours and it all depends upon temperature and seasonal factors.

Adult

The period from oviposition to the emergence of first offspring is about 7–10 days in *Anopheles*. Adult starts mating on day one after emergence. Females usually mate only once but produce eggs at intervals throughout their life.

Competency addressed: The student should be able to:
CM 3.7: Identify and describe the identifying features and life cycle of vectors of public health importance and their control measures

Objective: Student identifies the vectors of diseases by collecting the adults/larval stages of vectors at breeding places.

HOW? Learner observes breeding places, collects larval stages and adult mosquitoes and other vectors to learn their bionomics and identifies their features under dissecting microscope.

Expected outcome: Student identifies the breeding places of common vactors, collects larval/adults stages and observes application of integrated vector control measures in community and at household level.

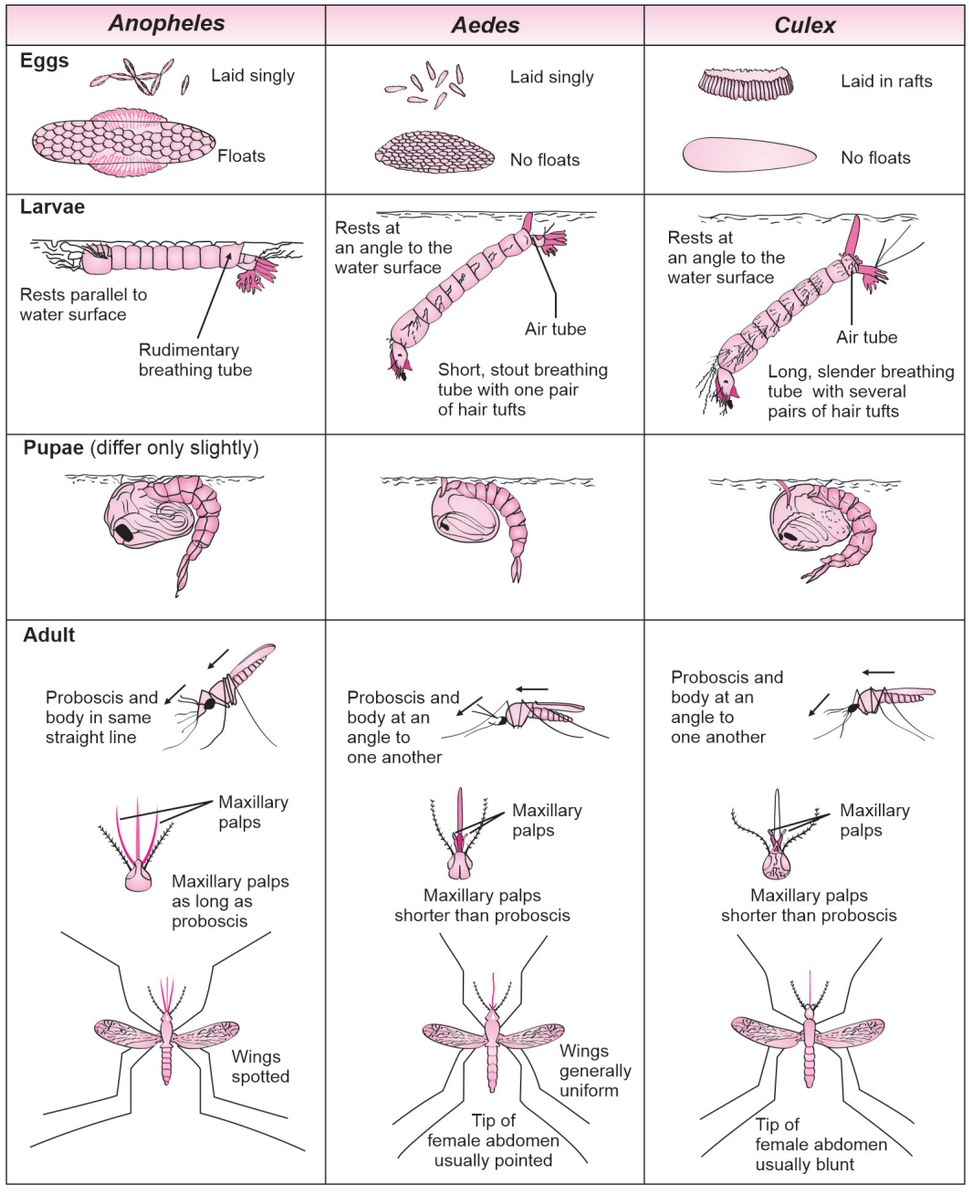


Fig. 3.7: Main features for identification and differentiating *Anopheles*, *Aedes* and *Culex* (WHO) and their life cycles

Biting Behaviour

Anophelines as a rule show a decided preference for either human (anthropophilic) or animal blood (zoophilic). Though both males and females can live on vegetable sap and carbohydrate food, a blood meal on the part of female anopheline is essential for maturation of the ovum. *Anopheles* is both *zoophilic* and *anthropophilic*. Keeping animals in and around dwellings affords protection wall to human beings.

Once the cattle sheds are sprayed with insecticide, the mosquitoes shift readily to dwellings and bite human beings. Under the insecticide spray policy, cattle sheds are now not taken-up for spray activity.

Resting Habits

After feeding the blood meal, the female mosquitoes rest in some sheltered place for the purpose of digesting blood and development of ovum. Indoor resting habits are called **endophilic.** It is endophagic (feeding indoor).

Flight

Anophelines adult mosquitoes can cover long distances. An average flight range is 0.75–1.5 km. This is significant for effective control of mosquito vector breeding.

Lifespan

On an average, the lifespan of *Anopheles* in India is about a month. Hibernating mosquito may live longer (6 months or more).

Anopheles is an important vector in the epidemiology of malaria. The longer it lives the greater is the chance of its being infected and infective.

Species and Disease Transmission

1. *Anopheles culicifacies* has a very wide distribution in India. It is **most important vector** in **malaria transmission**. It prefers clear water and breeds in open irrigation channels, river beds, pools, ponds, lakes, springs, and back water, burrow pits in fruit and vegetable gardens and even in wells. The larvae are also found in seepages and other collections of stagnant water.
2. It is more *zoophilic* than *anthropophilic*.
3. Adult culicifacies survive for about 4 weeks.

Infective Density of Anophelines

Infective density is the average number of infective anophelines per room per night. *Infective* mosquito is one, which shows sporozoites in their salivary glands, while *infected* mosquito is one, which shows any stage of malaria parasite (gametocytes, oocysts and sporozoites).

Bio-ecological Characteristics of Principal Malaria Vectors in India

An. culicifacies

It is vector of *rural* and periurban malaria in the North, South and Central India. Usually breeds in water not rich in organic matter, irrigation channels, river bed, pools, tanks, ponds, in rice fields, irrigation wells, and even brackish water, footmarks and cart tracks (wheel ruts), rainwater collection in burrow pits along rail, canal and road, and rock pools.

Resting habits: Predominantly indoor rester—cattle sheds and human dwellings. Prefers pools with low disturbance places, some may rest outdoor after spray. Bites in dusk, peak time is 10.30 pm to 12.30 am. It is mainly zoophilic, indiscriminate feeder at high density. Flight range is normally 1 km and up to 3 km at high density.

An. stephensi

It is normally an *urban mosquito* and urban **vector** for **transmission** of **malaria** in **urban** and industrial areas. It prefers small collections of clean water for ovipositing such as overhead cisterns, wells, small water reservoirs, pools, springs, marsh and collection of rainwater.[1–3]

Breeding: Urban areas—domestic and peridomestic water collection and underground tanks, wells, cisterns, fountain, ornamental tanks and artificial containers, water collection on roofs and withstands heavy pollution. It often breeds in large number in river beds.

It is also a vector of rural malaria in Rajasthan and breeds and rests in the water storage tanks called 'tankar'.

Resting habits: Differs widely but common places are—human dwellings and cattle sheds. Bites soon after dusk. Peak—4 to 6 AM. It is indiscriminate feeder on human and cattle. Flight range is 1 km. However, it does not disperse to long distances from the breeding places.

An. minimus: In NE states, North West Bengal, breeds in streams.

An. fluviatilis: Foothills all along the Himalayan range seepage and in irrigation channels.

An. dirus: Deep forests in NE region breeds in streams.

An. sundaicus: Andaman and Nicobar islands—breeds in brackish water. Rests often in human dwellings.

Control Measures

Integrated vector management under NVBDCP by insecticides: Indoor residual spray (IRS), larvicides, biological and environmental control measures (source reduction) are being adopted for control of mosquitoes.

CULEX MOSQUITOES

These mosquitoes are principal intermediate host of *Wuchereria bancrofti* (filaria) in India. This species is one of the commonest of Indian mosquitoes and is found everywhere in this country up to 6,000 feet or more. It is alone responsible for the winter and spring plague of mosquitoes experienced almost all over India. It is essentially a domestic and peridomestic species (Fig. 3.7).

Egg

Culex mosquitoes lay eggs in polluted water contaminated with sewage, e.g. in cesspools, septic tanks, ground pools, cement pits, sewage farms and drains having high organic matter. The egg has micropollar process at one end. Eggs are laid in clusters which acquire the shape of raft consisting of as many as 200 eggs glued to each other. Egg stage lasts for 2 days when it hatches and larva emerges (Fig. 3.7).

Larva

The larva has long and narrow siphon tube. It has much slower and snake like movements. The respiratory openings lie at the end of siphon tube. Larva hangs from the surface, hence not a surface feeder. The larvae subsist on bacteria and other organic matter. Larval stage lasts for 5–6 days.

Pupa

It is a comma-shaped structure and this stage lasts for 2 days. The period from egg to adult stage takes 8–10 days. The egg, larva and pupa are aquatic stages.

Adult and Diseases Transmitted

Adult mosquito has head, thorax and abdomen.

In culex, the thorax makes an angle with the abdomen, i.e. it has a hunch backed appearance. The flight range is 1–3 km or even more from breeding area. The mosquito is very active during dusk and night. The female sucks blood and is anthropophilic (sucks human blood). *Culex quinquefasciatus* is prevalent universally and is most important vector of *W. bancrofti* (filariasis). It is highly anthropophilic (prefers human blood). *Culex vishnui* group of mosquitoes are the most important in the transmission of Japanese encephalitis in India. The average lifespan of culex mosquito is about 21 days. The vector prefers mainly outdoor resting and outdoor feeding (exophilic and exophagic).

Control

Prevention of stagnation of sewage contaminated water, i.e. source reduction is best method. But this is difficult to achieve. Larvicidal measures are supplementary measures. Antilarval measures, on regular basis (once a week) ensure control of breeding but these are expensive. Paris green, kerosene oil or pyrethrum can be used as antilarval measures.

Control of adult mosquitoes is done by insecticidal spray, malathion fogging/ultralow volume spraying (ULV). Malathion fogging is restricted to urban and periurban areas. Integrated vector control measures are recommended.

AEDES AEGYPTI

It is the vector for dengue fever, chikungunya fever and yellow fever. It is known most commonly as tiger mosquito or container mosquito (because it breeds most commonly in containers). Once thought to be urban vector, it has now spread to vast rural areas of the country. *Aedes aegypti* index is being kept below 1 by effective control measures.

Breeding Habits

Aedes aegypti profusely breeds in desert coolers, storage tanks, earthen pots and other receptacles with rainwater or stored clean water, in flower vases, neglected cups, tyres, broken glasses and discarded plastic containers.

Life Cycle

It completes its life cycle around human dwellings.

Female lays eggs in all types of man-made and natural containers. Egg is elongate, blackish in colour and the shell is highly chitinized. Eggs are glued to the surface in damp areas above water surface and generally 60–100 eggs are laid during each oviposition. Female distributes eggs in several containers. Within 24 hours the embryonic development takes place but eggs can withstand long periods of desiccation, up to 1 year. Eggs when flooded hatch rapidly leading to emergence of first instars larvae. There are three larval instars and larval development is completed within a week, but it all depends upon temperature. Pupal stage lasts for 24–30 hours leading to emergence of adult mosquito.

Adult Mosquito

Like all other mosquitoes adults have head, thorax. abdomen and six legs. The adult mosquito is ornamented with silvery white scales all over the body. The mosquito is of black or blackish brown colour with silvery spots and markings. Because it bites and feeds on humans fearlessly, it is also called tiger mosquito (Fig. 3.7).

Bionomics

Adults seek dark and quiet places to rest on unsprayed objects such as clothes, curtains, bedrooms, bathrooms, kitchen, on walls, furniture, hanging articles, e.g. clothings, ropes and closets. Average survival for male is 20 days and that of female 30 days.

Female mosquitoes bite throughout the day and it is quite vigorous in biting and can bite many persons. Flight range is usually 400 meters, thermal death point is reached

at 41–42°C. The vector density and other indices have been discussed in Chapter 8 under dengue fever. An infected mosquito is capable of transmitting virus to susceptible individuals for the rest of its life.

Diseases Transmitted

Infected mosquitoes transmit dengue and dengue haemorrhagic fever (DHF), chikungunya, yellow fever, as also Zika virus infection. Yellow fever is absent in India but dengue and DHF are common and occur in epidemic form from time to time.[4, 5]

Control

Source reduction measures involve: Do not allow breeding of mosquitoes in coolers, flower vases, discarded tins, broken bottles, tyres, plastic containers, etc. This requires people participation and not legislative measures. Thus, education of people is most essential.

During epidemic, vector control would require the use of space sprays to knock down the infective vector population. ULV and thermal malathion fogging may also be used under special situations for a limited period to fight the epidemic. Fogging should be done at least once weekly and fog should stay inside rooms for about 10–15 minutes for it to be effective. Most situations are not suitable for fogging hence main reliance should be on source reduction.

MANSONIOIDES (*MANSONIA* MOSQUITOES)

This mosquito is recognized by speckled wings and legs. These mosquitoes depend for their breeding on aquatic plants (*Pistia stratiotes*) for the supply of oxygen. The eggs are laid in clusters on or under surface of the leaf of Pistia plant. The larvae and pupae do not come to the surface until shortly before the emergence of the mosquito.

Disease Transmission

Two species of this vector *Mansonioides uniformis* and *M. annulifera* transmit *Brugia malayi* infection of filariasis in India.[6]

Implications

For the control of this mosquito, the control of vegetation, i.e. removal of Pistia plant is significant to reduce the disease transmission. Clearance of pistial plants reduces the breeding (Fig. 3.8).

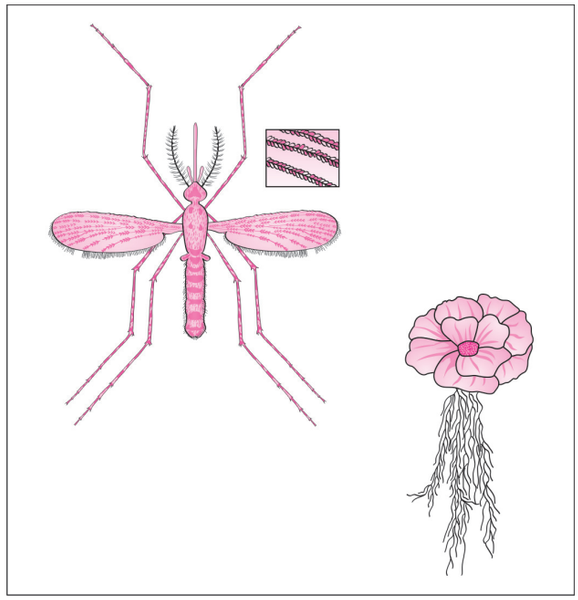


Fig. 3.8: *Mansonioides uniformis* female in flight and Pistia plant

SANDFLIES

They belong to genus *Phlebotomus*. The important species consist of *Phlebotomus argentipes*, *P. papatasi*, *P. sergenti* and *P. braziliensis*. These are vectors for transmission of leishmaniasis (kala-azar or visceral leishmaniasis, oriental sore and espundia). Sandflies also transmit the virus of sandfly fever.

These insects are small and of greyish yellow to brown colour, 1.5–3.5 mm long. Sandflies are not capable of flying any long distance but they move by hopping from one place to another. They have very short lifespan.

Head, thorax and abdomen are covered with hair. The antennae are long and filamentous and carry whorl of hair at the joints. The thorax is humped and bear a pair of wings which are hairy. The insect has 3 pairs of slender legs and are much longer in proportion to the size of the insect. Long legs are adapted for hopping. The abdomen has 10 segments and covered with hair and last two segments of abdomen are modified into sexual organs. Male and female insects can be distinguished on the basis of claspers which are present only in male insect (Fig. 3.9).

Life History and Bionomics

Eggs are laid on organic matter (animal's excreta and other decaying material). The eggs are torpedo-shaped and hatch out in 3–4 days in summer season and after one week in winter season. Larvae feed on organic matter and mature to pupa stage in 2 weeks time after undergoing three moultings. The larvae bear two anal spines. Cattle sheds are favourite breeding ground of sandflies, usually under the earthen ware feeding trough. Larvae can penetrate the soil to a depth of 3 or 4 inches in loose and sodden soil. Thus, most commonly larvae are found in cattle sheds and poultry houses. Blood meal is required by female for maturation of ova. Within 10–15 days, the pupa develops into adult insect. The whole life cycle takes about 30 days,

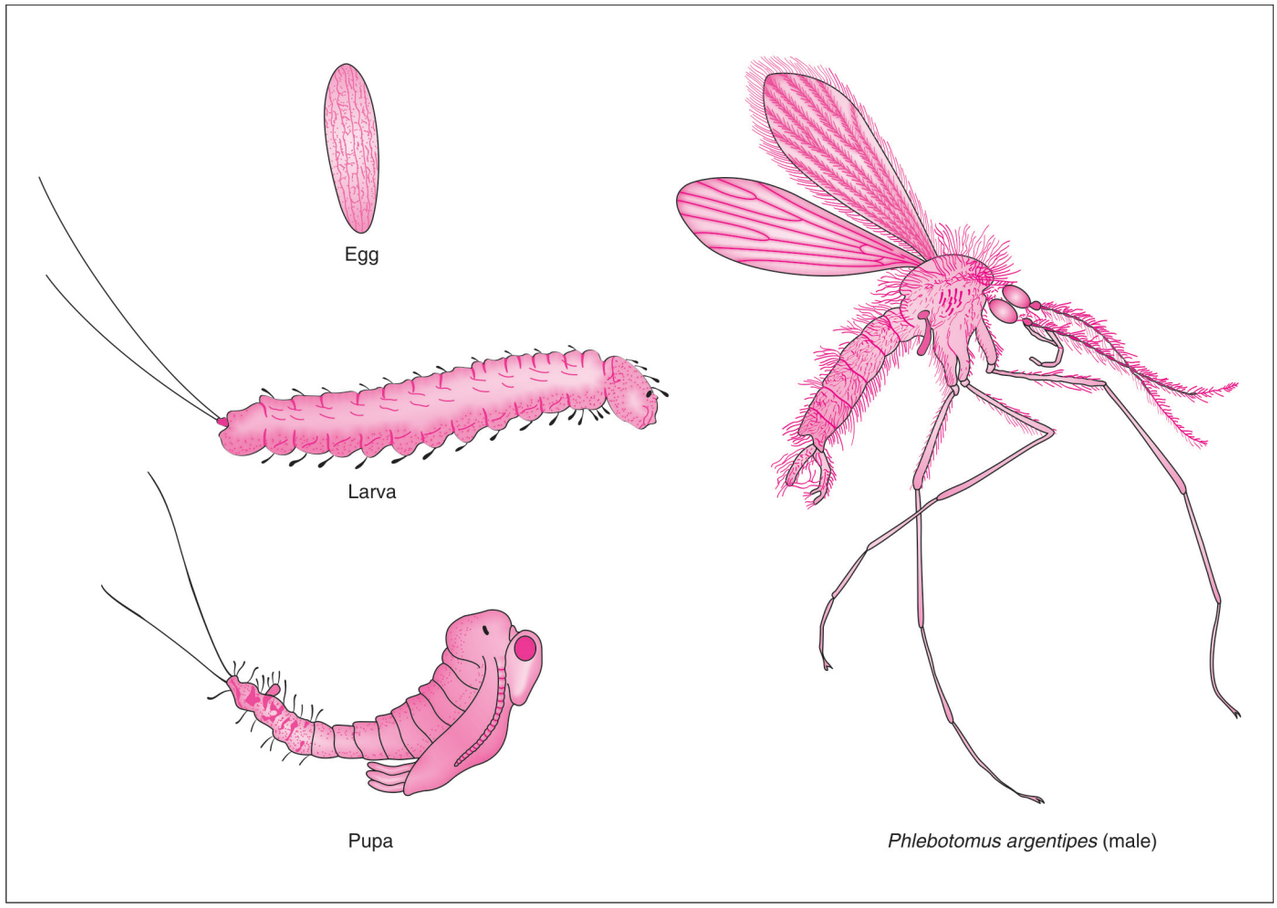


Fig. 3.9: Complete metamorphosis of a sandfly

the egg, larva and pupal stages requiring 4, 14 and 7 days respectively in most favourable conditions.

The female insect is blood sucker and male lives on plant juices. Female insect sucks blood of animals as well as man. Sandflies remain confined to their places of breeding and can cover only short distances. The man gets bitten accidentally when walking bare foot or coming in contact with soil infested with insect or contaminated with animal excreta (stables, poultry houses and cattle sheds).

Sandflies are active during night in the dark, usually attack the lower extremities and are capable of biting through thin clothes and can cross through meshwork of nets because of being very small. Lizards and spiders are the natural predators of sandflies.

Disease Transmission

Sandflies transmit *Leishmania donovani* from man to man as man is the only known reservoir of kala-azar. It is necessary that sandfly should survive at least for 8 days after the infected blood meal for development of infective form of *Leishmania donovani* (aflagellar forms). Sandflies feed on cattle, goats and man.

Control Measures

- ***Source control:*** Abolition of breeding grounds or short of it is frequent removal of animal dung from stable and cowsheds and improving sanitation. Cracks, crevices and holes must be closed by cementing techniques.
- ***Anti-adult measures:*** Residual insecticide like DDT spray is quite effective against adult insect. Widespread use of DDT under malaria control and eradication programme kept the population of sandflies under control. It was a collateral benefit of DDT spray under malaria programme. Sandflies have developed resistance to DDT and now synthetic pyrethroids are in use.
- ***Personal protection:*** Proper clothing—long trousers with socks, tops drawn over the trousers cuffs or ankles worn over them. Use of repellents is also helpful.

HOUSEFLY

Housefly belongs to order diptera. There are many species of which *Musca domestica* is distributed worldwide and known commonly as housefly. Housefly has retractile proboscis. In early summer and during monsoon, their population is enormous. Because of lack of sanitation in urban slums and rural areas they breed in a prolific manner. Apart from nuisance, the housefly act as a mechanical carrier for several diseases. Since open defecation is widespread and excreta around houses/homes is abundant, fly can carry on its body parts, part of faecal matter, garbage and disease producing germs and can shift these to food, and eatables which are left uncovered.

Diseases Transmitted

Flies are mechanical carriers and propagate disease germs which can be carried on hair, bristles, wings, foot pads, proboscis and it can regurgitate the germs in its saliva. The flies have been incriminated for spread of diarrhoeal diseases, cholera, typhoid fever, dysentery, intestinal worms, poliomyelitis, viral hepatitis A and E, enteroviruses, trachoma, conjunctivitis, anthrax, yaws and tuberculosis. Fly can deposit its eggs on wounds and causes myiasis.

Life Cycle

Different stages in the life cycle of fly are—egg, larva, pupa and adult (Fig. 3.10).

Eggs

Eggs are laid by gravid female flies in garbage, human and animal excreta, which is rich in organic matter. Heaps of cow dung and garbage along with refuse dumped around houses and municipal dumping ground around periurban area provide most favourable breeding place for flies to breed. The eggs are glistening white and look like tiny grains of polished rice, oval in shape and measure about 1 mm in length. The fly generally deposits its eggs in dark places. A fly may lay 300–900 eggs in 3–6 batches and subsequent development depends upon temperature and moisture. The eggs hatch in summer after 8–16 hours and it may take longer time to hatch in winter. There are three larval stages. The larva moults twice. The larva is about half an inch in length and is quite active. Larva is without eyes or legs. The larvae burrow deep down to the garbage or loose soil up to variable depth before they pupate.

The larval stage lasts for 3–6 days when they migrate to dry soil and change to pupa.

Pupa

The pupa is barrel-shaped structure about 6 mm in length. It is sluggish, it neither feeds nor grows. The pupal stage does not last more than 3–7 days and adult fly emerges out of it. Under favourable conditions, the whole life cycle of fly gets completed in 5 days time in summer and during winter it may take longer time, range is 6–42 days.

House dumps of garbage and refuse must be removed periodically and with such frequency which should not allow the fly to complete its life cycle. The garbage must be removed daily or at least once in 3 days to safer place to prevent breeding of flies.

Adult Fly

The adult fly measures about 6–9 mm in length and has labile proboscis which can be retracted and projected for feeding. The body of fly consists of head, thorax and abdomen and three pairs of legs. It has compound eyes and powerful wings to fly with speed and acrobatics. House flies are attracted to sweets—sugar and exposed food and it feeds intermittently and at times voraciously. After

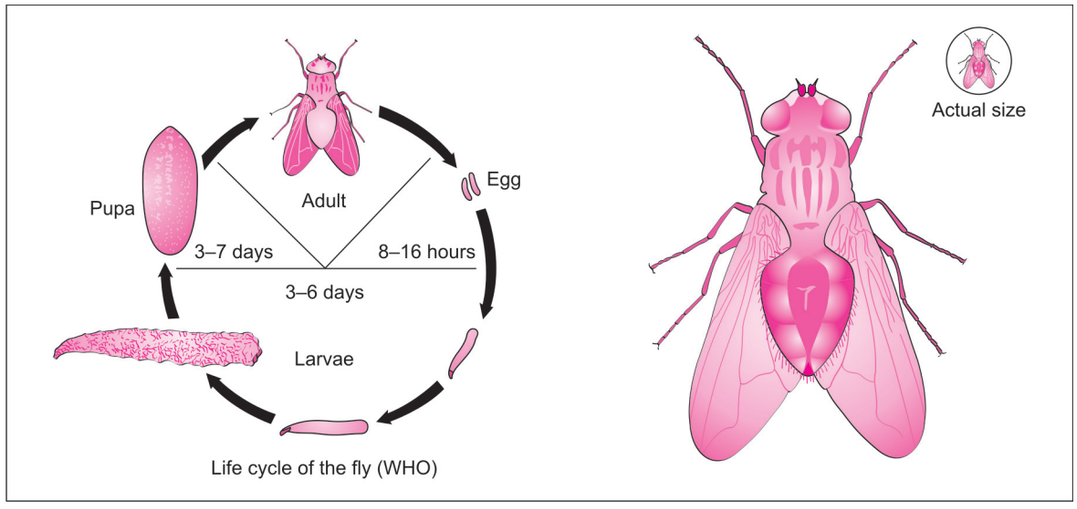


Fig. 3.10: Housefly—*Musca domestica*

feeding, the fly cleans its head and proboscis with its armour, i.e. legs. It has habit of sitting on filthy material such as animal and human excreta, garbage, sputum and sores, etc. From time to time, it vomits and regurgitates its food on the substance, probably to soften the solid food and saliva helps such solids to be converted into liquid form.

The fly has restless nature, it is intermittent feeder, and it continuously defecates and vomits every now and then and it feeds indiscriminately on filth and articles of foods meant for human consumption. These habits of fly are highly conducive to the spread of pathogenic organisms. The total lifespan of adult fly is about 15 days in summer and 25 days in winter.

Fly Control and Prevention

Environmental Control (Control of Breeding)

1 It is difficult to eliminate flies altogether, however, their population can be reduced. Eliminate breeding places. Dumping of refuse, garbage and animal cow dung near dwelling should be avoided by developing scientific manure pits away from dwelling. Compost pits and manure pits of appropriate sizes can be developed near to the field. It means removal of garbage, refuse and animal excreta on daily basis to manure pit, which is not an easy task. It means more work for women. Men must participate.

2 Gobar gas plant installation is also effective measure to dispose off animal as well as human excreta, and we get excellent manure and user-friendly fuel for cooking.

3 Indiscriminate defecation promotes fly breeding. Promoting sanitary latrines will (under *Swachh Bharat Abhiyan*) prevent fly breeding and prevent soil pollution and reduces the spread of hookworm and intestinal parasites apart from diarrhoeal diseases. Improving environmental sanitation is a long lasting measure to control flies.

4 Removal of garbage and refuse and safe composting by municipal authorities is the key function of civic authorities. This leaves much to be desired. The disposal grounds should have sanitary tipping and scientific approach (Bengaluru or Indore composting methods should be adopted). Municipal bodies have poor budget and this aspect is neglected. The system is well developed in some corporations.

Control of Adult Flies

Residual spray

1 The housefly has developed resistance to several organochlorine compounds. Residual spray with malathion and synthetic pyrethroids on resting sites such as manure dumps, and walls is helpful.

2 Pyrethrum 0.1% is useful for destruction of adult flies to suppress their population.

3 Poisonous solid baits containing 1–2% diazinon, DDVP and malathion have been successfully tried.

4 Sticky fly paper and swatting is useful.

Physical control: Use of light traps (electrocutors) are very useful in dining areas and public eating places.

Fly proofing: Using fly-proof containers and cupboards and covering the food with proper fly-proof mesh. Doors and windows need fly proofing.[6]

FLEAS

Fleas belong to the order Siphonaptera; widely distributed all over the globe. They belong to two main groups 'Coombless flea' and 'Coombed flea'. The most important species are: *Xenopsylla cheopis*, *X. astia*, *X. braziliensis*.

Diseases Transmitted

X. cheopis transmits *bubonic plague* from rat to human beings and epizootic in rats.[7] Besides *X. cheopis*, *X. astia* and *X. braziliensis* can also be effective vectors. *Rickettsia typhi* is also transmitted from its rodent reservoir to man by the same rat fleas. Fleas can also transmit rat trypanosomiasis, cat and dog tapeworm, canine leishmaniasis and chiggerosis. **Flea index** of 1 or above is critical for potential outbreak.

Morphology

The adult flea is wingless, small insect and its body is laterally compressed, size varying from 1.5 to 6 mm, legs are long and powerful, these characters allow the insect to move freely in the hair of host. The cuticle is strongly chitinized. The flea lives on warm blooded animals (rats mostly) and mouth parts are adapted to suck blood of mammals; which is the only food for the insect. The body parts consist of head, thorax and abdomen and mouth parts are best suited for biting, piercing and sucking blood. Both male and female suck blood (Fig. 3.11).

Life History and Bionomics

The flea undergoes a process of complete metamorphosis through the successive stages of egg, larva, pupa and adult.

The eggs are often laid in rat holes, burrows, in rubbish, debris under carpets, and in granaries. The eggs are never laid on the body of the host. It continues to lay eggs throughout its lifetime. During the summer, it takes 4–5 days for eggs to hatch.

The larva is footless hairy caterpillar like maggot, extremely active and it thrives on animal's dropping or excreta. The larval body consists of head, thoracic and abdominal segments. The head carries a pair of antennae. The larva is devoid of eyes but very sensitive to light. Direct sunlight kills the larva. The flea larva moults twice and has three larval stages. The third stage larva spins a cocoon around

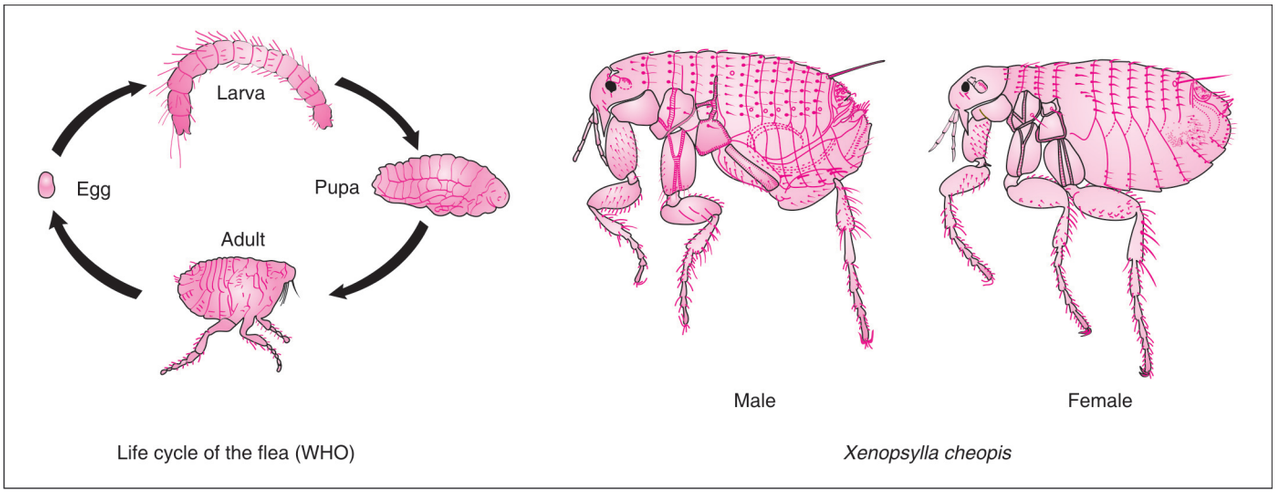


Fig. 3.11: Flea

it and becomes inactive. The normal larval stage lasts for 15 days then it transforms itself to pupal stage. The pupal stage in the cocoon lasts for 7–15 days and may be prolonged for a considerable time. The whole process of metamorphosis takes around 2–4 weeks but may be prolonged considerably if conditions are unfavourable.

The average flea is able to jump about 3 inches from the ground when gorged and 4 inches when starved. Fleas of both sexes thrive exclusively on blood meal which is necessary for their own nutrition and maturation of the ovum. Flea may leave the rat or when rat blood is not available it may attack man. Oviposition takes place within 24 hours of copulation. Fleas are very sensitive to light and air. They always hide under dark objects. The average lifespan of flea is 4 weeks approximately.

Vector Control

Indoor residual insecticidal spray (IRS) at the lower one meter of the wall surface and adjacent floor area is effective. Choice of insecticide is diazinon or malathion. Dusting with diazinon 2%, malathion 5% or carbaryl 2% may be applied at a dosage of 2–3 g/sq. meter under grain bins or rat runs, and furniture. Dusting brings down flea density considerably.[8]

Dusting of pet dogs and cats also helps to get rid of fleas. Similarly, rodent control measures are helpful in reducing the population of rat flea. This is an indirect measure to control rat flea.

Murine Typhus (Endemic Typhus) or Flea-borne Typhus

It is an acute febrile illness caused by *Rickettsia typhi* and transmitted to human by the bite of infected *Xenopsylla cheopis*. The mode of transmission is by contamination of broken skin by rickettsia-laden faeces of flea and dried flea faeces gaining entry through conjunctiva or respiratory tract by aerosol. This is endemic in India as the animal reservoir, rats, are abundant in every town. It necessitates direct control measures against rodents and rat flea. In India, endemic typhus has been reported from Pune, Lucknow, Mysore, Kolkata, Golkunda, Karnal, Rewari and Kashmir.

CHIGGEROSIS

The flea *T. penetrans* has been reported from Western parts of India. This is originally South American species. It flourishes best in sandy soils. Domestic animals usually play the host to this flea and this flea has not been able to establish in India.

Disease Relationship

Tunga penetrans (flea) causes chiggerosis in man and domestic animals. It usually attacks sole of the foot and palm of the hand. The toes and fingers are affected. The female embeds itself into the skin of foot and it causes considerable inflammation and discomfort. Insect is treated and killed with 8% pyrethrum ointment over the affected part and dead fleas are removed.

LICE

The head and body lice belong to order Anoplura. These are parasites on mammals. They belong to genus *Pediculus*. The important species of human lice consist of *Pediculus humanus capitis* (head louse), *Pediculus humanus corporis* (body louse). The other louse is *Pthirus pubis* (crab or pubic louse).

Habitat

The head louse (*Pediculus humanus capitis*) infests the head-hair mostly around the occiput and behind the ears

and neck region. Their population increases in winter months; but they persist throughout the year. Body louse infests the hair of chest, breast and axilla and is confined to the seams of clothes or fibres on which eggs are laid.

The crab louse infests the hair of pubic region, perineal region and even spread to abdomen, thighs and forearms and occasionally in eye lashes and eyebrows leading to blepharitis and conjunctivitis. Lice lead parasitic life and feed entirely on blood. In the absence of host, these will not survive. There are no constant differences between the head louse and body louse but for sizes. *P. capitis* is small as compared to *P. humanus corporis*. Body is pigmented in *P. humanus capitis* and pigmentation is absent in *P. humanus* corporis or body louse.[9]

Disease Transmission—Pediculosis

Only body louse is a vector for the transmission of *Rickettsia prowazekii*, causing the epidemic typhus; *Rochalimaea quintana* causing trench fever, and *Borrelia recurrentis* causing relapsing fever. 'Pediculosis' mean infestation of body parts with lice, it leads to irritation, scratching and intense scratching leads to secondary infection and it causes considerable inconvenience to man. They bite quite often at night which often interferes with sleep.

The bites are associated with local pigmentation of skin, and skin gets hardened and at one time it was known as vagabond disease.

Morphology

The body of lice is flattened dorsoventrally, the integument is highly chitinized, wings are absent the mouth parts are well adapted for piercing of skin and sucking of blood and the metamorphosis is incomplete. Both male and female thrive on blood sucking, hence both can transmit the disease. The body of lice is elongate and divided into head, thorax and abdomen and they have 3 pairs of legs with strong claws. Female louse is much larger in size as compared to male louse (Figs 3.12 to 3.14).

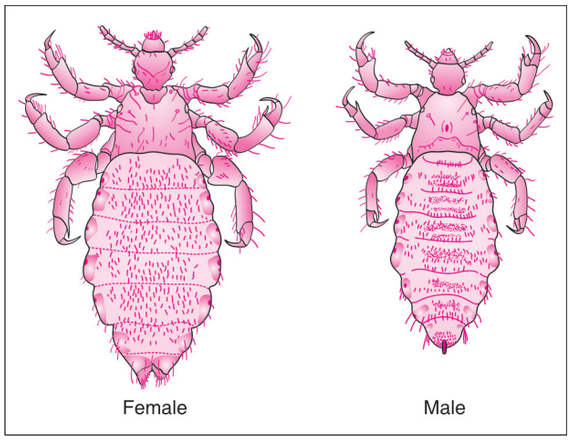


Fig. 3.12: *Pediculus humanus*

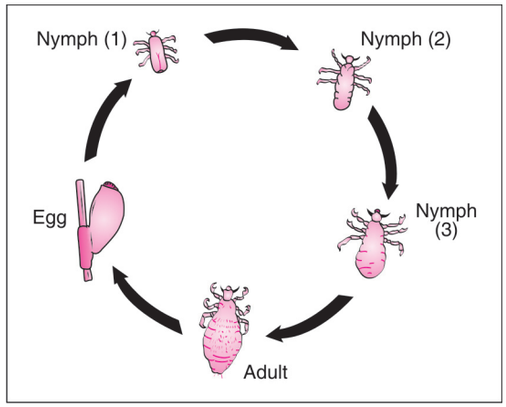


Fig. 3.13: Life cycle of the louse

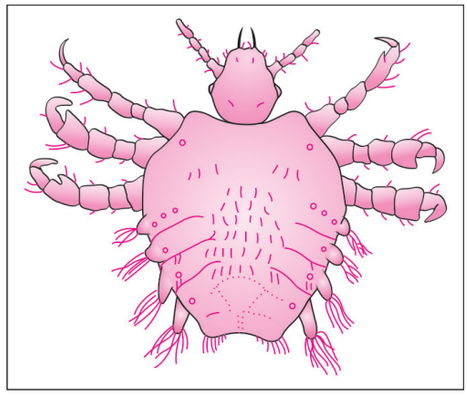


Fig. 3.14: *Pthirus pubis*, female

Life History and Bionomics

Oviposition usually begins 24–36 hours after the adult female emerges from the third larval skin. The egg is oval and pearly white and appropriately very large and these adhere to hair (called nits) (Fig. 3.7). Body louse lays eggs in the seams of the vests or clothing. Only one egg is laid at a time. It takes 4 days time for egg to hatch under suitable temperature. When the larva or nymph emerges from eggshell the empty shell usually remains attached to hair for quite some time even more than 6 weeks. There are three larval or nymphal stages in the development cycle of *Pediculus* and accordingly three successive moults occur before the insect acquires adult stage from immature nymph stage. On an average, a total period of 15–16 days is necessary between hatching of egg and appearance of the adult stage. Average lifespan of louse is 34 days.

Dissemination

The multiplication of louse depends upon the neglect of personal hygiene and wearing of underclothing days together. The dissemination occurs, because of close contacts and overcrowding and sharing of beds. The overcrowding in urban slums and metropolis is a common feature.

Where many individuals stay in small shelter, the spread of louse is quite common. Conditions are favourable when the people congregate in refugee camps, and barracks. Spread is faster during famine and war conditions. By sharing beddings, clothes, blankets, towels, coombs and brushes the lice can be easily disseminated.

The *pubic louse* can be disseminated by *sexual contact* also and hence it is one of the STD.

Louse-borne Epidemic Typhus

Man is the sole reservoir of epidemic typhus. The causative organism is *R. prowazekii*. The disease is transmitted by human body louse *P. humanus corporis*. The organism *R. prowazekii* multiply intracellularly in the midgut of louse. Within a period of 10 days midgut cells rupture. A large number of rickettsiae appear in the body fluids and in the faeces of louse. The infection is transmitted by entry of infectious faeces, the gut contents and the body fluids of crushed louse through abrasion on the skin caused by scratching. The dried excreta can be inhaled and infection can also be transmitted through conjunctiva. The infected lice remain infective throughout their life. Infected lice die within 2–4 weeks.

Due to epidemic typhus, about 30 million cases and 3 million deaths occurred in Soviet Union between 1918 and 1922. This causes prolonged febrile illness lasting for days. The average incubation period is 6–15 days. The case is infectious to louse during the last 2–3 days of incubation period and throughout the febrile period which lasts for 12–14 days. In India, the endemic spot is Kashmir. In some who recover from the disease, the rickettsiae remain latent in the lymphoid tissues or organs for years. Such latent infection leads to recurrent typhus or Brill-Zinsser disease.

TRENCH FEVER

It is transmitted from man to man by body louse (*Pediculus humanus corporis*). The causative organism is *Rochalimaea quintana* which grows in the gut of louse. When faecal matter of louse comes in contact with abraded skin the infection occurs.

Louse-borne Relapsing Fever

This disease is caused by *Borrelia recurrentis*, transmitted by body louse. The disease organisms can enter the body through abrasions, wounds or the mucous membrane when the infected body lice are crushed between finger nails or the teeth.

Weil-Felix test—commonly used test. The Weil-Felix test is helpful in establishing presumptive diagnosis in disease caused by members of typhus and spotted fever group of Rickettsiae. The sensitivity and specificity of Weil-Felix test is low as compared to specific serological tests for detection of IgM antibodies.

Prevention and Control

- Best way to prevent louse development is adequate personal hygiene, regular bathing and washing of clothes. Good personal hygienic practices keep away lice.
- When the louse infestation develops steam disinfection of clothing and sun drying of clothing along with shaving the hair helps to get rid of lice.
- 10% DDT powder dusting of garments of lousy individuals causes rapid reduction of infestation. If need be second application can be done after 10 days this will eliminate the infestation. 60 g of powder is needed for one application.
- Anti-lice shampoos are available which include permethrin 1%, fenitrothion (0.2–0.4%), deltamethrin shampoo (0.03%). An emulsifiable concentrate known as NBIN containing 68% of benzyl benzoate, 6% DDT, 12% benzocaine and 14% tween 80 (an emulsifier) is also useful. After bath the emulsion is applied after diluting it five times. Treated person should not bathe for 24 hours. About 20 ml of this emulsion is required per person. Impregnation of garments can also be done with these emulsions.

ITCH MITES AND SCABIES

Itch mite (*Sarcoptes scabiei*) causes scabies in man. They are also called burrowing mites and are responsible for mammalian scabies. *Sarcoptes scabiei* is small globular in shape and of whitish colour. There is no definite segmentation of the body though it is clearly divided into two regions by a fold or the integument. The integument shows transverse striations and is provided with scales, hair and spines. The legs are short and stumpy and are arranged in two groups, each is provided with powerful claw. The mite is hardly visible to the naked eye but with hand lens it can be better appreciated (Fig. 3.15).

Life History

The female itch mite burrows into epidermis of skin. The parts of the body selected for burrowing and oviposition are well defined which include, interdigital spaces, the wrists particularly the ulnar margins, elbows, anterior folds of axilla, the penis, scrotum and buttocks, the back of the knee, ankles, toes and abdomen.

Oviposition commences almost with burrowing. Eggs are laid in burrows. The egg is ovoviviparous. The larvae emerge from eggshell after 3–4 days and on emerging from eggshell these quickly escape to the surface. It has a short life and it moults to form nymph in 2–3 days. The nymph digs into the hair follicle for the first time. A papule appears at the spot selected by the nymph for burrowing and it develops into vesicle. The appearance of vesicle synchronizes with the maturation of nymph to adult which

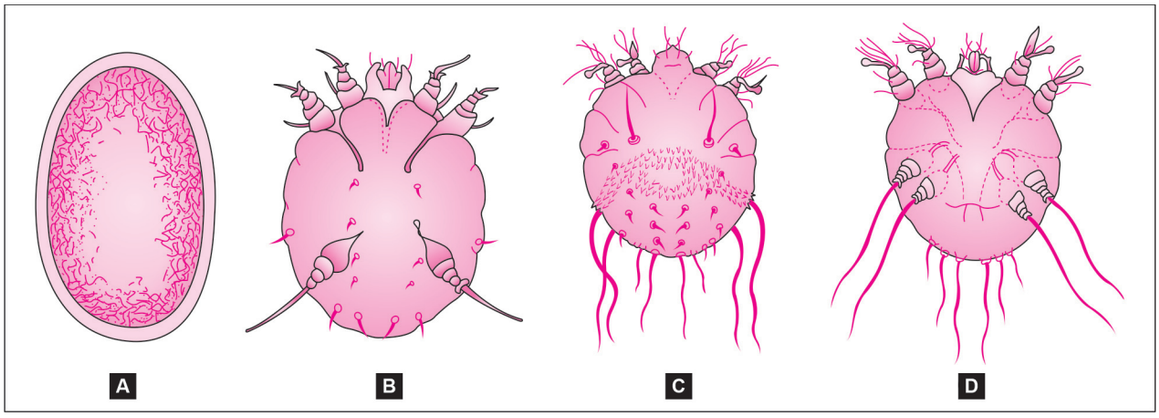


Fig. 3.15: Egg (A) and larva (B) of *Sarcoptes scabiei* (female) from man; dorsal and ventral aspects (C and D)

takes 4–8 days. The whole life cycle gets completed in 9–15 days.

Scabies

The appearance of papule causes intense itching, irritation and this induces scratching and it enables the parasite to escape to the surface of the skin. The female after depositing the full complement of eggs dies at the blind end of the burrow. The itching is more intense at night than daytime. The transmission of scabies occurs by close contacts and prolonged contacts and sleeping on the same bed and sharing of linen is necessary for spread of disease. Most often all the family members are affected one after the other because they share same beds and clothing. Scabies run into family and invariably affects all family members. Its implication is that the treatment should be given to all family members; otherwise the infection tends to persist in the family. Infection does not provide any immunity.

Prevention and Control

Scabies is seasonal disease and affects those families and individuals who lack personal hygiene. Good personal hygiene—regular bath and clean linen and clean undergarments and exposure of bed linen to sun, prevents scabies. Therefore, best prevention against scabies is personal hygiene.

Treatment

All the family members must be treated as scabies is household infection and affects all the family members. It is the household which needs to be treated. Beds and linen be washed and sun dried.

Treatment: After bath with soap and water the application of benzyl benzoate emulsion 25% all over the body; the body should be painted with this emulsion, below neck and avoiding application to eye. The application may be repeated after 12 hours and thereafter bath with soap and hot water be given. The clothes, bed linen should be washed and sun dried. Permethrin cream 5% apply all area below neck and wash of after 6–14 hours.

BITING MITES

Mites are known by several names such as chiggers, harvest mites, kedany or scrub mite and house dust mites. Numerous species of mite are parasitic on mammals and birds and occasionally attack humans. The trombiculid mites transmit typhus fever due to *Orientia tsutsugamushi* in Asia and Pacific.

Distribution

The most important species are:

1. *Leptotrombidium deliense* which is vastly distributed in Indian Subcontinent and south-east Asia. In India, it is distributed in whole of the Shivalik ranges, Eastern and Western ghats and Vindhyachal ranges in Central India. It transmits scrub typhus.
2. *Leptotrombiculum akamushi* is widespread in Japan.

Disease Relationship: Scrub Typhus

Biting mites can transmit a number of rickettsial diseases to humans, but the most important one is scrub typhus. It is caused by gram-negative bacterium of family Rickettsiaceae—*Orientia tsutsugamushi* and leads to high grade fever with chills, severe headache and lymphadenopathy. At the site of attachment of the infected larvae (chiggers), a primary skin lesion consisting of a punched-out ulcer covered by eschar commonly develops before the onset of the fever attack. In severe cases with pneumonia and myocarditis, the mortality rate may reach 30%.[9]

Morphology

The adult trombiculid mite is 1–2 mm in size bright red or reddish-brown in colour, of velvety appearance and its

body is densely covered with hair. The mouth parts are suited for bite and proboscis has cutting apparatus called chelicerae (Fig. 3.16).

Life Cycle

The mite passes its life cycle through four stages: (a) Egg, (b) larva, (c) nymph, and (d) adult. Eggs are laid in the soil. After about a week, the egg hatches and larva emerges. Larva is very active. It moves actively in search of host such as rat, mouse, bandicoot and human host. Only larval stages are parasitic. The larva (chigger) feed on lymph and tissue fluids of the animal host and remain attached to skin of the host for 2 days to a month. After feeding, the larva drops on the ground or loose soil it takes 7 days time to digest the food and to develop to next stage, i.e. nymph. The nymphal stage lasts for 14 days. After about 10 days adult mite with differentiated sex emerges. Overall it takes 6–12 weeks time for its development from egg. All stages except larva develop in soil. Chigger index of ≥ 0.69 per host is critical indicator of implementation of vector control measures.

Animal Reservoirs

The animal reservoir for larval stage of mite are rats, mice, bandicoots, shrews and humans. These play host for larval mites. These animals also serve as reservoir of rickettsiae. Mite-borne scrub typhus is caused by rickettsial organism: *Orientia tsutsugamushi* which is transmitted to man by bite of infective larval mite. Man is accidentally involved when he comes in contact with infected larvae of mite in infested soil. A large number of cases occurred in army personnel during 1965 and 1971 conflict with Pakistan. In India, scrub typhus has been reported from Rajasthan, J&K, Vellore, Himachal Pradesh and Sikkim. 836 cases and 26 deaths were reported in HP in 2016.

Control Measures

Infected persons can be treated with tetracycline or its derivatives. Prevention is possible by avoiding contact with mite and application of repellents to skin and clothing. Residual insecticide spray (malathion) in infested area is effective against mites.

TICKS

Ticks included in the order Acarina are divided into two families, Ixodidae and Argasidae. The family Ixodidae includes hard ticks and family Argasidae includes soft ticks. The hard tick is a jungle tick while the soft tick is domestic or household tick like a bedbug.

HARD TICKS

Hard ticks belong to superfamily Ixodidae. The common hard ticks in India which belong to genera *Ixodes*; are *Dermacentor, Amblyomma, Haemaphysalis, Rhipicephalus, Hyalomma and Boophilus*.

Diseases Transmitted

These ticks transmit Kyasanur forest disease (KFD), tick-borne relapsing fever, Q fever, lyme disease, Rocky Mountain spotted fever, tick typhus, Colorado tick fever and Crimean-Congo haemorrhagic fever (CCHF) and encephalitis. These ticks also transmit Tularaemia besides tick paralysis.

Morphology

The body is oval, segmentation into head, thorax and abdomen is obliterated. Hard ticks are readily recognized

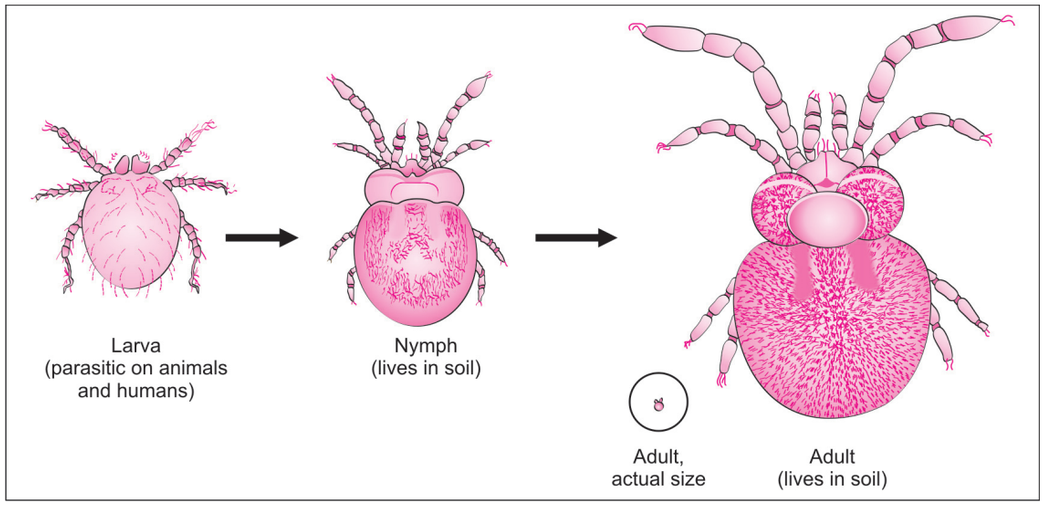


Fig. 3.16: Biting mite (*Trombicula* species)

by their dorsal shield called scutum and also by the capitulum which lies anteriorly. The scutum may be ornate with grey or white pattern. The two sexes can be easily differentiated. The scutum or hard shield is derived from the integument and becomes highly chitinized. In male, it covers almost the whole back and this prevents the tick from increasing to any appreciable size, whereas in the female it covers only a small part of the back; thus allowing female tick to increase in size considerably. The females are thus much larger in size. At the anterior end, lies the false head or capitulum and posteriorly the abdomen. The capitulum has rectangular or hexagonal shape. From its anterior part project, the proboscis or beak which includes cutting instruments called chelicerae. Antennae are absent. Eyes may or may not be present. Metamorphosis is incomplete and sexes are separate. Both sexes thrive on blood alone and lead an intermittent parasite life during the major part of their cycle. The host range includes warm blooded and cold blooded animals. Majority of the ticks live on ground in forest. Adults have four pairs of walking legs. The larvae has three pairs of walking legs, while nymph has four pairs (Fig. 3.17).

Life Cycle

The life cycle consists of four stages: Egg, larva, nymph and adult.

- After mating, the eggs are laid in cracks, crevices or on grass in vicinity where female tick has dropped off from the host. Large number of eggs are laid. The oviposition often occupies more than a week. The egg is proportionately large, round and brown in colour when ripe. Hard ticks deposit all their eggs in a single act of oviposition after which the female dies. The egg seldom hatches before 3 weeks. From the eggs emerges hexapod larva.
- Larva survives on ground and waits for appropriate host. It attaches itself to host to suck blood, and when its body is full of blood meal it drops on the ground and remains quiet till the blood gets digested. It moults and develops into next stage, i.e. nymph.
- In the same way as larva does, the nymph seeks a new host, feeds on blood and falls on the ground where it moults and get transformed into an adult. After fertilization and feeding has been completed the life history begins again. This is an instance of three host tick where adult, larvae and nymphal tick abandon their hosts after feeding. Thus, they require access to host on three occasions—in the adult, larval and nymphal stages.

Bionomics

Most members of genus *Rhipicephalus* and *Boophilus* spend whole of their life cycle on one host hence they are called 'one host tick'. It means adult, larva and nymphal stage thrive only on one host for their total development cycle.

- *R. evertsi* which is a two host-ticks undergoes metamorphosis from larva to nymph upon the host.
- Medically important hard ticks belonging to genera *Ixodes*, *Haemaphysalis* and *Dermacentor* are all 'three host-ticks'.
- In soft ticks genus *Ornithodoros*, each stage of the five moults is completed on different hosts and hence such ticks are called 'multiple host-ticks'. Adult may also feed intermittently on different hosts.

Vector Potential

Ticks are capable of producing disease in man by transmitting the viruses, such as CCHF virus, rickettsia, spirochaetes and bacilli of infectious diseases. Ticks feed entirely on blood. Wide range of host helps their survival in nature. First lab confirmed case of CCHF was reported in Gujarat in 2011. Its case fatality is high at 10–40%.

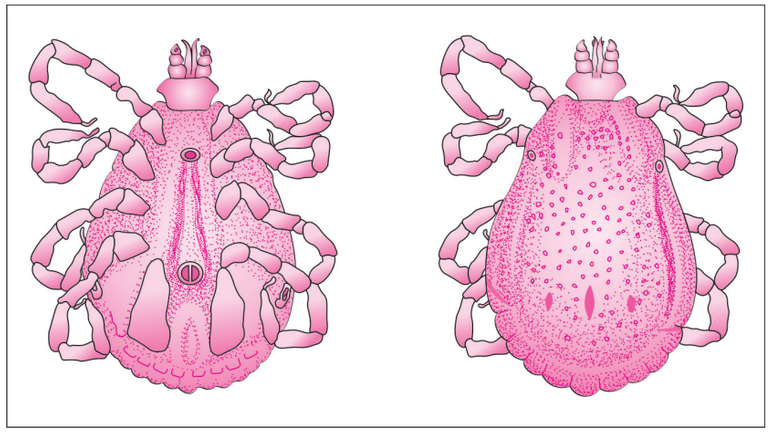


Fig. 3.17: Ventral and dorsal aspects of *Rhipicephalus sanguineus* (hard tick)

Indian Tick Typhus

The disease is caused by *R. conorii* and is transmitted to man through bite of hard ticks such as *Rhipicephalus sanguineus* in Kashmir, *Ixodae ricinus* in Almora and *Haemaphysalis leachi* var *indica* in Manipur. The ticks are acquired by man from domestic animals like cattle, horses and dogs. The disease occurs in sporadic form in India and has been reported from many parts of the country, namely Allahabad, Narsapatnam, Ratlam, Secunderabad, Bangalore, Jhansi, Pune and Lucknow.

SOFT TICKS

Soft ticks of genus *Ornithodoros* are important. In soft ticks the dorsal cover or scutum is entirely absent, hence they are called soft ticks. The capitulum lies ventrally and mouth parts are not visible from above. Sexual diamorphism is absent (Fig. 3.18). They feed during night. Soft ticks are domestic and are able to live much longer without any food (even about a year). These are found in human dwellings and cattle sheds and attack man and animals during their sleep. They, however, live away from their hosts, like bed bugs, in cracks and crevices and only emerge at night to feed on the host.

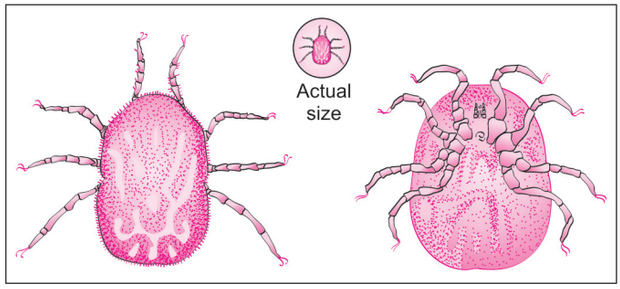


Fig. 3.18: Soft tick *Ornithodoros moubata*; dorsal and ventral aspects (WHO)

Disease Transmission

Soft ticks of genus *Ornithodoros* transmit various types of spirochaetes causing relapsing fever in certain parts of the world.

Relapsing fever is caused by *Borrelia duttoni* in Africa and it is transmitted by soft tick from man to man by the human tick called *O. moubata*. The tick serves as true intermediate host for this disease and the infection is transmitted through ovaries (transovarian) to their offsprings. *O. turicata* is prevalent vector in America. *O. lahorensis* is found in central Asia and North West India. In India, they are found in Kashmir and are known as *O. crossi*.

CONTROL OF TICKS AND MITES

Tick infested areas can be treated with appropriate insecticide. Since the hard ticks are in forest it may not be possible. In human dwellings, the ticks can be controlled by regular spray operation or dusting with insecticide can be helpful. Suspension of 50% HCH water dispersible powder, one kg in 10 litres of water sprayed over 500 meters or Lindane 0.5 kg/hectare are also effective. It can be repeated after 8 weeks. This is useful if a camp is to be set-up for refugees or army or for persons who have to work in forests.

Premises or Dwellings

Application of HCH suspension on floors and wall surface on alternate days, malathion, fenitrothion or carbamate compounds can also be used as 0.5–1.0% spray or as 5–10% dust. Dogs and other pets can be treated by wash or spray containing 2.0% malathion.

Personal Protection

It includes wearing of shoes and proper clothing and application of repellent like dibutylphthalate (DBP), diethyltoluamide (DEET) and benzylbenzoate. These are applied to clothing and skin. Application to clothing is more effective.

RODENTS AND COMMONLY USED RODENTICIDES

Rodents in India are significant because of their nuisance and alarming population, besides losses of crops after harvesting. The rodents are reservoir of many diseases of public health significance. Rodent population (particularly rat population) is much more than human population. In view of this, it becomes necessary to control their population. Rats should be destroyed not only for the reason that they are principal reservoir of bubonic plague in man but also are responsible for economic loss.

COMMON RODENTS

- Common house mouse is known as *Mus musculus*.
- Roof rat is known as *Rattus rattus*.
- Sewer rat is known as *Rattus norvegicus*.
- Besides these, there are several wild rodents.

In *R. rattus,* the tail is often one and a quarter time long as the head and body combined, the eyes are large and prominent, the ears are large, muzzle narrow, tail uniformly dark, feet slender. The colour in the Indian species is usually brown. It is widely distributed in India. It is a domestic rat and is a good climber.

In *Rattus norvegicus,* the tail is almost 90% the length of head and body. It is a heavy bodied rat with large heavy tail, ears and eyes are small, the feet are large, heavy and flesh coloured, no long piles or bristles on the body. It is a drain rat and visits houses at night. It is also a burrowing rat and good swimmer (Fig. 3.19).

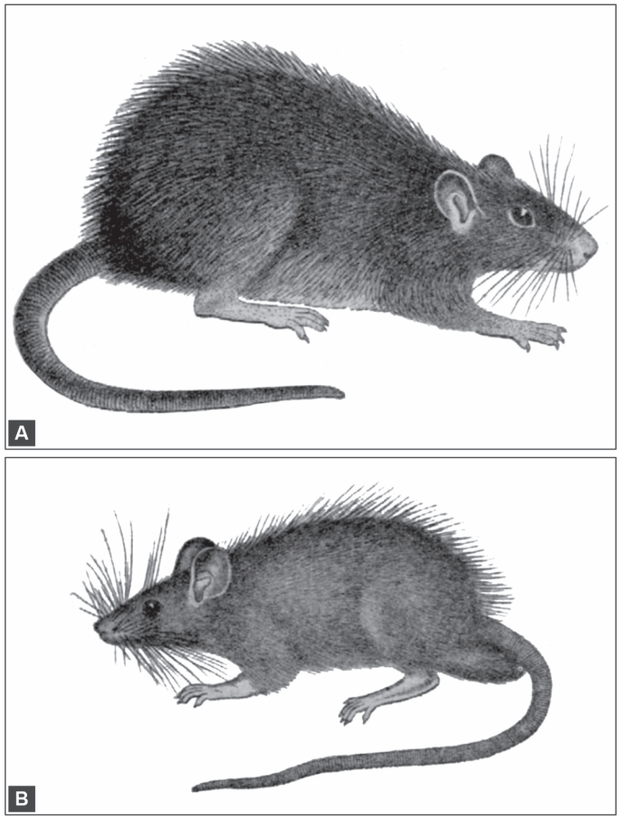


Fig. 3.19: (A) *Rattus norvegicus,* (B) *Rattus rattus*

Significance

Rodents are responsible for zoonotic diseases and they serve as reservoir of many zoonotic diseases the major zoonotic diseases related to rodents are:

i Rodents act as hosts to ecto- and endo-parasites causing human and animal diseases. Rat flea is most important ectoparasite of rats which transmits **bubonic plague** in man. Other bacterial infections transmitted through rodents are *P. tularensis* and salmonellosis.

ii Rat flea also transmits Murine typhus **(endemic typhus)**. It is caused by *R. typhi*.

iii Wild rodents are reservoir of **scrub typhus**, when infective mite larva transmits infection to human beings accidentally.

iv *Allodermanyssus sanguineus* mite infest rats and transmits rickettsial pox.

v Tick typhus is also associated with rodents.

vi Transmission of three species of spirochaetes, namely *Leptospira icterohaemorrhagica*, *Spirillium minus* and *Borrelia recurrentis* and *B. duttoni*, causing **Weil's disease** or **leptospirosis**, rat-bite fever and relapsing fever respectively are related to rodents.

vii Virus of lymphocytic choreomeningitis, haemorrhagic fever, encephalitis and certain parasites like leishmaniasis, Chagas' disease are other infections associated with rodents.

ANTI-RODENT MEASURES

Environmental measures include town planning and slum clearance. Denying the rats to hide and access to food are the cardinal principles. Common places where rat population thrive in abundance include warehouses, provision houses, slaughter houses, hostels, restaurants and slum areas. In rural settings, rats thrive in granaries, cattle sheds, rooms, piggeries, horse stables which provide them abundance of food, breeding and places to hide. Each home in rural setting is a granary as grains are stored for months together till next harvesting. Thus, all homes are vulnerable and rats thrive on in abundance on these grains. Most engineering measures are required in these settings. Similarly, rat breeding is abundant at disposal grounds selected by the municipal corporation as it provides them food and place to hide in burrows. All wastes arising from these establishments should be disposed off hygienically, incineration is preferred. If high standards of environmental sanitation are observed we can reduce the menace of rat population. Godowns should be properly planned both regarding their sites and construction. These should be away from habitation. The godowns must be not only rat proof but also be equipped with arrangements for fumigation.

Temporary Methods

These include trapping of rats by baits. Traps are set along the rat runs or near the burrow. After trapping, the rats can be killed by various methods:

Competency addressed: The student should be able to:
CM 3.8: Describe mode of action and application cycle of common rodenticides.

Rodenticides

Rodenticides are used after baiting exercises, subsequently the poison can be added to bait. Baits can be prepared by adding following poisons:

- **Barium carbonate:** It is inexpensive, but toxic to man and cat. It can be mixed with wheat or rice flour or any pretested bait in the ratio 1:3 (one part powder of barium carbonate and 3 parts of flour). After mixing water, the mixture can be rolled into pills and used appropriately.
- **Zinc phosphide:** Widely used rodenticide. It can be used in the ratio of 1 part to 10 parts of flour (wheat or rice). It emanates garlic smell. Toxic to man. It is used in granaries, godowns and on docks.
- **Warfarin (a derivative of dicumarol):** It is an anticoagulant and causes slow death in rats. It is used in the ratio of 1 part of poison to 19 parts of dry-meal in flour or chapattis or bread crumbs. This is commonly

used on board, the ships, and also in granaries. It is toxic to man.

- **Alpha-naphthylthiourea (ANTU) 1–3.5%:** It is specific for *Rattus norvegicus*. It is sprinkled in and around rat burrows, holes and runways.
- **Coumatetralyl:** The compound is available as Racumin tracking powder (0.75%) one part of poison in 19 parts of wheat flour can be used.
- **Fumigants:** Fumigants are widely applied in enclosed spaces such as ships, granaries, godowns and rodent burrows. Commonly used fumigants are sulphur dioxide, carbon disulphide, calcium cyanide **(cynogas)**, carbon monoxide and methyl bromide. Cynogas has been widely used in India. Fumigation is done by mechanical devices.
- **Aluminium phosphide tablets (Al-phos):** 6 g tablet per rodent burrow is effective in field. The burrow should be sealed with wet soil after the bait is placed.

Note: All baits mentioned above are poisonous to human beings and domestic animals. These should be used with great precaution. Left out baits should be carefully counted and removed safely.

- Commonly used insecticides (*see* Chapter 8, page 350).

CYCLOPS OR WATER FLEA

These are minute creatures and popularly known as water fleas and they have the capability of swimming in water with jerky movements. They are visible to naked eye (Fig. 3.20).

Disease Relationship

Cyclops are intermediate host of guinea worm (*Dracunculus medinensis*). The disease has been eradicated from India since 2000.

Cyclops exist almost over the globe and found in pools, tanks, ditches, step wells and ponds and thrive on spores of aquatic plants and algae and minute insects. These can be easily strained by piece of muslin cloth. Ordinary domestic strainer can be used to separate cyclops and to make drinking water safe. In fact, strainers were widely used as part of guinea worm eradication programme to make the water free from cyclops. Boiling of water also kills cyclops.

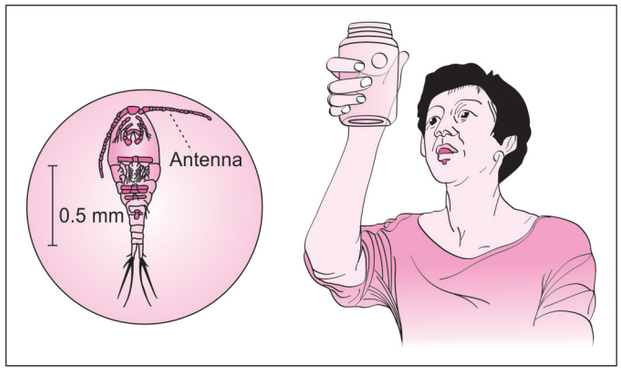


Fig. 3.20: Cyclops—intermediate host of guinea worm (WHO)

Characters

It is an insect which is demarcated into cephalothorax and abdomen. The head is fused with thoracic segment. It is pear-shaped. The head always carries two pairs of antennae. The other appendages of head consist of three pairs of jaw. The chiten is strongly calcified. The sexes are separate. The life cycle passes through the stages of egg, larva or naupilus and adult. The eggs can resist dry conditions and are blown by winds and contaminate water source at distant place.

Control

1. The cyclops can be easily filtered by a piece of muslin cloth or domestic nylon strainer. Strainer and muslin cloth can withhold cyclops.
2. Boiling of water can kill cyclops. Similarly, super-chlorination kills cyclops. Guinea worm disease has been eradicated now by provision of alternate sources of safe water supply and by education campaigns.

REDUVIID BUGS

It belongs to family Reduviidae and genus *Triatoma* and also called cone-nosed bug. It is much larger than bed bugs and found in all parts of the world. The body is elongate, the head is also elongate and eyes are placed well forward. It is a blood sucker. Size is about an inch or more in length and it attacks man. The bug thrives in old houses, crevices and holes.

Disease Relationship

It transmits *Trypanosoma cruzi* which produces Chagas' disease in South America. This parasite develops in the intestine of bug and man becomes infected due to faecal contamination of the wound.

Control measures: By observation of sanitation measures. The bugs are killed by insecticide like pyrethrum.

Competency addressed: The student should be able to:
CM 3.6: Discuss National Vector-borne Disease Control Programme.

NATIONAL VECTOR-BORNE DISEASE CONTROL PROGRAMME (NVBDCP)-2003

The National Vector-borne Disease Control Programme is comprehensive umbrella programme for prevention and control of vectorborne diseases namely—malaria, filaria, kala-azar, Japanese encephalitis, dengue fever and chikungunya which is now covered under the overall

umbrella of NHM. Out of these six diseases, three diseases namely-malaria, Kala-azar and lymphatic filarlasis are targeted for elimination. The NVBDCP was launched in 2003–04. The programme is being implemented by the states through existing healthcare infrastracture. The general strategy for prevention and control of vector-borne diseases under NVBDCP is described below.

1 **Disease management:** Including early case detection with active, passive and sentinel surveillance and complete effective treatment, and strengthening of referral services.

2 **Epidemic preparedness** and rapid response—*see* Chapter 8.

3 **Integrated vector management** (for transmission and risk reduction) by: Indoor residual spray (IRS) in selected high-risk areas, use of insecticide treated bednets (ITN), and long lasting insecticidal nets (LLINs) use of larvivorous fish, anti-larval measures in urban areas including bio-larvicides, and source reduction by minor environmental engineering methods. For mode of action and application of common insecticides, *see* Chapter 8 under malaria.

4 **Surveillance:** Surveillance of NVBDCP is an important epidemiological tool to control the spread of NVBD and predict epidemic, to investigate epidemic and to ensure rapid response.

5 **Entomological surveillance:** Under NVBDCP entomological surveillance in the programme is being carried out by entomological zones and entomological set-up at regional offices. The parameters being collected are—vector density, and susceptibility status (adults test and larval test).

6 **Supportive interventions** including behaviour change communication, (BCC), public–private partnership and intersectoral convergence, human resource development through capacity building, operational research including studies on drug resistance and insecticide susceptibility, monitoring and evaluation through periodic review/field visits and improving management information system (MIS) besides involvement of *Panchayati Raj* Institutions. Using standard treatment Protocols for treating vectorborne diseases at various levels is another important component.

7 **Vaccination only against JE**

8 **Annual mass drugs administration (only against lymphatic filariasis).**

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CHAPTER

4

Principles of Health Promotion and Education

Community medicine promotes healthy behaviours and lifestyles as: "Behaviour is the second most important determinant of health"; "Single biggest problem in communication is "illusion" that it has taken place"

— George Bernard Shaw

Competency addressed: The student should be able to:
CM 1.6: Describe and discuss the concepts, the principles of health promotion and education, IEC and BCC.

HEALTH PROMOTION BY: HEALTHY PUBLIC POLICIES

Ottawa Charter of 1986 described the principles and practice of health promotion. The Ottawa Charter focuses on the following key strategies for health promotion:

i Building healthy public policy.
ii Creating supportive environments.
iii Strengthen community actions.
iv Develop personal skills by life skills education.
v Reorient health services for advocacy.

The goal of healthy public policy is health promotion, i.e. to enable people to increase control over and to improve their health. Healthy public policies mean "Health in all Government Policies/Sectors" such as water and sanitation, nutrition, education, development, agriculture, women and child development, sports, town and country planning, industry, etc. Health promotion is thus a multisectoral activity. Government policies must promote healthy behaviours and lifestyles such as avoiding tobacco, healthy diets, physical activities, personal hygiene, safe sex to promote positive health in schools and at workplace.

HEALTH EDUCATION

Health Determinants

The most important determinants of health are *environment*, *behaviour*, *health services* and heredity to some extent.

'Behaviour' comes next to environment. Behaviour means 'visible action or practice in an individual, family and community'. 'Behaviour' of an individual, family and community determines their 'health', hence all efforts must be made to promote 'healthy behaviours' to achieve the goal of 'health in all'.[1]

Healthy actions on the part of individual, family and community should become part of life to prevent diseases and promote healthy life. That is why the 'health education', 'IEC' and 'behaviour change communication' forms an integral part and one of the essential components of all the national health programmes and comprehensive primary healthcare in India. Communication of facts for life on reproductive and child health (RCH), communicable and non-communicable diseases and nutrition has been adopted as one of the important strategies and means to prevent diseases promote health by adopting healthy behaviours (Fig. 4.1).

'Health in all' remains a cherished goal to be attained by an individual, family and community. Goal is "the enjoyment of highest attainable standard of health" inclusive of all dimensions of health as defined by WHO.

'Health education' is an important mean and process to achieve the goal of 'health'. Thus, health education concerns itself with process of change, its aim is to help individuals, families and communities to attain and maintain positive state of health by their own 'efforts' and 'actions'.[2]

Health Education (Definition)

"Health education (HE) is a gradual process of learning that informs, motivates and helps people to adopt and maintain healthy practices and lifestyles. It also advocates environmental changes as needed from time to time to facilitate this goal and conducts professional training and research for achieving the same end."

According to Lawrence W Green "health education is any combination of learning opportunities designed to facilitate voluntary adoption of behaviour which will improve or maintain health".

Aims of Health Education and Principles

The main aims of health education are threefolds: First to *inform* and educate people on the principles of hygiene

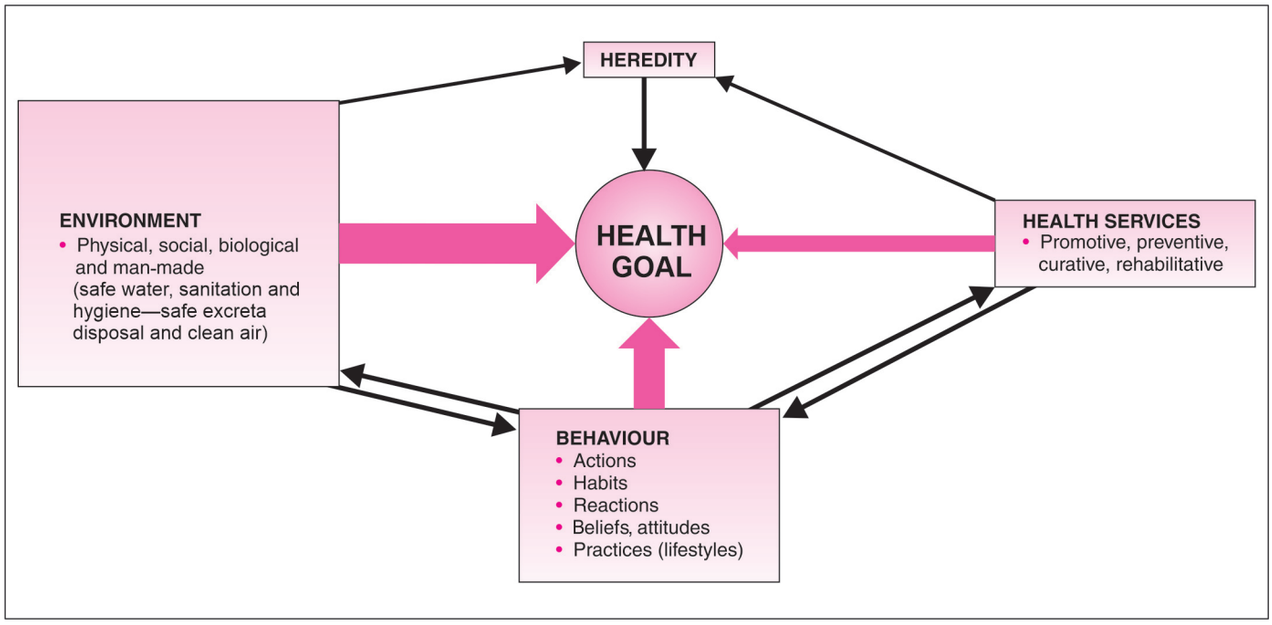


Fig. 4.1: Determinants of health and barriers to good health (WHO)

and healthy living; second to *motivate* people to change their habits and ways of living and practices that are detrimental to health; and lastly to guide people into *action* about the medical and health services provided for their benefit and encourage them to utilize these services.

There is a distinct shift from earlier strategies. To begin with, the emphasis was laid on awareness generation, which was considered necessary but not sufficient. Awareness is no guarantee that it will lead onto behaviour change. In India, awareness on contraception is almost universal (100%) but nearly 56.5% of couples practice modern contraception. Therefore, in second phase—health education and extension education strategy was adopted in 3rd, 4th and 5th five-year plan period.

Subsequently, we adopted the strategy of information, education and communication (IEC). Of late we have adopted a strategy of communication for behaviour change, which is much more comprehensive. The stages of evolution were as under.

Awareness generation (by mass media)
↓
Health education and extension education (mass media + interpersonal communication and opinion leaders camps)
↓
Information education and communication (IEC)
↓
IEC provides information, does not specify time frame, what and how behaviours, attitudes and practices to be changed as also the outcomes
↓
Behaviour change communication is more specific and comprehensive

EVOLUTION OF HEALTH COMMUNICATION IN INDIA

The shift in policy can be summed-up as:

Past focus was on		*Present focus is on*
Awareness generation	to	Behaviour change
Instructive	to	Empowering
Generic approach	to	Specific information
Centralized plan of communication	to	Decentralized approach

Behaviour change communication is a dynamic process, which **specifies** the 'behaviour' to be changed within **specified time** as also **methods** and **outcomes** (*see* Table 4.1).

Classification of Behaviours

It is an action or observable practice/practices in an individual, family and community. Most prevalent practices or behaviours can be classified into:

Harmless: Such as wearing charms, amulets, worshipping and appeasing gods and goddesses. Leave these behaviours as such.

Good behaviours and best practices: *Best practices*—exclusive breastfeeding, immunization, washing hands, eating clean food, drinking safe water, spacing births and limiting the size of the family, using iodized salt, brushing teeth, regular exercise, etc. These behaviours and practices are to be promoted through communication.

Harmful practices: Early marriages, bottle feeding, drinking unsafe water, tobacco use, chewing pan-masala, excessive use of alcohol, unprotected sex with stranger

and physical inactivity are unhealthy behaviours, hence need to be changed. We have to analyze all the behaviours and practices and put them into these categories for appropriate action.

PRINCIPLE 1—Define Objective, Target Audience and their Concern

Health Information to People (Information for All)

Information means knowledge, ideas, emotions, skills and data on health. The fundamental **principle** of health education is to provide or give scientific health information or knowledge to people, which would empower them for self-reliance and actions. Health knowledge is a power and great mean to improve their health. On health/disease knowledge explosion has occurred and health technologies have made rapid advance. The knowledge and information on simple health technologies and advances is unfortunately confined to hospitals, doctors, paramedical workers and other health professionals. The knowledge and information has not reached to those who need it most. The poor, illiterate and disadvantaged have been deprived of 'vital health information and knowledge' which they need most to save their lives and of their children apart from promoting and maintaining their health. Adequate information on health is the right of everyone.

Information, which could enable parents and families to drastically reduce disease, malnutrition, deaths and disability among their children, is the **information,** which every parent should have. It is the **information,** which ought to be part of every family's basic stock of knowledge. It is the **information,** which ought to be part of the normal way of bringing-up children, and made available to every community through multiple channels. It is the information to which all families now have a right and almost all parents can put into practice, in some degree, at very low cost (UNICEF).

PRINCIPLE II—Frame what you Expect from Audience

Information Revolution

The coming decades should be observed as information revolution and communication (IRC) decades. All out, intensive efforts be made in these decades to create people movement for self-reliance in matters of health. Information which could enable individual, families and community, to reduce disease, malnutrition and deaths is the information which all must have. It is the information which ought to be made available to every community via schools, the radio, the television, the newspaper, the religious leaders, the health workers and every other possible means of communication and support. In other words, it is an urgent task of **mass communication** to most needy, the poor. Task is too big for health sector alone, others have to join hands and intersectoral approach will pave the way.

The following are top ten **messages** adopted from facts for life (UNICEF) for action, which are most relevant to our country and we can add to these messages, the messages of lifestyles and chronic non-communicable diseases which are emerging fast in our country besides the epidemic of HIV/AIDS and accidents and COVID-19.

1. The health of both women and children can be significantly improved by spacing births at least 3 years apart, by avoiding pregnancies before the age of 18 and after 35 and limiting the total number of pregnancies to two or less.
2. To have safe pregnancy by having adequate prenatal check-ups and safe delivery by trained person.
3. Exclusive breastfeeding for first 6 months of life and adequate complementary feeding after 6 months of age by home available foods.
4. Complete all immunization by one year of age and get booster doses at 1 and ½ years of age and every woman in child bearing age should be immunized against tetanus.
5. Diarrhoea kills by dehydration (loss of fluids from body). Home available fluids, breastfeeding and ORS prevent dehydration and deaths due to diarrhoea. Handwashing before eating prevents diarrhoea.
6. Most coughs and colds get better on their own. But if the child with cough is having difficult and fast breathing and there is indrawing of chest, then the child is seriously ill and it is essential to go to a health facility quickly. A child with cough and cold should be kept warm, continue breastfeeding, give more fluids and continue feeding.
7. Children under 3 years have special feeding needs. They need to eat 5 to 6 times a day. Adequate feeding of young children is essential for their growth. Fats and oil should be added along with vegetables. Whatever is cooked in home should be fed to child in enough quantities.
8. Many illnesses are caused by germs and germs enter the mouth. This can be prevented by clean eating, drinking safe water, and handwashing with soap and water and by using sanitary latrines.
9. After each episode of illness, one extra meal should be given to every child for a few days to make-up the losses due to illness.
10. All girls and boys should be enrolled in schools at the age of 6.

Malaria, HIV/AIDS, injury prevention and disasters and emergencies are other areas.

We can add to these the messages on: Healthy lifestyles, such as no smoking, no alcohol, and regular exercise, maintaining appropriate weight, eating healthy foods, avoiding junk foods and regular brushing can prevent many illnesses (chronic diseases).

PRINCIPLE III—Select Right Channel

The major task remains as **how to communicate** the **available information** and **knowledge** to individuals, parents, families and community in rural, tribal, and urban

slum areas. Communication for behavioural change has become a major strategy in reproductive and child health as also for all other national health programmes.

We have over 10.72 lakh ASHAs, 13.4 lakh *Anganwadi* workers, 180769 health worker females, 52696 male health workers, 161829 sub-centres, 31053 primary health centres and 6064 community health centres and manpower of Indian system of medicine and non-governmental organization to inform and educate people besides self-help groups and system of village *Panchayats* and *Nagarpalikas*. Thus, India has a massive manpower to reach rural and urban slums of the country. Apart from this, the system of elementary education is near universal to reach every village to cover the schoolchildren for inculcation of healthy lifestyles and healthy habits. If the knowledge and information is made available to target population and is acted upon, it will save millions of lives and disabilities. It is needed most in India.

Expected outcomes: The student classifies observed behaviours into harmless, beneficial and harmful and prepares health messages.

Competency addressed: The student should be able to:
CM 4.1: Describe various methods of health education with their advantages and limitations.

Various Methods/Strategies/Approaches in Communication/Health Education their Merits/Demerits

Three approaches are commonly used, individual, group and mass communication/education.

(A) Interpersonal (Individual Approach)

It is one-to-one communication, which happens during home visits by health workers when they contact family and care givers. It is most precise and specific communication dealing with the precise needs of an individual for behaviour change communication (BCC).

Merits

It occurs in most friendly manner. It is also called interpersonal communication (IPC). It is most interactive and participatory. Message passes directly from source to receiver.

Interpersonal communication skills of workers need to be sharpened through training and retraining in group dynamics, group discussions. Home visits programme of health workers, their beat programmes should focus attention on interpersonal communication based on individual's health needs and suggest home-based actions within the capacity of family. Every contact of worker with the people should have an element of need-based education. This should be the major strategy in the clinics and hospitals. Support health education material (printed and visuals) and case material or live situations can enrich the interpersonal communication process.

Demerits: Reach in limited coverage is minimal, and it is time consuming activity.

Enhancing Interpersonal Communication

Interpersonal communication can be enhanced by:

- Empowering *Mahila Swasthya Sanghs* (MSS) who could take responsibility of contacting married women in their neighbourhood on regular basis.
- ICDS functionaries like *Anganwadi* workers and health workers should be trained together and make joint home visits for interpersonal communication.
- *Mahila Mandals* and *Mahila Arogya Samitis* and elected women *Panchayat* members and ASHAs can spearhead interpersonal communication in RCH programme to the best advantage of women in reproductive age group.
- Interpersonal skills—to be nice, polite, friendly, empathic, and patient.

(B) Group Communication/Group Discussion

When health worker female organizes a small group of *Mahila Swasthya Sangh* (10–20 women), she organizes a group discussion and group meets to discuss a common problem say problem of anaemia in pregnant women it is called group communication. All members of the group are encouraged to participate and express their views and come to an agreed upon solution for an identified problem. In a group discussion, group dynamics are important. Many methods are used in group communication, it could be a demonstration, discussion, an audio-video show, organized listening and watching television, question–answer, etc. It all depends upon the communication skills of health workers and their supervisors. Group communication with *Mahila Swasthya Sangh, Mahila Mandal*, village *Panchayats*, self-help groups and adolescent girls and boys could be most rewarding experience. Health workers must be trained on how to organize a group communication. Sitting in a circle and semicircle, on ground or on chairs, provides an opportunity of visual contacts and generates a sense of equality amongst all group members. In this arrangement, group members can see each other and can interact in a friendly manner. Regular Village Health Sanitation and Nutrition Committee meetings must be organized at *Anganwadi* centre once a month.

Merits of Group Discussion

It is participatory method of education and two-way communication process based on felt needs. Group discussion is a process in which a group of individuals come together; deliberate on an issue or problems so as to arrive at a solution or consensus opinion. In this process the group goals are jointly set, all the members participate and contribute to group discussion, usually facilitated by a leader, find solution, evaluate their effectiveness and finally try to arrive at a consensus.

Anganwadi workers and health workers have been made responsible to organize mother's meetings once a week and *Mahila Swasthya Sangh* meeting/VHSC meeting once a month at the village level. This has been done to enhance **interpersonal communication** for behaviour change on pressing problems, such as breastfeeding, illegal abortion or sex-selective abortions and PNDT Act, sex-ratio of under six children, anaemia and maternal mortality, safe pregnancy and safe delivery.

Demerits

Workers have seldom organized group meetings and they have seldom been adequately trained to organize meaningful group meetings. The purpose is not clear and end results are obscure. Hence, the health manager should take-up this challenge to build capacity of health workers for organizing women groups, group formation, group dynamics, group discussion and ensuring their regular meetings at least once a month. Every month, a chosen subject is discussed by a group of women. It can be organized more frequently with the help of *Anganwadi* worker, traditional birth attendants and accredited social health activist (ASHA).

Women are already busy and have least time for group discussion. This is a big challenge. Only meaningful, informative and interactive group discussion lasting for 30–60 minutes time is enough. If women cannot come out because of busy work schedule, the smaller group meetings can be held during home visits to discuss the pressing problem and behaviour change.

Essential Component of Group Meeting

The group size consists of 10–15 men or women of a locality. Priority should be women of economically weaker sections. The group could be homogeneous say—pregnant women, lactating mothers, women having children below 2 years of age, and adolescent girls. There could be heterogeneous group as well.

- The day/date of meeting should be well publicized and place should be well prepared for their reception.
- The meeting should be organized at familiar place, like *Anganwadi* centre, *Mahila Mandal* premises, or sub-centre. It should be easily accessible.
- Make arrangement for sitting. Everyone in the group is equal. Prefer a circle or semicircle arrangement.
- Select a most pressing problem you wish to address or women feel to know/understand.
- Arrange or obtain learning resource material—printed material, posters and demonstration material if possible. Demonstration is best method in a group.
- Health workers should act as facilitators and not as teachers and they should not talk at people.
- Let women discuss the chosen problem themselves and arrive at a solution. Let women express different/ divergent views on the chosen subject. The health workers should facilitate and ensure that everyone participates. Health worker's responsibility is to prepare notes or record salient points of discussion and provide supportive information on the subject.
- Prime role of the worker is to listen attentively all the viewpoints and discuss the various facilities made available at village *Anganwadi* centre, Sub-centre and PHC.
- Worker should never forget that women themselves and family itself are very important resource to deal with the identified problem.
- The group must reach to a consensus decision and workers must ensure follow-up actions on decision made to build confidence amongst the women group. It should not be merely a discussion but followed by a concrete action either by women or by family themselves or with the supportive services available at various levels.
- Group discussion, which are purely theoretical are least effective. These can be made most productive and interactive by use of demonstration, women-to-women communication of a life experience, such as use of copper-T as spacing method, preparation for safe delivery, early breastfeeding initiation and exclusive breastfeeding, and immunization.
- The workers in group discussion should never sit on chair and act as teachers, they should sit with women on mat.
- It is better to identify a group leader on voluntary basis to conduct meeting and regulate time.
- Refreshment during group meeting is optional, it should be offered by community and women group leader and not by government expenses.

During the group discussion, if health manager or supervisor is available, it provides additional support and it enriches group discussion and status of discussion rises, but health manager must sit with women group and have face-to-face discussion.

In this manner, direct feedback can be obtained from group.

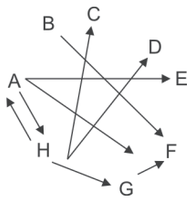
Role of Members

Some members in the group dominate and do not give chance to other women to speak, this should be discouraged and controlled by group leader.

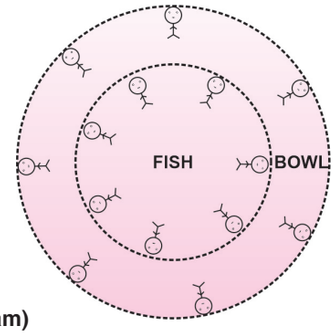
Some members keep silent and do not participate at all. Encourage such women to speak on the issue and tell them nothing is wrong or right. Other members obstruct and disturb the proceedings and they play negative roles, discourage this practice. Some women are quite positive they give information and seek more information and promote harmony in the group, some members may even be hostile and some are engaged in mutual discussions.

Interaction between group members and interaction of group members with the facilitator/resource person during group discussion is known as *group dynamics*. This can be shown by arrows (who interacted with whom and how many times). If arrows are connected it becomes a *sociogram*. Regular group discussions provide lot of feedback

to improve the health services. The students can be given this exercise for better comprehension of group dynamics.



Group dynamics (sociogram)



Fish Bowl

Fish Bowl

The group sits in two circles. Inner circle group members (FISH) deliberate a problem/issue to arrive at solution. The outer circle group members record, and observe the behaviour/interaction of each member of the inner circle group and later on present and discuss in the group. This is known as **fish bowl formation** in group discussion.

Focus Group Discussions (FGDs)

Focus group discussions are thematic discussions among small homogenous group of potential programme beneficiaries. It is a method of learning directly from the 'clients' in the clients own words, what they think of certain products or why they uphold certain practices and what benefits they hope to experience from both. FGD is a technique adapted from **applied psychology** to obtain 'top of the mind' responses from clients or beneficiaries of the programme. A theme is chosen on the basis of observations made by the workers during their home visits or contact with the clients during mother and child protection sessions or contacts at sub-centre or *Anganwadi*. The theme could be use of ORS to prevent dehydration and deaths in children having diarrhoea or use of home available fluids to prevent dehydration.

Participants in FGD: Their number should be 6–8. They could be young mothers with child under 36 months, whose child has had diarrhoea at sometime in the past. The FGDs are conducted by a moderator and someone takes the notes and analyses the results of discussion. Recruiters recruit the participants. This way consultation of consumers is obtained and right message for right client, at right place and right time is delivered, suited to their need and cultural practices.

FGD method is commonly used in social marketing to popularize a product or service such as contraceptives, ORS, immunizations, etc. Thus, FGD is an extremely valuable research technique and can be used along with other research techniques to collect information directly from the clients on behaviour change communication (BCC) needs.

Projective Methods

Like FGD, projective techniques are also adapted from applied psychology to collect data on perception of individuals or more complex emotional information. The projective tests have been standardized to know the personality of a person. Standard set of pictorials are used and inferences drawn based on established criteria. We can analyse the make-up of a person by these research methods.

Case Study Method

This method conducts in-depth analysis of a social unit and is widely used for learning purposes and assessing Communication and management needs (CNA and MNA). Case could be an institution such as functioning of sub-centre or primary health centre or it could be a person such as work schedule or home visit of health worker or it could be a disease event or beneficiary of a programme.

(C) Mass Communication—Merits

Radio, television, and print media (newspapers) reach and communicate masses and **cover a wide geographical area** and population in short time. The message can be disseminated to large population with a clear focus on target groups. This is known as mass communication. The mass communication is most **cost-effective** and is primarily used to generate awareness and impart knowledge to masses. It needs to be followed up and supplemented and supported with group and individual communication to facilitate the process of adoption and acceptance of a practice. Family planning programme used mass media to build-up awareness and as a result, now the awareness about contraception is almost universal (100%) but 56.5% are using modern contraceptives. Similarly, pulse polio programme used mass media at national level to build a favourable climate and message through a popular actor (Amitabh Bachchan) ***Do Boond Zindgi Ki*** (two precious drops of polio vaccine for life) had a mass appeal for massive social mobilization. Similarly, message of Honourable Prime Minister on polio had mass appeal. Mass communication must be supported by services and accessibility to quality services to achieve the desirable success.

Commercialization of media by producing audio-tapes and video-tapes for self-learning and learning at family level on the pattern of social marketing strategy can go a long way. Weekly audio messages in "KILKARI" and SMS Messages in "Mother and Child Tracking System is a revolution".

Demerits

It is a one-way communication.

Effects of Communication

The health message reaches the audience, they gain attention, understand, accept it, change their behaviour leading to improvement in health.

The most important effect of communication is change in behaviour. Effective communication results into change in behaviour or practice. There are three main effects of communication.

1 ***Change in knowledge:*** It adds on the knowledge and builds 'cognitive domain' and generates awareness.
2 ***Change feelings/attitude:*** Attitude means a human attribute indicating a particular mental state or an outlook to life. It mainly includes affective domain chiefly related to feelings, moods, thinking, thoughts, emotions and inclinations. The communication may lead to change in thinking and perception of an individual, group or community. This is second effect that the feelings (attitudes) may change. Negative attitudes may change to positive attitudes and often indicates an action that the individual may take.
3 ***Behaviour change:*** Change in action (practice). These are changes in overall behaviour, such as adopting a contraceptive, quit smoking, starts brushing teeth, and ultimately reduction of fertility, incidence of disease and improved health status.

These three changes usually occur in sequence that is a change in knowledge precedes change in attitude which precedes change in behaviour, but not always; attitude change often follows an action.

Adoption Process

Emerging out of interplay of ideas in a given environment, the communication leads individuals and communities to 'action' passing through stages of awareness, interest, evaluation, trial and adoption. Thus, the diffusion of new ideas and knowledge passes through distinct stages:

1 ***Awareness:*** In this stage, the person acquires new knowledge about the issue or his health need.
2 ***Interest:*** In the second stage, person develops interest and seeks more knowledge to solve the problem.
3 ***Evaluation:*** In this stage, the client evaluates the pros and cons of the decision involved, evaluates its usefulness to him or her and this may result in decision.
4 ***Trial:*** The method, idea, or skill is tried. The idea may be tried out on himself or a friend or other trusted source, such as relative. The person seeks the approval of friends and relatives at the trial stage. During the stage of trial, the health system should support the person in implementing the decision and see that he/she succeeds in the attempts. The support may include health counselling, providing supplies and referral services.
5 ***Adoption:*** If the result of trial is good the method, idea, or best health practice is adopted for regular use.

Competency addressed: The student should be able to:
CM 4.2: Describe the methods of organizing health promotion and education and counselling activities at individual, family and community settings.

METHODS OF ORGANIZING HEALTH PROMOTION, EDUCATION AT INDIVIDUAL, FAMILY AND COMMUNITY SETTINGS

Learning Health Behaviour

Most of health behaviour is learned through:

Family

The foundation of learning (behaviour—healthy practices) is laid by the family and its environment.

The first school for child is the family. Family and parents have the responsibility to cultivate healthy behaviour in their children. The behaviour or practice of washing hands, wearing shoes, using toilets, brushing teeth and no smoking, dietary habits are developed and nurtured in the family and in home. Parents have to become ideal role models for their children. By the time the child is 5 years, over 80% of his brain gets developed. ASHAs and AWWs regularly contact families by home visit for health promotion and education.

Extra-familial Institutions

Anganwadi and creche are extra-familial institutions where the young children learn a lot. Here learning is informal and through play-way activities and it is joyful learning. *Anganwadi* workers provide varieties of stimuli and lay down foundations of physical, mental and social development and motivate parents to provide learning stimuli at home. Habit of handwashing, brushing teeth, rinsing mouth, eating clean and eating enough, nail cutting, getting themselves weighed, use of toilet/sanitary latrine, drinking clean water and playing safe are promoted by AWWs apart from language and psychomotor development. It has positive influence on parents who continue what *Anganwadi* workers initiate and vice versa is also true. This is a first or initial organized step in education and health promotion.

School—Right to Education Act

It is a formal institution of learning. Elementary education infrastructure is universal. Learning in school is a cherished memory for lifelong period. The teachers are role models for the taught. Universal elementary education, schooling of minimum of 8 years for everyone is a nation building activity apart from personality development and developing 'healthy lifestyles' and value system. It is sustainable development goal 4. Personal hygiene (washing hands, brushing teeth, nail cutting, balanced diet, drinking clean water, no smoking, regular exercise, etc.) is best learnt in schools during an hour of socially useful and productive work (SUPW). Teachers leave an indelible impression on the minds of students.

Health and nutrition, reproductive health, adolescent health practices can be best improved and built in the schools through curriculum and extracurricular activities. Not only children learn themselves but also they act as ambassadors of health to their families and neighbourhood.

Learning through peers has great influence on the life of schoolchildren. The learning continues in colleges. Prevention of HIV/AIDS and reproductive health can be taught at appropriate age.

Ayushman Ambassadors

Ayushman Bharat aims to create about 2.2 million teachers—one male and female teacher as Health and wellness ambassadors in 1.1 million government schools. These Teachers will be trained to transact health promotion and disease prevention sessions of one hour every weak on every Tuesday. These health promotion sessions will promote healthy lifestyles of young children and adolescents and use students force to act as messengers to communicate messages to their family and community. Health promotion strategy has been laid down in the National Health Policy 2017—"Health in all". The states would plan coordinated action plan on seven priority areas for health promotion through inter-sectoral convergence. Convergence is visible and operational with education department for school-based health promotion, for Rashtriya Bal Swasthya and Kishore Swasthya Karyakarm, Pre-school health promotion through ICDS at *Anganwadi* centres, and water and sanitation department for safe water supply.

Population Education

It was an effort initiated under family welfare programme by Government of India with an emphasis on life cycle approach—population education for the young. Its focus is young adolescents in schools, colleges and out of schools; systematic population education by formal and non-formal methods was one of the important planks of the revised family welfare strategy. In pursuance of the revised strategy, population education was introduced in the school education system, adult education programme and higher education system in the country with UNFPA assistance. Population education messages were included in the textbooks of schools through National Council of Education, Research and Training (NCERT). The emphasis was on population explosion, trends, raising the age of marriage, safe motherhood and spacing, child survival (ORT and immunization), antenatal and postnatal care with stress on women's status to counteract the son preference and to promote male responsibility.

At Sub-centre, PHC, CHC/Hospitals (Health Facility)

These are the storehouses of information and learning. The education and information is provided or targeted to specific groups like women in reproductive age group, eligible couples, pregnant and nursing mothers and young children. The focus of education is reproductive and child health besides the major killer diseases, their prevention by immunization and by other means. Adequate information depends upon the skills of person managing such institutions as also availability of information material in such situations. These institutions can enrich the process of education by demonstration and participation of mothers and families in the total process during home visits.

These institutions can provide organized information for action and are available to offer any clarification and remove doubts of the clients. During waiting time in hospital, patients and attendants can be provided health information. Home visits focus on specific health need of household with precise health information for action.

At Workplace

The owner or corporate house/industrial set-up or business organizations have the responsibility to provide health information to their staff, regular health check up, healthy environments, healthy diet and physical exercise. Peers have great influence on the behaviour of the person. Peer education holds the promise in these situations.

Swasthya Nagric Abhiyan—*see* page 54.

COMMUNICATION SKILLS IN HEALTH

Competency achievement: The student should be able to:
CM 1.9: Demonstrate the role of effective communication skills in health is simulated environments.

Definition

Communication is a process of transfer of information (including ideas, emotions, knowledge-skills, data, etc.) from a person or persons to others. Daily in our life we perform activities of **listening, speaking, reading, writing, Reasoning** and take recourse of facial expression, gestures, movement of hands and arms, body movements and feelings. Spoken words are the most important means of communication. We call it oral or *verbal communication*. We also communicate through facial expressions, gestures and body movements, signals, which we call *non-verbal communication*.[3]

Purpose and Goal

Communication has a purpose. Identify the behaviour you would like from your audience. Single over-riding communication objective (SOCO) guides the communication strategy. Purpose and goal of communication is to change behaviour of people. Promoting and adopting healthy behaviours, which improve and maintain health and discontinue behaviour, which is harmful to health.

Verbal or Oral Communication

Spoken words are often the most common means of communication. **Oral method** of communication is a weak

method of communication. Some doctors and health workers are very good in speech and they articulate it so well that it leaves indelible impression on the minds of people. Most often, we 'talk at people', it should be discouraged. This is authoritative communication. 'Talking with people' by group discussion, demonstration of a good practice and having return demonstration are the examples of *participatory communication*. Discussing the results of growth monitoring with mothers is *participatory communication*. Verbal/oral communication, which is traditional or conventional method of communication, can be enriched by use of pictorial and action photographs and live situations like demonstration techniques, which leave good impression and motivate people to accept the things.

Non-verbal Communication

Body language and silence also communicates a lot and makes much more sense. You communicate through visual contacts, nodding your head, symbols, movement of your body parts, facial expressions, gestures, sadness and anger. Combining verbal and non-verbal skills is an art to enrich the process of communication. One should learn how to interpret body language.

Anganwadi worker in ICDS programme uses her skills of non-verbal communication for developing cognitive, affective and psychomotor domains in young children through play-way activities.

Elements of Communication Process

There are various elements of communication process which are: *Source* of information, *message* or content of information, *channel of information,* the *receiver* of information and *feedback*.

Source

The first element in the process of communication is the source. The source is the originator of the message. The source can be an individual, group of individuals or an institution or an organization. The source of '*Hum do Hamare do*' message was the Government of India. The source should be credible, accessible, acceptable and legitimate. Source creates an idea (ideation) or chooses a piece of information for communication.

"Only 10–30% of ever married women in India had comprehensive knowledge of HIV/AIDS." The most important source of information on HIV/AIDS to these women was television (78.8%) followed by radio (41.5%). About one-third of women who know AIDS also report receiving information on AIDS from friends and relatives. Health workers appeared to be marginal source of information on AIDS (3.6%).

Similarly, family planning messages disseminated through mass media were seen or heard by 60% of ever-married women in India. The most common source of message was again television. 44% of women reported having seen a family planning message on television and 38% heard on radio. The major source of pulse polio immunization (PPI) happened to be *Anganwadi* workers.

Message

The message is an idea or information being communicated. The message is the intended action, which the source wishes the receiver to take. The message links the source and receiver. The message should be very simple, in local language and dialect, easily understandable and action oriented. Longer the list of actions lesser is the likelyhood to perform any of them. The message should be pretested among the intended audience before being communicated. Too often, the messages are designed centrally and may not be relevant to specific situation. The messages and pictorials (visual literacy) should be produced locally. A picture is worth thousand words. It should address both men and women and would be most effective if this is supported by adequate supportive services and information. For example, message "get your child fully immunized before 12 months of age" will go well if vaccines are made available when the children need these with arrangement of safe injection. Further the message should address the most significant problem or needs of target groups. **Message creates demand** and we must have arrangements to meet these demands.

Key Messages

1. Space births at least 3 years apart—use spacing methods. Why? For healthy mother and healthy child, to improve chances of survival, to avoid low birth weight babies, to reduce anaemia in mothers, to reduce morbidity and mortality in mothers and children. The risk of death for young children is increased to 50% if interval between births is less than 2 years.
2. Becoming pregnant before 18 years and after 35 increases the health risk for both mother and child.
3. Know AIDS for no AIDS.
4. Prenatal sex determination is unlawful.
5. Sex test of foetus is illegal.
6. Diarrhoea can be killer.
7. Deaths due to diarrhoea can be prevented by giving plenty of fluids, home available fluids, ORS and feeding.
8. Breastfeeding is best for a child and a complete food for child up to 6 months of age.
9. Hypertension is a silent killer.
10. Use iodized salt only.
11. Tobacco kills, tobacco causes cancer.

Channel of Communication/Select Right Media

The channel is the means or vehicle by which the message or information travels from source to receiver/audience. The important channels of communication are media (television, radio, newspaper or print media), person-to-person, telephone, or satellite transmission. The choice of channel is important. To ensure maximum coverage of audience

or receivers, more than one channel can be used to convey the message or information. Ownership of television in urban areas is 76.7% and in rural India is around 33.4% while radio ownership is maximum 93.3% of households own mobile phone. Apart from mass media, interpersonal communication channel should be extensively used. Health workers should increase the frequency of home visits and contact with family and women in reproductive age group and adolescents. At the moment, 7–31% of women in rural and 10% of urban women have received a visit of health worker in the past 1 year which is quite distressing.

Receiver or Target Audience

Define your audience and their concern. *Seek first to understand then to be understood*. Who are the target audience or receiver of information and specific messages? Target audience needs to be segmented according to their knowledge, beliefs and practices, incidence and severity of illness or health problems, literacy level, economic level, geographic locations, media reach and social network. The audience or receiver is not the end-point. Audience segmentation is seldom done. Examples of target audience are:

1. Currently pregnant women.
2. Married women with 1, 2 and 3 children.
3. Adolescent boys and girls.
4. Women with child below 6 months (lactating mothers).
5. Newly married couples.
6. Community leaders—men and women.
7. Health workers male and female, ASHAs, AWWs and their supervisors.
8. Women who have accepted IUD or satisfied customers.

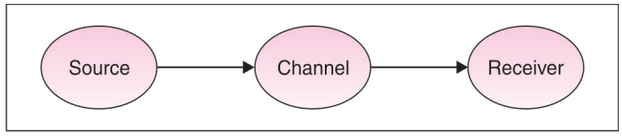
Feedback

Feedback is an essential element of communication. Feedback is the reaction or response of the receiver to the source. Feedback from receiver helps the source to improve the message and information or its modification. An experienced and wise communicator is always keen to get a feedback and continuously modifies his message in the light of what he observes or hears from the intended audience. Without feedback, the communication is one-way traffic or one-way communication. In a group discussion, the feedback is obtained on the spot.

Case Study in Communication

After audience research on listening and reading habits we launched a programme of "Radio in support of mother and child development". Organized listening groups were formed with the help of AWWs, who acted as group *animators* (a local person chosen by community trained in communication who canvases from house to house and facilitates 'mother's meeting'). After listening the broadcast programme, the reply paid letters received from AWWs (incorporating the views of mothers who listened the programme) helped us a lot to improve the programme. Continuous feedback from audience is seldom obtained hence it is weakest element in the system of communication. Continuous feedback guides the source and planner to improve the contents of message and better management of the programme.

ONE-WAY AND TWO-WAY COMMUNICATION MODELS



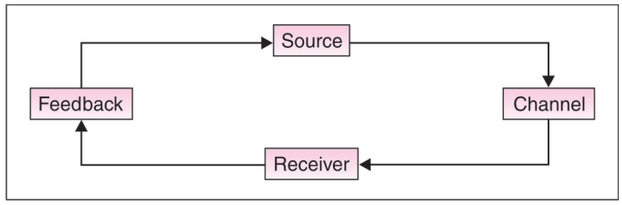
One-way communication model

i Systems that provide health information to the user (one-way communication)

ii Systems that tailor specific information to the user unique situation (customized communication)

iii Systems that allow the user to communicate and interact with healthcare providers or other users (two-way communication).

When the source is communicating the information to receiver or audience and there is no feedback it is one-way communication. It has many disadvantages.



Two-way communication model

When there is feedback from receiver to the source it is two-way communication.

Example: When mothers are involved in growth monitoring and their reactions are obtained, it is two-way communication. When AWW weighs alone and mothers are not involved, it is one-way or no communication. Mass media is one-way communication most of the time. Interpersonal communication is two-way communication.

Competency addressed: The student should be able to:
CM 4.3: Describe and demonstrate steps in planning, organizing, implementation and evaluation of health communication/education programme

Steps in Planning, Organizing, Implementation and Evaluation of Health Communication/Education Programme

Planning of health communication means who says what to whom, where, when, how with what effect and why?

This involves collecting data on Knowledge, attitudes, beliefs, practices, and information on channels reaching to potential beneficiaries of a programme. This requires application of epidemiological and behavioural sciences to the selection of appropriate objectives and planning of communication processes as explained below:

(a) Planning

The objectives must be defined—what behaviour needs to be changed and within what period? Example is 'to increase the acceptance of condom from current level of 9.5% to 12% within a span of 4 years' could be objective. You must define objective for communication (single over-riding communication objective (SOCO) to guide the strategy) as illustrated in Table 4.1.

(b) Communication Needs Assessment (CNA)

Determining the communication needs means measuring the prevalence of knowledge, attitudes, beliefs and practices specific to a chosen problem. This can be done by contacting the clients through routine visits and annual survey of eligible couples, or any opportunity of contact with mother or parents, such as immunization sessions. Communication needs are seldom assessed. Communication needs assessment (CNA) are to be listed client-wise, family-wise; so that these can be met **(a best practice)**.

Example: Need of newborn is survival, breastfeeding, asepsis, clean cord. Communication should focus on these needs. Know the practices and list the harmful practices and change these harmful practices to **best practices,** focusing on most urgent ones, which save lives. In short know your people, know their knowledge, attitudes, beliefs, practices, myths, and misconceptions on the issues of MCH and family welfare and NCDs.

Key principles of communication

i Define your target audience
ii Understand the concern of the audience
iii Frame what you expect from audience—the expected behaviour of audience.
iv Select the right media
v Find the right tone

(c) Define your Target Audience and Understand their Concern

Seek first to understand the audience then to be understood. Identify the families, which need your help most. Weaker section of community or those families which have problems; families having pregnant women, infant and young children could be your target audience. Segment your audience based on their economic status, caste and literacy, practices/behaviour. Segmentation is essential as one size does not fit all.

(d) Message: Frame what you Expect from Audience

Message should be specific. It should not only generate awareness but also lead onto behaviour change. In family planning, messages on promoting the norms of small families are disseminated to build up an awareness rather than providing method specific information to clients. Provide information on all methods to promote informed choice. Adequate education material must be made available to communicate message to target groups.

(e) Selecting Right Channel to Reach the Audience

Select appropriate channel of communication, such as television or radio, print media, women groups (MSS), health workers (male and female) and person or persons (inter-personal channels) whom you think to be most effective. It should reach to maximum number of clients; the intention is maximum coverage and channels chosen must be effective to carry the message to target audience. Always use multiple channels to enhance the coverage. Priority channel for each audience needs to be selected and planned.

(f) Tracking Clients to Sustain Behaviour Change

After messages have been given, these must be repeated. Use a tone that will create trust with audience (empathy) and keep contacts with the clients to observe the effect of communication and measure your success and failure and learn lessons from those who have understood your message and who have changed their practices and who have adopted a method of contraception, etc. Sustained contacts with client build a mutual trust, increase understanding and generate confidence. Right now the health workers ever talked to only 24% of females non users of contraceptives, it means tracking of client is very low or insufficient. Information on all these elements (a to f) is collected for evaluation.

Manage activities within the budget provided and train the staff for communication (particularly on communication skills and organization of groups and use of educational material).

Competency addressed: The student should be able to:
CM 4.3: Demonstrate and describe the steps in evaluation of health promotion and education programme.

Objective: The objective of this competency is to assess the **gaps** in health communication for behaviour change communication.

(g) Steps in Evaluation

Finally, we need to evaluate the results of communication. Evaluation means change in KAP as a result of health education. The evaluation is done by the workers themselves during their home visits and contacts with the audience or clients, exit interviews as also through annual surveys and updating of couples or through district rapid household surveys under RCH programme.

i The knowledge can be evaluated by asking standard questions about a specific problem.

ii The feeling (attitudes) can be evaluated by 'Likert scale'—a scale measuring the degree to which people agree or disagree with a statement; usually on a 3–, 5– or 7– point scale.

Example: Spacing births 2 years apart is good for the health of mother and survival of child (statement).

3-point scale: Agree.....neutral.....disagree

5-point scale: Strongly agree.....agree....neutral... disagree.....strongly disagree.

iii Behaviour change—practices can be evaluated by observations—like practice of washing hands, nail cutting, delivery room, cord cutting, cooking food and feeding practices.

The prevailing pattern of evaluating health promotion and education programme is to just count the activities generated such as number of clients contacted, number of orientation training camps held, handouts distributed, villages visited, group discussions held, film shows held, leaders contacted, etc. However, real test of effectiveness is how many individuals have changed their behaviour in terms of thinking, feelings and actions/practice. This involves collecting information on current behaviours/ practices (base line data) and expected behaviour/practice after a specified time interval (repeat or annual survey data) to know the effects of sustained health education/health promotion intervention as shown in Table 4.1. Varied methods of evaluation can be adopted (*see* Chapter 16: Monitoring and Evaluation).

How?

Learner can assess the knowledge, belief, attitudes and practices of potential beneficiaries of a specific national health programme (immunization, FP, HIV, NCDs) by exit interviews, observation, group discussion and interaction with community and family, adolescents, and school teachers.

NFHS 1–5 have been undertaken nationwide to provide useful information on evaluation of communication efforts. Similarly, behavioural surveillance surveys under National HIV/AIDS Control Programme provides useful information on evaluation for further action to improve the communication process. The process evaluation is most important.

The communication gaps, barriers, health seeking behaviour, and needs as identified by NFHS 4 and 5 in 2015–21 were:

1 Among the women aged 20–24 years, almost one-quarter 23.3% got married before 18, the legal minimum age of marriage.
2 The total fertility rate was 2.1 in rural and 1.6 in urban area which indicates high fertility rates in rural area.
3 Teen age (15–19) contributes to 6.8% of total fertility.
4 Nearly 64% of children under 6 months of age were exclusively breastfed.
5 Early initiation of breastfeeding (<1 hour) 41.8%.
6 Sex ratio at birth for children born in last 5 years 929.
7 Female sterilization is predominant method of contraception, men participation is low; only 0.3% of men accepted sterilization against 37.9% of women.
8 High maternal mortality rate of 97 per 100,000 live births.
9 Nearly 58.1% of mothers received at least four or more antenatal check ups.
10 15.6% or men and 13.5% of women were diabetic.
11 Under 5 years children who were underweight 32.1%.
12 Postnatal care was provided to 78% of mothers within 2 days of birth.
13 Nearly 40% of currently married women in India report at least one reproductive health problem (RTI).
14 Immunization coverage: 76.4% of children age 12–23 months were fully immunized.
15 ORS used rate was nearly 60.6%.
16 22% of births weigh under 2.5 kg.
17 38% of men and 8.9% women used tobacco.
18 People without latrines 29% in 2020.

Thus, the communication needs are obvious. This tells us clearly, where we stand and what are the cardinal needs for behaviour change communication (BCC).

Table 4.1: Evaluation of health education matrix of behaviour change communication to increase men participation

Area of concern	*Current behaviour or practice 2021*	*Expected behaviour in 2025*	*Target audience*	*Message*	*Media and channel*	*Outcome indicator of change in 2025 (evaluation)*
Use of spacing methods by women	7.8% of women practice	10%	Currently married women with one child	Spacing births at least 3 years apart to improve the health of mother and survival of child	Interpersonal communication by health worker female • TV • MSS groups	• Percentage of women with one or two children who are using spacing methods (annual survey data of workers)
Use of spacing methods by men (condom use)	9.5% of men use condom	12%	Currently married men with one child	Do	Interpersonal communication by health worker male • Opinion leaders • TV	• Percentage of men using condoms (annual survey data of workers)

Responsibility of planning and evaluation lies with medical officer incharge of primary health centre and community health centre.

Barriers or Blocks in Communication

i Only talking at gives advice not listening
ii Physical barriers—noisy situation, obstruction or blocks
iii Cultural and social barriers and arrogance
iv Lack of empathy, trust and understanding
v Poor or no eye contact or facial expressions, looks away
vi Low credibility and respect of source
vii Language, and dialects and medical Jargon as barriers
viii Frequent interruptions—attending telephones, office files/papers
ix Lack of visual literacy and health literacy
x Looks at watch, looks bored, gets up to do something and returns, begins to do some work and does not stop.

National Communication Strategy in Reproductive and Child Health Programme (RCH)[4]

The communication strategy aims to facilitate awareness, dissemination of information regarding availability of and access to quality healthcare within public health system. The key objective of the strategy is encourage a health seeking behaviour that is doable in the context in which people live. The strategy views recipients of health services as not merely passive *users* of services but key *participants* in generating demand for services.

The national strategy on communication under RCH programme lays stress on:

- Interpersonal communication for behaviour change at the field level.
- ***Decentralized planning for communication:*** Production of material and messages at state and district level. Districts will prepare their own plans for IEC.
- Use of mass media for advocacy and awareness.
- Increased involvement of non-governmental organizations (NGOs).
- Capacity building and training at all levels to undertake the newly developed tasks and thrust areas under RCH I and II.

  The responsibilities of central government, state and district have been defined. In the decentralization of IEC activities, the role of states and district is crucial.

Thrust areas for communication under RCH:

- Meeting the unmet needs of contraceptives, both for spacing and terminal methods.
- Improving maternal health.
- Raising chances of survival.
- Adolescent health.
- Implementation of PC—PNDT Act to achieve balanced child sex ratio.
- Coverage of urban slums and tribal areas.
- Newborn care.

Evaluation

In order to achieve the goals of RCH programme, the communication interventions have to focus on behaviour change. Accordingly, the matrix of behaviour change has been indicated under the RCH strategy on communication (Table 4.1).

The areas or issues to be focused are: Unwanted fertility, unmet need of contraception, unsafe abortions, high maternal mortality, maternal morbidity, adolescent reproductive health, RTI/STI, infant mortality, drop in immunization coverage, newborn care, adverse child sex ratio, urban and tribal health.

Expected outcome: The student assesses the knowledge, attitude and practices of potential beneficiaries exposed to a messages of a specific programme in community or allotted family, e.g. chronic disease or common childhood problem-diarrhoea and ARI.

Competencies addressed: The student should be able to:
CM 4.2: Describe concept and method of health counselling.

COUNSELLING IN HEALTH AND DISEASE

COUNSELLING IN RCH AND OTHER PROGRAMMES

Concept of Counselling[5]

Counselling is one person helping another as they talk person to person. When you help a client make a decision or solve a problem you are counselling.

Through counselling, you help clients make informed choices that suit them. For example, some clients are choosing family planning methods; other clients are deciding how to avoid sexually transmitted diseases. Young clients (adolescents) may be choosing whether to delay sexual activity. All these clients make better decisions with your help.

Definition

"Counselling is **face-to-face** communication by which you help the person to make decision or solve a problem. Counselling is a helping process aimed at problem-solving. It helps people to understand themselves better in terms of their own needs, strengths, limitations and the resources they can avail of. It brings about a change through supportive relationship aiming to make client independent

through the interpersonal contact along with an opportunity to ask questions and to seek frequently needed help greatly."

Counselling Skills

1. Greeting

Make a good connection and keep it. Make sure that each client is greeted in a friendly and respectful way. It makes good connection between provider and client right from the start.

2. Asking

The provider asks questions effectively and listens actively to client's answers. Asking question to understand clearly the clients problem or worries and help client go deeper into his/her own awareness or insight. The question is centered on the prime concern of the client and open-ended questions are better than close-ended.

- Use words, such as 'then'? 'And' 'Oh' these worlds encourage clients to keep talking.
- Show your interest and understanding at all times. Express empathy. Avoid judgment and opinion.

3. Listen Actively

You have to listen actively. Attentive and active listening is essential. How to listen actively? Some guidelines are as under:

- Accept your clients as they are, treat him/her as an individual.
- Put yourself in the client's shoe as you listen. Listen to what your client says and how they say it. Notice tone of the voice, choice of words, facial expressions gestures and body movements.
- Keep silent sometimes. Give your clients time to think, ask questions and talk more at the client's speed.
- Listen to your client carefully instead of thinking what you are going to say next.
- Every now and then, repeat what you have heard. Then both you and your client know whether you have understood.
- Sit comfortably. Avoid distracting movements. Look directly at your clients when they speak, not at your papers or out of the window.

Responding to Client's Feelings

Once you recognize client's feeling let them know in clear and simple words that you understand. This is called 'reflecting feelings'. Two examples are given hereunder. You cannot change client's feelings. Only they can do that, but when you reflect feelings, you are showing that you understand. You also are saying it is all right to feel that way (Fig. 4.2 and Table 4.2).

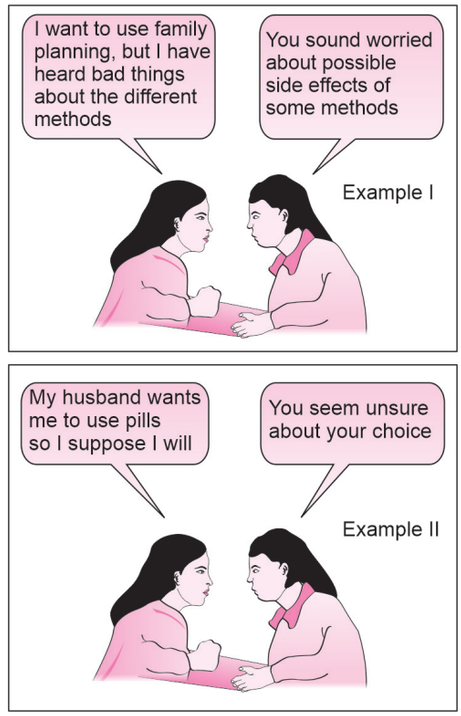


Fig. 4.2: Reflecting feelings

Table 4.2: Sharing facts and feelings*

	Share facts	*Share feelings*
Provider's job	• Give clear, accurate information that the client wants and needs • Help the client apply this information to his/her own life	• Care for client by showing understanding respect and honesty
Client's job	• Describe personal situation and health conditions • Ask questions and make sure of understanding	• Express attitudes, preferences, concerns, expectations and wishes

***Note:** The client makes good decisions when provider and client share facts and feelings.

Paraphrasing

Repeating in one's own words 'what the client has said' to show one understands. Saying it in a few words, so that it gives a summary essence of client's words.

Interpretation

Giving back to client the core or basic issue he/she is talking around or hinting at. Picking-up what the client is feeling but not saying. This skill involves going to a slightly deeper level of the issue to point out the feeling of meaning or meanings, which are just below the surface of the client's awareness. Check with the client, if one's interpretation is correct.

GATHER Approach to Counselling about IUDs

There are six steps to counselling.
Word GATHER stands for: Greet, Ask, Tell, Help, Explain and Return for follow-up.

G: *Greet clients:* The provider greets clients politely and gives them full attention. It makes good connection between provider and client, builds trust and clients rely on providers they trust.

A: *Ask clients about themselves:* The provider asks clients about their family planning needs and obtains information that will help the provider to advise and inform each client individually.

T: *Tell clients about family planning methods:* The provider lists the available family planning methods and clearly describes those that interest the client—how they work, advantages and disadvantages and possible side effects. Even clients who immediately express a preference for the IUD or some other method should know of other available methods for future reference and so they can inform friends and family members.

H: *Help clients choose a family planning method:* Some women may have already decided that they want an IUD. Others may want advice and guidance from the provider. In either case, the provider helps the woman decide on a safe method that suits her needs and plans. If the method is not appropriate, the provider explains why and helps the client select another method. If there are reasons that another method would be preferable, the provider and client compare the risks and benefits of the IUD and of other contraceptive methods and consider the risks of an unintended pregnancy. The final decision to use an IUD—or any other method must be an **informed choice** made by the client. If possible, involving the husband in counselling is a good idea. In an African study, husbands' wishes accounted for many IUD removals after postpartum insertion.

E: *Explain how to use the chosen method (IUD):* Once a woman decides to use an IUD, the provider explains:

- When, where, and how it will be inserted
- The common side effects
- The slight chance of more serious complications, expulsion, or unintended pregnancy
- Reasons to return to the clinic or see another provider
- When a copper or hormone releasing IUD should be replaced.

Women who understand that mild cramping and bleeding in the days following insertion and heavier menstrual periods while using an IUD are common and usually harmless will be less likely to have their IUDs removed unnecessarily.

It is helpful to give clients printed material to take home, particularly a card with the name and picture of the IUD, noting the date of insertion and time for removal (printed materials can help providers, too). During counselling and screening, flip charts, wall charts, cue cards, and checklists help providers maintain accuracy and remember what to cover and they help clients to understand.

The client should be told if and how she will be notified when it is time for the IUD to be replaced. The family planning program should keep records for each IUD user showing the type of IUD and when it was inserted. These records should be used to answer questions from women who have forgotten when to have their IUDs replaced and to follow-up users when the time for replacement approaches.

R: *Return visits help clients continue for follow-up:* When a woman has an IUD inserted, she and the provider should plan for a follow-up visit 3 to 6 weeks later, after her next menses. While no further scheduled follow-up visits are required for the safe use of the IUD, the women should be strongly encouraged to return whenever she has questions or problems or if she wants the IUD removed. Also she should return as soon as possible if she notices any warning signs. The provider should be sure that the woman knows both when and where to seek medical care.

Counselling in HIV/AIDS at ICTCs[6]

Counselling is concerned with preventing infection with HIV and its transmission to people from persons living with HIV/AIDS, estimated 2.40 million in India.

The main steps of preventive counselling are to:

- Determine whether individual/group has high-risk behaviour pattern.
- Help people understand and acknowledge their high-risk behaviour patterns.
- Define with them how their lifestyle and self-image are linked to their behaviour.
- Help individuals define their potential for changing behaviour.
- Work with individuals to introduce and sustain the modified behaviour.

Health Promotion

This involves counselling those individuals having high-risk behaviour patterns but not aware of the magnitude and the nature of risk involved to their life. It aims at creating this change focusing on behaviour that presents a risk of HIV infection and reviewing ways of managing individual change.

Specific Protection

Those infected with HIV should be given instructions as to ways by which they can prevent the spread of infection to others. An attitude of understanding should be adopted as the fact that he has tested positive is traumatic enough to accept. Since behaviour change is going to be difficult, he should be asked to take certain precautions:

- Do not donate blood.
- Use condoms while having sexual intercourse.
- Do not share needles and syringes.

Psychosocial Support

People diagnosed with HIV infection-related illness and those close to them are confronted by a multitude of problems and often need emotional support and/or practical support. People have anxieties regarding hospitalization and depression because of stigma attached to their conditions. Counselling should help those infected by HIV to live full and productive lives by enabling them to take charge of their lives and help in decision-making, thus enabling people to remain active in their work and in their education. Families and friends can help to reduce their dependence on health and social services and reduce their psychosocial problems.

Requirement of Counselling

Approaches to counselling will differ from individuals and groups depending upon the characteristics of the people being counselled and their social and family network. Certain points, which remain constant irrespective of the situation, are given below.

Rapport

The client must not be rushed with the news that he is HIV positive. Sufficient time should be taken to establish rapport with the client, so, as to understand his mental framework and basic level from where the counselling should be carried forward. This basic level will determine the number of sessions required by the person to take decision about his lifestyle.

Acceptance

The people infected by HIV should not be shunned on the basis of the behavioural patterns adopted by them. They should be treated with respect whatsoever their background or behaviour.

Accessibility

People found to be HIV positive are bound to develop anxieties and fears, which will be always raising some doubts in their minds. Therefore, counselling services should be available easily where the individual can approach at any time and get clarification.

Consistency and Accuracy

Any information provided through counselling should be consistent; therefore, the counsellor must equip himself with all the latest knowledge and management of HIV infection and disease so as to be able to clarify doubts/uncertainties arising in the minds of the client. He should not pretend to know or acknowledge a thing when in doubt but try to clarify it.

Confidentiality

Being diagnosed HIV positive creates uncertainties in the mind of the clients. The counsellor should be able to gain the trust of the client and convince him that all information provided by him will be kept confidential.

What to Counsel?

As HIV infection is progressive, it is necessary that counselling should be undertaken regularly to understand what the client is going through due to the various changes occurring within him and those around him. The counsellor should also provide to the client necessary information regarding where he will be able to get medical support, community resources and what changes he can make in his lifestyles to cope with emerging needs.

Counselling before HIV Testing (Pretest Counselling)

Counselling before the test should provide the individuals being tested with information on technical aspects of screening and possible personal, medical, social, psychological and least implications of being tested positive or negative. The information should be simple and up to date. Testing should be organized in a way that minimizes the possibility of disclosure.

Issues in Pretest Counselling

Pretest counselling consists of two parts:

1. Personal history and assessment of risk.
   - Sexual behaviour multi-partners, prostitutes, unprotected sex, homosexuality, bisexuality.
   - Drug users.
   - Blood transfusion.
   - Organ transplant.
2. Assessment of factors and knowledge.
   - Why test is being requested?
   - What behaviour/symptoms are of concern to the client?
   - What the client knows about test and its uses?
   - What will the client do if test is positive or negative?
   - Beliefs regarding HIV transmission.
   - What roles will family play?

Counselling after HIV Testing (Post-testing Counselling)

If Result is Negative

The client may feel relief, however caution should be exercised as following exposure to HIV, there is a **window period** of 6–12 weeks between initial infection with HIV and the time when HIV antibodies can be detected in the blood. A blood test performed during the **window period** may yield a negative test result for antibodies. These cases may require further testing after 12 weeks. A negative test result becomes a certainty if 6 months have lapsed after last exposure. HIV infection can be prevented by avoiding high-risk behaviour, safe sex and avoiding sharing needles. In general, development of safe sex behaviour to be advocated to the client.

If Result is Positive

People diagnosed as having HIV infection should be told about their results privately and in confidence. Single test giving positive result does not necessary mean HIV infection. To establish HIV infection, *three tests* for antibodies based on different antigen methods are to test positive. Time should be allowed for the client to absorb the news. After a period of preliminary adjustment, the client should be given clear and factual explanation or what the news means. This does not mean speculating about prognosis of estimate about the time left to live but for providing support; and encouraging hope for achievable solutions to personal and practical problems that may result. The client must be informed where resources are available and possible treatment for some symptoms to HIV infection and efficacy of antiviral treatment.

Psychological Issues

The uncertainty involved when the individual comes to know he has tested positive are longevity of life, etc. Clarifications are to be given regarding the fears which arise related to illness, death, etc. Besides these, the individual feels at loss due to stigma attached by society and the speculation in the minds of people regarding the behaviour of those infected with the virus.

There is generalized anxiety regarding all aspects of life, anger and expression of the fact that he has tested positive; can even lead to suicidal thinking within the individual.

These numerous feelings can only be changed through counselling and giving correct information about the infection and disease and building the self-esteem and the positive thinking ability of the individual. Besides the individual who has tested positive, those dealing with them, i.e. the health workers and family face their share of fears and uncertainties regarding their getting the infection. All those involved with those who have tested positive need to be given proper and full information so that they can provide the support, which the individual requires to be able to face their problem.

VOLUNTARY COUNSELLING AND TESTING CENTRES (VCTCs/ICTC/HCTS) (IT RELATES TO AETCOM 3.4)

Now VCTCs have been renamed as integrated counselling and testing centres (ICTCs). New terminology for ICTCs is HIV counselling and testing services (HCTS) after the release of National HCTS guidelines in Dec 2016.

The HCTS include:

1. ICTC/HCTS
2. Prevention of parent to child transmission of HIV (PPTCT) and
3. HIV/TB collaborative activities

The HIV counselling and testing services, started in the year 1997, have been scaled-up in the recent years. Today there are more than 34,500 counselling and testing centres which are located at all levels of the public healthcare system—(standalone and Facility-based ICTCs). The earlier voluntary counselling and testing centres (VCTCs) and facilities providing prevention of parent-to-child transmission (PPTCT) of HIV/AIDS services are now remodelled as a hub to deliver integrated services to all clients under one roof renamed as 'integrated counselling and testing centres' (ICTCs).

Though counselling and testing services have been implemented in India for the past 25 years, now 78% of the people who are living with HIV/AIDS are aware of their HIV status. Under the National AIDS Control Programme Phase III (NACP-III), it was planned to have 22 million clients counselled and tested through ICTCs every year. An equal number of clients will be tested in the private sector.

What is an Integrated Counselling and Testing Centre?

An ICTC is a place where a person is counselled and tested for HIV, on his own free will or as advised by a medical provider. The main functions of ICTC include:

- Early detection of HIV.
- Provision of basic information on modes of transmission and prevention of HIV/AIDS for promoting behavioural change and reducing vulnerability/risk.
- Link people with other HIV prevention, care and treatment services. Such as ART centres.
- Outreach visits to the homes of HIV positive clients facing severe crisis.

ICTC can be located in the obstetric and gynae department for pregnant women, or with tuberculosis microscopy centre for TB patients, at workplace, on national highways, in universities and STD clinics.

Voluntary counselling and testing (VCT) provides for all segments of the population, an opportunity to access complete and accurate information on HIV/AIDS.

This is a critical entry point to prevention, care, support and treatment for all people, and particularly for those already infected and affected. VCT services enable the 'client' to confidentially explore and understand his or her risk of HIV infection, provides an opportunity to fully comprehend the implications of one's serostatus and to learn about precautions for one's protection and preventing the further spread of HIV infection. VCT facilitates personal, and more informed decisions about HIV testing. Counselling is client centered. This promotes trust between the counselor and the client. The client is helped to identify and understand the implications of a negative and positive result.

In the event of positive HIV test result, counselling strengthens strategies for coping with the immediate stress, possible stigma, psychological and social impacts. It provides referrals to appropriate facilities for care, support and treatment and promotes more informed choices for the future.

This common facility will remove fear, stigma and discrimination among the clients. The ICTCs have common television and video-based health education material that are screened continuously in the waiting area. Further two strategies are adopted in ICTCs for HIV testing—'opt out' and 'opt in' strategy.

1 *Provider-initiated counselling and testing*—'opt out'. These clients are referred by healthcare providers. There are three varieties of patients who are offered provider-initiated counselling and testing:
   a Patients who present at a health facility with symptoms suggestive of HIV infection (pneumonia, TB and persistent diarrhoea).
   b Patients with STI/RTI.
   c Pregnant women who register at antenatal clinic.
   In such cases the client is given basic information on HIV, and educated about testing for HIV. The counsellor will ask each client, "Do you wish to test for HIV or not?" The client can 'opt out' or choose not to test for HIV. If a client does not 'opt out', then he/she is tested for HIV.
2 *Client-initiated counselling and testing*—'opt in' or direct walk in clients/self-referred clients.
   These clients who present themselves at the ICTC of their own free will based on their individual risk behaviour or information and advice received from a friend, sexual partner, or outreach worker or peer educator. Here the client is counselled for HIV and then 'opts in' or actively agrees to be tested for HIV. **Written consent** has to be obtained from such clients before testing.

As per the National AIDS Prevention and Control Policy, all HIV tests are voluntary based on **the clients consent,** accompanied by counselling and confidentiality of the results.

VCT services have reached up to block level in high prevalence states. The moderate and low prevalence states are in the process of extending VCT services to district and subdistrict level.

Different Types of ICTCs/HCTS—34500 HCTS

There are three types of ICTCs.

1 Fixed facility ICTCs
2 Mobile ICTCs
3 Public–private partnership ICTCs

A fixed facility ICTC can be of three types:

1 'Standalone' ICTC having full time counsellor and a laboratory technician located in medical colleges and district and in some sub-district hospitals. It is envisaged under NACP-III to have such ICTCs established up to the level of CHC (block level).
2 'Facility-integrated' ICTC which does not have full time staff and provides HIV counselling and testing as a service along with other services. Such centre caters to small number of clients, below the block level in high prevalent states.
3 Public–private partnership ICTCs.

Core Staff

Depending upon resources available and size of VCTC/ICTCs the core staff could include:

1 VCTC incharge/VCTC manager (often a microbiologist).
2 Two trained counsellors (one male and one female) or ideally as per client load (per counsellor 8–10 counselling sessions per day).
3 One trained laboratory technician.

Counselling in VCT consists of *pretest* and *posttest* counselling. During pretest counselling, the counsellor provides to the individual/couple an opportunity to explore and analyse their situation, and consider being tested for HIV. It facilitates more informed decisions about HIV testing. After the individual/couple has received accurate and complete information they reach an understanding about all that is involved. In the event that, after counselling, the individual decides to take the HIV test, VCT enables confidential HIV testing.

Posttest counselling: Consists of how to cope up with positive test and live positive life and share result with spouse and family members, notify partners and prevent transmission of HIV infection.

Peer Counselling

Peer counsellors are HIV positive men and women specially trained to hear the concerns of clients and offer support and referral services. A peer counsellor is an individual who is open about his/her HIV positive status and shares experiences with client and is willing to sustain his/her behaviour change and that of peers.

Peer counselling is a process that is carried out as a one to one interaction, followed by group interaction. During this process, experiential information is shared among the peer group to modify knowledge, attitude and beliefs to bring about change at the individual level. Counselling provided through this modality has a component of informality to it and addresses client issues through following processes.

- Sharing feelings about similar experiences and emotions.
- Sharing of information for availability of HIV/AIDS prevention, treatment and care services.
- Narrating their success stories to the peers and conveying messages of positive living.
- Advocating on behalf of the clients rights.
- Supporting clients in becoming more involved in community activities.
- Enable clients to learn self-help skills.

Goals of Peer Counselling

- To modify the attitudes, beliefs and behaviour of persons with high-risk behaviour.
- To identify actions needed to achieve behaviour change.

Competency addressed: The student should be able to:
CM 4.1: Describe social marketing programme (SMP) in health and family welfare: An education method.

Social Marketing Programme (SMP) in Health and Family Welfare[7,8]: An Education Method

The NPP 2000 stressed the need to formulate and implement Social Marketing schemes for advocating 'products and services' through partnerships between the voluntary sector, non-governmental organization and the private corporate sector, government, *Panchayati Raj* Institutions and the community. This will reduce the unmet needs of contraceptives and family welfare services.

What is Social Marketing?

Social marketing applies commercial marketing skills and technologies to the analysis, planning, execution and evaluation of programmes designed to influence the voluntary behaviour of target groups in order to improve their personal well-being and that of their society.

Objectives

i Objective of SMP is to increase the number of outlets of services or products, such as condoms, oral pills, ORS, MTP and CUT.

ii To improve the quality of services and products.

iii To involve or enhance partnership between government and private sector.

iv To improve the access to services of family welfare.

Scope

SMP techniques are used to promote the products and services of family welfare.

Apart from this, the SMPs are also used to change the attitudes and behaviour in areas like smoking, use of seat belts, drug abuse, heart disease and other chronic diseases associated with lifestyles.

Approach

The SMP recognizes the 'Consumer' as 'king' of services and ensures consumer consultation about the product and services suiting to his/her need. It analyses the needs of consumers, their felt needs, likes and dislikes and satisfaction level. This early 'consumer consultation' is called feed-forward by Manoff. It attempts to define in what the consumer is interested, what do they think and what are their reactions about presentations of products or idea or service.

The viewpoint and concern of clients is ascertained through various techniques, such as focus group, discussions, interviews and surveys.

In conclusion, it is the *precise delivery* of *precise product* or *service*, *precise idea*, to *precise client* at the *precise time* of their *precise need*. This is social marketing's primary tactic, a focus on priority need, when, where and for whom it is essential. In SMP, primary *focus* is on the *consumer*—on learning what people want and need in terms of social behaviour and services.

In government service set-up, this approach is seldom stressed and this sector most of the time considers only providing services, ideas, products, *pushing these as directives*, seldom consults the consumer and works on a strategy to "Take or leave it basis".

Information Education and Communication (IEC)

While IEC creates health-seeking behaviour, social marketing facilitates the practice of such behaviour by promoting, distributing and selling socially beneficial tangible products, services, ideas at affordable cost to low income group people. Consumer can access these through wide range of private outlets.

Planning of Social Marketing Programme in India

Planning of social marketing programme (SMP) requires a consumer focus by addressing the different elements of the 'marketing mix', i.e. *the concept of **p**roduct, its **p**rice, distribution **p**lace, its **p**romotion, **p**artnership involved and **p**olicy environment (6 Ps)*.

Product

People must perceive the problem and need of contraception. The SMP analyses such needs and perception of clients and thereafter SMP for RCH provides a diverse range of products, such as condoms, oral pills, sanitary napkins for girls and services, such as medical termination of pregnancy and to practices, such as breastfeeding, oral rehydration therapy (ORT). The product under SMP is distinguished and bears a special label or logo.

Price

Price of product should be affordable by the poor also—both in rural and urban settings.

Place

Place of selling or outlets of products must be identified and known to people. It could be through *Mahila Swasthya Sangh* in RCH or through women's organization or through grocery shops or a pharmacy or chemist.

Promotion

Promotion of sale of product is through mass media—advertisement, publicity and interpersonal communication. The focus is to create sustained demand.

Partnership Involved

The partnership in SMP under RCH is essential as no single agency in a diverse country like India can provide or make

impact. Key partnership between private sector, NGOs and government is essential.

Policy Environments

The government policy must encourage and support the SMP to sustain the practice or behaviour initiated by SMP.

Achievements of SMP in India

1 The social marketing of condoms increased from 16 million pieces in 1968–69 to 483.21 million pieces in 2017–18. Condoms marketed under SMP represent one-third of the total condoms distributed in India.

2 The social marketing of oral contraceptive pills (OCPs) increased from 7.24 lakh cycles in 1987–88 to 206.31 lakh cycles in 2017–18, i.e. one-third of the total oral contraceptives distributed annually in India through social marketing.

3 Since the introduction of the SMP in 1968, for condom promotion and that for oral pills in 1987, awareness regarding condoms and oral contraceptive pill has substantially increased, and is reflected in declining total fertility rates and increased contraceptive prevalence rates from 10.4% in 1951 to 56.5% in the year 2019–21.

4 SMP has helped to change the choices and options within each product (condom and the OCP) for the consumer.

5 Social marketing pilot project in rural India: In Madhya Pradesh, a trust of Hindustan Latex Limited, and in Uttar Pradesh, by the State Innovation in Family Planning Services Agency (SIFPSA) have been successful in demonstrating the feasibility of social marketing in rural area. Lot of field is open in rural area for SMP.

6 The brand name "NIRODH" (GOI-owned brand) also distributed through social marketing, has become a generic name for condom in India.

7 National AIDS Control Programme is promoting use of condoms through SMP.

National Strategies on SMP in India

- Maximize use of public health infrastructure in rural and urban areas. As till now SMP largely confined to urban areas—make use of sub-centres, PHCs, CHCs and Indian system of medicine as outlets for SMP.
- Expand the basket of products—add diverse brands of condoms, low dose oral pills because usage of contraceptive in India has been quite low; this step may increase usage of spacing methods.
- Enhance partnership between private, NGO and government for SMP products.
- ***Introduce services:*** Social franchises—in India private sector provides higher profit curative services only. Motivate this sector to support national health goals and provide preventive services to weaker sections at affordable cost.
- Promote information education and communication for SMP. The overall thrust of SMP is to accelerate achievement of socio-demographic goals of National Population Policy (NPP)-2000.

Under the social marketing programme both condoms and oral pills are made available to people at highly subsidized rates, through diverse outlets. The social marketing organization are given Deluxe NIRODH condom at ₹ 2 per packet of 5 pieces and this is sold at ₹ 3 per packet of 5 pieces to consumers. One cycle of oral pills is given to social marketing organization at ₹ 1.6 and is sold to consumer at ₹ 3 per cycle under the brand name of 'MALA-D'.

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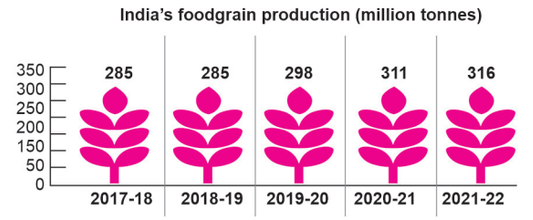
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CHAPTER

5

Nutrition

"Eat right… 'choose a healthy life', nutrition during the first 1000 days—from conception to 2 years of life matter most"—Journey of first 1000 days.
On India's proposal year 2023 declared as international year of millets by UN.





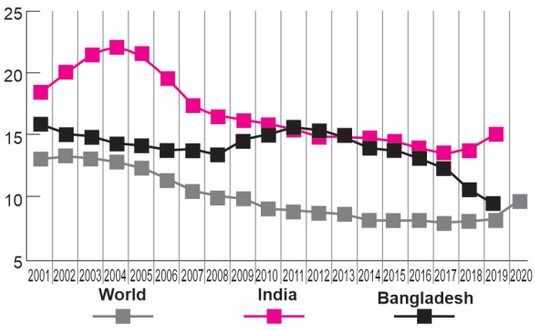


Fig. 5.1: Prevalence of undernourishment (%)

Source: A Amarender Reddy, Principal-Scientist, Chandigarh, Monday The Tribune, 21 Feb 2022.

GLOBAL TARGETS ON NUTRITION

Goal 1: United Nations 'Sustainable Development Goals' seek to eradicate extreme poverty for all people everywhere, currently measured as people living on less than $ 1.25 a day. By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions, leaving no one behind.

Goal 2: End hunger, achieve food security and improved nutrition and sustainable agriculture. By 2030, end all forms of malnutrition, including achieving by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age.

Global targets on nutrition for mothers and young children by 2025 from the base year 2015:

1. 40% reduction in childhood **stunting**.
2. 50% reduction in **anaemia** in women of reproductive age group.
3. 30% reduction in **low birth weight babies**.
4. No increase in childhood **overweight**.
5. Increase in **exclusive breastfeeding** in the first 6 months up to at least 50%.
6. Reduce and maintain **childhood wasting** to less than 5%.

In spite of increased found grains production undernourishment among people is rising in recent years. Prevalence of undernourishment (proportion of population whose habitual food consumption is insufficient to provide dietary energy levels that are required to maintain a normal active and healthy life) increased from 13.8% in 2018 to 15.3% in 2020.

National Food Security Act (household food security) 'food for all' passed in 2013 to provide food grains at highly subsidised rate to BPL families. This law entitles 820 million people in India to food at an affordable cost.

Famines and starvation in India were common features before independence. Nearly 3 million people died in great famine of West Bengal in 1943. India was food deficit country for about two decades after independence. India has not only become self-sufficient in food production but now has surplus food grains and enough of buffer stocks of over 60 million tonnes. The foodgrains production has increased to the level of 316 million tonnes in 2021–22 from 89.36 million tonnes in 1964–65. There was dilemma and paradox, that we had vast stocks of food grains but shortages were faced in some parts. Malnutrition persists as over 32% of young children being underweight, while the food rots in the godowns and in open and granaries overflow with food grains. Adequate access to food was not there because of poverty and inadequate and weak public distribution system (PDS).

India will need to produce 450 million tones of food grains in 2050 to be able to feed its population.

Besides undernutrition, we now have emerging problem of obesity and 'lifestyle diseases', India is thus facing double burden of malnutrition, i.e. we have the problem of **overnutrition** as also **undernutrition**.

Major Nutrition-related Public Health Problems

Malnutrition a triple burden:

1. Chronic energy or macronutrient *deficiency* and undernutrition (protein calorie malnutrition).
2. Micronutrient deficiency (hidden hunger) which includes:
   - a. Anaemia due to iron and folate and Vit B_{12} deficiency.
   - b. Iodine deficiency disorders (IDDs)
   - c. Vitamin A deficiency (VAD).
   - d. Zinc deficiency.
3. Chronic energy *excess* and obesity.

FAO and United Nations Global Report on food crisis 2020 reported 155 million people across 55 countries faced 'acute hunger' in 2020 due to war/conflicts.

Competency addressed: The student should be able to:
CM 5.1: Describe the common sources of various nutrients and special nutritional requirements according to age, sex, activity and physiological conditions.

Common Sources of Various Nutrients and Recommended Dietary Allowances According to Age, Sex, Activity and Physiological Conditions

The available foodstuffs (sources of nutrients) are broadly classified as cereals, pulses, nuts and oil seeds, vegetables, fruits, milk and milk products and flesh foods. These foods contain substances known as **nutrients** which perform various functions.

The **nutrients** include proteins, fats, carbohydrates, vitamins, minerals and salt. Foods are classified sometimes as protein rich foods, carbohydrates rich foods, etc. Oil and ghee provide mostly fat while sugar is purely a source of carbohydrate (Table 5.1).

Proteins, fats and carbohydrates are also sometimes called 'proximate principles'. They are oxidized in the body to provide the energy required for various activities of life. Together with water, proximate principles form the main bulk of foods.

SOURCES OF VARIOUS NUTRIENTS (FOOD GROUPS)

Cereals form the Base of Food Pyramid—Eat Cereals Adequately

Rice, wheat and millets (*Jowar, Bajra, Ragi,* etc.) are the main cereal grains consumed in India. Cereals are the most widely eaten staples. These are cheapest **sources** of calories and they constitute as much as 70–80% of the calories in the diets of majority of the population in our country. In view of the large amounts in which cereals are included in the diet, they form **important sources** of **nutrients** in an average Indian diet. Most cereal grains contain 6–12% proteins and in general cereal proteins are deficient in the essential amino acid—lysine, which limits the protein quality of cereals. Rice protein, however, is richer in lysine compared to other cereal proteins and for this reason rice protein is of better quality.

Cereals are an excellent basis for the diet of young children in India, however because of their bulky nature the child is unable to eat enough hence cannot meet the energy requirement of young children. Energy density of cereals can be increased by adding fats and oils in cereal preparations. To promote consumption of millets, India declared 2018 as national year of millets and UN declared year 2023 as international year of millets as food security in the wake of climate change scenario.

Whole cereal grains are important sources of B-complex vitamins especially thiamine and nicotinic acid. Since these vitamins are present in the cereal grain in the outer bran layers, the vitamin content of the finished product depends upon the removal of the outer layers. Excessive milling of rice and excessive polishing of rice removes outer covering and hence decreases the thiamine content of rice. Parboiled rice on the other hand contains significant amount of thiamine because during the course of parboiling in which paddy is subjected to steaming or boiling in water, the vitamin seeps into the inner portions of the grain so that even if the grain is milled and polished, significant amount of vitamins are still retained in the grain. Cereal grains do not contain vitamin A except yellow maize which contains some amount of β-carotene. The total fat content in cereals vary from 2 to 5%. Considering the amount of cereals consumed, it is estimated that fat present in cereals in our diet can meet more than 50% of essential fatty acid requirement. Cereals together with pulses can nearly meet the EFA of adult. On an average 444 g of cereals were available per person per day in India (2019).

Whole wheat flour contains more B vitamins, iron and calcium than white flour. Whole wheat also contains more phytates and 'dietary fibre' which interferes with the

absorption of iron and calcium. Cereals are deliberately withheld in the diet of young children because of **wrong beliefs**.

Pulses (Legumes) Eat Adequately

Pulses are rich source of proteins. Pulse proteins, however, are of relatively low biological value because of deficiency of the essential amino acid—methionine. Red gram is deficient in tryptophan also, however, pulse proteins are rich in lysine and they are therefore of good supplementary value to cereal diets. Eight parts of cereals and one part of pulses make good combination and supplement. The lysine deficient in cereals is made good by the lysine present in pulses and thus, the overall biological value of cereal pulse diet is better. Pulses are rich in B vitamin, especially thiamine and folic acid. Sprouted pulses especially sprouted green gram and Bengal gram become rich source of vitamin C and folic acid. Most pulses contains 20–25% of proteins and soya bean contains 40% of proteins. Pulses with their higher content of total fat (visible and invisible) contribute along with cereals to meet the essential fatty acids needs of an adult. On an average, 47.9 g (in 2019) of pulses per capita per day was the availability in India.

Legumes

Legumes contain some natural toxins but usually this is removed by soaking or in normal cooking procedures. *Khesari dal* (*Lathyrus sativus*) contains toxin BOAA (β-oxalyl amino alanine) which can be removed by soaking the pulse in water for sometime before cooking. Legumes are good for young children provided these are cooked and finely mashed and can be mixed with other food items. Trypsin inhibitor is present in soya bean which can be removed by soaking soya bean in water overnight and cooking thereafter.

Soya bean oil is excellent source of EFA and tocopherol (vitamin E) and this makes it a high quality vegetable oil.

Nuts and Oil Seeds

Like pulses, nuts and oil seeds are also rich in proteins and in addition they contain fat (almond, cashewnut, groundnuts contain 20–25% protein and 40% fat) so they are rich in calories also (570–650 calories per 100 g). Most of the oil seeds produced in the country are used for extraction of edible oil and the cakes left after extraction are richer in proteins. Off flavour can be removed and cakes can be made suitable for human consumption. Oil-seed proteins are of low biological values because of relative deficiency of amino acid—methionine. Sesame protein, however, is relatively richer in this amino acid as also the sunflower-seed protein.

When nuts are stored for long time a fungus *Aspergillus flavus* grows on nuts and produces aflatoxin and this toxin may cause liver damage (liver cancer), thus only clean and wholesome groundnuts should be used as food.

Green Leafy Vegetables (GLVs) Consurne Liberally

Many types of green leaves, such as *palak*, amaranth, fenugreek leaves, drumstick leaves, mint, coriander, mustard leaves, colocasia leaves, raddish and turnip leaves as also *Chenopodium* (*bathua*) are **rich sources** of iron, β-carotene, vitamin C, riboflavin and folic acid and calcium. Besides these vitamins and minerals, green leafy vegetables provide 'dietary fibre' and antioxidants. Green leafy vegetables are therefore **inexpensive sources** of many nutrients which are essential for growth and maintenance of health. Green leafy vegetables can be grown in kitchen garden or in farm and field, some grow wild, their consumption should be promoted. Distressingly intake of GLV in Indian diet is no more than 15 g per day/CU against the recommended daily intake of 150 g per day. In place of fruits, green leafy vegetables should be recommended for poor families to improve their diet.

Root vegetables: Root vegetables are tapioca, potato, sweet potato, carrots, yam and colocasia. They all are rich in carbohydrate and provide energy. Carrots and some varieties of yam are also rich in β-carotene and food like potato contains significant amount of vitamin C. At times of cereal shortages, root vegetables can serve as an emergency food in famines and drought.

Other vegetables: These include brinjals, lady-fingers, French beans, gourds, pumpkins. Some of these are rich sources of vitamins and minerals besides dietary fibre.

Fruits: Eat liberally, fresh fruits are generally good **sources of** vitamin C and amla is especially a rich source of this vitamin. Yellow fruits like mango and papaya contain β-carotene in addition and dried fruits like dates and raisins are rich sources of iron. The commonly used banana is a fruit rich in carbohydrate and, therefore, yields energy also. If the green leafy vegetables are included in the diet in sufficient quantities, the need for fruit as an essential item in the diet is much reduced. Fruits also contain pectins (dietary fibre) which provide bulk to the diet and help bowel movement, reduce blood sugar of cholesterol levels.

Bioactive Phytochemicals

Bioactive phytochemicals include dietary fibre, anti-oxidants and detoxifying agents. These are present in fruits and vegetables. These are non-nutrient chemicals but have significant role in prevention of diseases, such as colon cancer, diabetes, cardiovascular diseases, cataract and gallstones, constipation and diverticulosis.

Dietary Fibre (DF)

Definition: Dietary fibre is the remanants of the edible part of plants and analogues carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the human large intestine. It includes—polysaccharides, oligosaccharides, lignin and associated plant substances. Animal foods donot contain any dietary fiber. Dietary fibre exhibits one or more

of either laxation (fecal bulking and softening, increased frequency and or regularity), blood cholesterol attenuation and/or blood glucose attenuation. There has been overwhelming evidence that dietary fibre is essential to maintain body weight and composition, blood level of sugar (low glycaemic index), triglycerides and cholesterol. **Glycaemic index** of blood is defined by the area under 2 hours blood glucose response curve (AUC) following the ingestion of a fixed portion of test carbohydrate (usually 50 g either glucose or white bread) as a proportion (%) of area under curve (AUC) of the standard.

DF is further divided into **insoluble dietary fibre** (IDF) and **soluble dietary fibre** (SDF). The sum of these two fractions is also known as total dietary fibre (TDF). The IDF fractions are—cellulose, lignin and some portion of hemicelluloses. The cereals, seeds, beans, many fruits and vegetables, bran and whole grains are food sources of insoluble dietary fibre. IDF is composed of structural components of plant cell. The SDF fraction are—pectins gums, β-glucans, and inulin. Soluble dietary fibre is derived from 'maltodextrins', inulin (from wheat, onion, banana and chicory) or oligofructose. While the IDF is known to reduce constipation and diverticulosis, the SDF is effective in delaying the *absorption of glucose* and delay the *secretion of insulin* as also *lower lipid level* and *cholesterol* levels by binding bile salts, removing bile acids and neutral sterols by excretion through faeces and inhibit cholesterol biosynthesis.

Fenugreek seeds (*methi* seeds) which have high levels of IDF (28%) and SDF (20.0 g%) is very effective in reducing blood glucose and cholesterol levels. Since TDF contributes bulk to diets, it may help in reducing energy intake and thus useful for reducing obesity. Adverse effect of DF include prevention of absorption of trace minerals like iron. The dietary fibre consists of wide range of complex polysaccharides, such as cellulose, hemicellulose, pectins, gums, mucins and lignins with different chemical physicochemical and physiological properties. These have biological functions, such as water-holding capacity, delay in nutrient absorption and binding toxins and bile acids besides lowering of blood cholesterol and lipids and reducing incidence of coronary heart disease, type II diabetes and obesity. The suggested intake of TDF is 20–35 g/day or 40 g/2000 kcal in diet is considered reasonably safe for adults.

Sources of DF: Whole grain cereals, pulses, green leafy vegetables and fruits.

Antioxidants (AO)

The role of AO in oxidant or free radical scavanging is of great significance. Dietary antioxidants include nutrients, such as β-carotene, provitamin A, ascorbic acid—vitamin C, tocopherols, tocotrienols, riboflavin, sulphur amino acids, cysteine and methionine and selenium. Similarly, non-nutrient antioxidants are various carotenoids, flavinoids, anthracyanins and indoles. These agents remove free radicals, such as oxygen (O_2), superoxide, hydroxyl, peroxide and lipid peroxide. These agents inhibit lipid per-oxidation. These agents lower cholesterol level and promote HDL levels, prevent cancer, cardiovascular diseases and cataract. Phytochemicals also help in detoxification, i.e. detoxification of drugs, toxicants, carcinogens and mutagens. Antioxidants are present in green leafy vegetables, plant foods and fruits like papaya, turmeric, palm oil, amla and guava. RDA of AO—400 g per day of vegetables and fruits is enough to meet requirement of AO.

Milk and Milk Products

Milk is an ideal food for infants and children and is a good supplementary food for adults. It contains proteins (3.2–4.3%) of good quality and also other nutrients in proper proportion and it is thus a complete food. Milk is rich in calcium. It is however, deficient in vitamin C and iron. Human milk contains more lactose and buffalo milk contains more fat as compared to cow's milk. Curd has the same nutritive value as that of milk. The nutrient contents of dried milk is more or less the same as that of milk on a moisture free basis. Milk consumption should be promoted. White revolution and operation 'flood' has led to increased production and consumption of milk and milk products. Milk is available in various forms because of advance in technologies. Cow's and buffalo's milk contain 3.2 and 4.3% proteins respectively while human milk contains 1.1% protein.

Sugar and Jaggery—Consume Sparingly

Sugar and jaggery are main sources of energy, though jaggery contains iron in addition. Frequent consumption of sugar in between meals increases the incidence of caries and excessive consumption may lead to obesity.

Flesh Foods—Consume Moderately

Flesh foods, such as fish and meat are rich in proteins of high biological value and in B vitamins, especially vitamin B_{12} is contained only in foods of animal origin and not in plant foods. Protein content of flesh foods is around 20%. Flesh foods are generally not good sources of vitamin A; but liver which is very rich in vitamin A is an exception. Fish is a good source of calcium, especially small varieties which are consumed whole. Fish also contain polyunsaturated fatty acids which protect against cardiovascular diseases. Haem iron of flesh foods is better absorbed than non-haem iron.

Eggs—Eat Moderately

Egg is a rich source of nutrients except vitamin C. The protein present in egg is considered to be perfect protein and because of its high biological value and digestibility, the egg protein is used in nutrition work as a *reference protein*. Protein content of egg is 13.3%. Raw egg-white contains a protein known as avidin, which renders the

vitamin biotin unavailable to the body. Duck egg contains trypsin inhibitor, heating and boiling destroys both avidin and the trypsin inhibitor.

Condiments and Spices

These are used as seasoning or flavouring agents in food to increase their acceptability. Some of the condiments like chillies and coriander are good sources of carotene. Green chillies supply vitamin C and turmeric and tamarind are fair sources of antioxidants and iron. Many of the condiments and spices are used in small quantities hence do not add substantially to the nutritive value of the diet.

Salt

Salt is universally consumed. Average salt intake in India is 10 g per person per day (ICMR survey). Salt is being universally iodated to eliminate IDDs. Now NIN recommends 5 g of salt consumption per person per day.

Recommended Dietary Allowances (RDA) by ICMR 2020 (Table 5.1) for Indians

RDA is the average daily dietary nutrient intake level sufficient to meat the nutrient requirements of nearly all (nearly 97%) of healthy individuals in a particular life stage and gender groups.

The RDA is derived from (i) the individual variability and (ii) the nutrient bioavailability.

Individual variability: Definition of RDA takes into account the variability (age, gender, weight, occupation or work, etc.) that exists in the requirement of a given nutrient between individuals in a given population group. The distribution of nutrient requirement in a population group is considered normal, the RDA corresponds to a requirement, which covers most of the individuals (97.5%) in a given population. This corresponds to estimated average requirement (EAR) + 2SD. This is termed as safe level of intake of a nutrient, that is, the chances of individuals having requirement above the RDA are only 2.5%. This principle is used in case of all nutrients except energy. In case of energy, intakes either in excess or below, the actual requirement of energy are not safe.

Bioavailability means absorption of nutrient in the intestine. Thus, RDA represents the level of nutrient to be consumed daily to meet all the requirement of most of the individuals in population. RDA is a level above the requirement of most of individuals in population. For RDA, reference woman and man have been redefined.

Reference Indian Adult Man and Woman (NNMB)[1, 2]

Reference man is in age group 19–39 years and weighs 65 kg with a height of 1.77 m with a BMI of 20.75 and is free from disease and physically fit for active work; on each working day, he is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work he spends 8 hours in bed, 4–6 hours in sitting and moving about, 2 hours in walking and in active recreation or household duties.

Reference woman is in age group 19–39 years, non-pregnant non-lactating (NPNL) and weighs 55 kg with a height of 1.62 m and a BMI of 20.95, is free from disease and physically fit for active work; on each working day she is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work she spends 8 hours in bed, 4–6 hours in sitting and moving about, 2 hours in walking and in active recreation or household duties.

Proteins

Proteins are building blocks and are chief substances in the cells of the body. Protein is required by the body for growth, replacement of body tissues as also for synthesis of enzymes, haemoglobin, hormones, antibodies and breast milk. Proteins are made of amino acids. Some of the amino acids are 'essential amino acids' which cannot be synthesized by the body and hence have to be supplied from dietary sources. These essential amino acids Indispensable amino acids are isoleucine, leucine, lysine, methionine, phenylalanine, tryptophan, threonine and valine. The presence of essential amino acid determines the quality of proteins.

Biological value of protein depends upon amino acid content and its digestibility. Animal proteins have high biological value as compared to vegetable proteins. Cereal proteins are rich in methionine but poor in amino acid (lysine), while pulse proteins are rich in lysine but poor in methionine. Combination of cereals and pulses (Dal-Roti) can enhance their value and it has mutual supplementary effect, and deficiency of one amino acid in one foodstuff can be made good by another. Therefore, eating mixed cereals and cereals plus pulses is nutritionally advantageous as it achieves balancing of amino acid content of food.

Egg and milk proteins are used as reference proteins. Biological value of egg protein is 94, milk 84, meat 74, fish 76 and that of rice, wheat and Bengal gram is 68, 65 and 68, respectively.

Safe level RDA for protein for adults: 0.83 g per kg body weight per day. Young children, pregnant women, and lactating women require more proteins. Proteins normally should supply 20% energy.

Carbohydrates (CHO) and Energy

Carbohydrates are main source of energy (about 60%) to the body. Carbohydrates are glucose, cane-sugar, and starch. Foodgrains are largely composed of starch. Foodstuffs like cane-sugar and glucose are pure carbohydrates. Being cheap source of energy carbohydrates form the bulk of an Indian diet. Energy deficiency is primarily food deficiency responsible for PEM in children. Major cause of undernutrition is energy deficiency or less food intake. **Energy requirements** for **different age groups** as per ICMR 2020 are adequately met by RDA.

Table 5.1: Recommended dietary allowances (RDA) for Indians according to age, sex, activity and physiological conditions—ICMR 2020[1]

*Energy** kcal/day*		*Category of work and age group*	*Body wt (kg)*	*Protein (g/d)*	*CHO (g/d)*	*Calcium (mg/d)*	*Iron (mg/d)*	*Zinc (mg/d)*	*Iodine (µg/day)*	*Thia-mine (mg/d)*	*Riboflavin (mg/d)*	*Niacin (mg/d)*	*Vitamin B_6 (mg/d)*	*Folate (µg/d)*	*Vitamin B_{12} (µg/d)*	*Vitamin C (mg/d)*	*Vitamin A (µg/d)*	*Vitamin D (IU/d)*
EAR	*Fats oil (g)*																	
2110	25	Sedentary	Men							1.4	2.0	14	1.9					
2710	30	Moderate	65	54.0	130	1000	19	17	140	1.8	2.5	18	2.4	300	2.2	80	1000	600
3470	40	Heavy								2.3	3.2	23	3.1					
1660	20	Sedentary	Women							1.4	1.9	11	1.9					
2130	25	Moderate	55	46.0	130	1000	29	13.2	140	1.7	2.4	14	1.9	220	2.2	65	840	600
2720	30	Heavy								2.2	3.1	18	2.4					
+350	30	Pregnant woman	55 +10	+9.5 (2nd trimester) +22.0 (3rd trimester)	175	1000	27	14.5	220	2.0	2.7	+2.5	2.3	570	+0.25	+15	900	600
+600		Lactation		+17.0	200					2.1	3.0		+0.26	330				
	30	0–6 m				1200	23	14	280			15			+1.0	+50	950	600
+520		7–12 m		+13.0	200					2.1	2.9		+0.17	330				
530		0–6 m* infants	5.8	8.0	55	300	–	–	100	0.2	0.4	2	0.1	25	1.2	20	350	400
680	25	6–12 m	8.5	10.5	95	300	3	2.5	130	0.4	0.6	5	0.6	85	1.2	30	350	400
1110	25	1–3 y children	12.9	12.5	130	500	8	3.0	90	0.7	1.1	7	0.9	120	1.2	30	390	600
1360	25	4–6 y children	18.3	16.0	130	550	11	4.5	90	0.9	1.3	9	1.2	135	2.2	35	510	600
1700	30	7–9 y children	25.3	23.0	130	650	15	5.9	90	1.1	1.6	11	1.5	170	2.2	45	630	600
2220	35	10–12 y boys	34.9	32.0	130	850	16	8.5	100	1.5	2.1	15	2.0	220	2.2	55	770	600
2060	45	10–12y girls	36.4	33.0	130	850	28	8.5	100	1.4	1.9	14	1.9	225	2.2	50	790	600
2860	50	13–15y boys	50.5	45.0	130	1000	22	14.3	140	1.9	2.7	19	2.6	285	2.2	70	930	600
2400	35	13–15y girls	49.6	43.0	130	1000	30	12.8	140	1.6	2.2	16	2.2	245	2.2	65	890	600
3320	40	16–18y boys	64.4	55.0	130	1050	26	17.6	140	2.2	3.1	22	3.0	340	2.2	85	1000	600
2500	35	16–18y girls	55.7	46.0	130	1050	32	14.2	140	1.7	2.3	17	2.3	270	2.2	70	860	600

*AI: Adequate intake + = Additional requirement, CHO = Carbohydrate; [1]ICMR 2020: Indian Council of Medical Research 2020

** There is no RDA for energy, the estimated average requirement (EAR) for energy is equivalent to the estimated energy requirement (EER)

Besides starch and other digestible carbohydrates, many foods contain cellulose and hemicellulose, gums, pectins and lignins which are also carbohydrates. These types of carbohydrates are called 'fibre' or roughage or unavailable carbohydrates to the body, as these are not digested in the human digestive system and are voided as such. These are designated as 'dietary fibre' and have important role to play in diet, such as removal of waste, prevent constipation and increasing contraction of muscular wall of the gut. Leafy vegetables, fruits and spices are rich in dietary fibre besides whole grain cereals. Dietary fibres make food bulky. Dietary fibres prevent obesity, cardiovascular diseases and cancer. Lack of adequate dietary fibre in diets containing refined foods, leads to constipation and colon cancer. Some of dietary fibre like gums, mucilages in our diets have shown to lower blood cholesterol and blood glucose. The daily diet of an adult should contain minimum 20–35 g of dietary fibre.

Energy

Practical nutrition work often involves the assessment of calories needs of group or persons. In such cases, it is usual to assess the needs of women and children in terms of those of the average man by applying various coefficients to the different age and sex groups. In the following scale which is suggested for practical nutrition work in India, the calorie consumption of an average adult male doing sedentary work is taken as 1 unit and other coefficients are worked out on the basis of calories requirements one unit of coefficient corresponds to energy requirement of 2110 kcal/day. It must be emphasized that the scale of coefficient is somewhat arbitrary one and concerns only for calories. It is not meant to be applied in assessing the needs of other nutrients.

With the help of food consumption tables, the calorie contents of diets can be worked out and compared with suggested requirements. In dealing with a group of mixed age and sex composition, the number of 'consumption units' (or adult man value) in the group is first calculated. For example, a family consisting of father doing sedentary work, mother of three children aged 10, 8 and 6 years has an 'adult man value' or consumption units (calculated on the above scale), comes out to be 3.9 (i.e. 1.0 + 0.8 + 0.8 + 0.7 + 0.6) and the minimum daily calorie requirement would be 2110 × 3.9 = 8230. It is necessary to draw-up a diet schedule for this family supplying approximately 8230 calories. It is safer to err on the side of excess by 100–200 calories to allow the waste of all kinds (Table 5.2).

Energy requirement: Per day in kcal. Finding energy requirement on the basis of intake that balances expenditure is now considered outdated. Energy (kcal) or calories requirement is now determined by energy expenditure which depends upon several factors like age, gender, physical activity at work, leisure and body build of a person. For the purpose of calculating energy expenditure reference man and a reference woman have been redefined by ICMR in 2020.

Table 5.2: Age-wise and sex-wise calorie coefficient consumption unit

Person/age	*Calorie coefficient consumption unit*[3]
Adult male (sedentary worker)	1.0
Adult male (moderate worker)	1.2
Adult male (heavy worker)	1.6
Adult female (sedentary worker)	0.8
Adult female (moderate worker)	0.9
Adult female (heavy worker)	1.2
Adolescents 12–21 years	1.0
Children 9–12 years	0.8
Children 7–9 years	0.7
Children 5–7 years	0.6
Children 3–5 years	0.5
Children 1–3 years	0.4

Physical activity ratio (PAR): Energy cost of an activity per minute. Energy cost of basal metabolism per minute (BMR). PAR values for activities performed in a day can be aggregated over that period to yield physical activity level (PAL), which is the ratio of the energy expenditure for 24 hours and the BMR over 24 hours.

Energy or calories requirements for adult male doing sedentary, moderate and heavy work are 2110, 2710, 3470 and for female 1660, 2130 and 2720, respectively. Pregnant women requires 350 additional calories and lactating mother requires additional 600 colories for first 6 months of lactation and 520 calories from 7–12 months. Infants require 550 to 670 calories.

Dietary Fats

Fats and oils are concentrated source of energy and increase the energy density of the diet. It supplies per unit weight more than double the energy provided by either protein or carbohydrate. 1 g of fat yields 9 kcal, 1 g of protein and 1 g of carbohydrate yields 4 kcal each. 1 g of dietary fibre yields 2 kcal.

Dairy fats, such as butter and ghee contain significant amount of vitamins A (retinol) and D as do some marine oils. These vitamins are not present in vegetable oils. Almost all vegetable oils contain vitamin E and are richest source of this vitamin in many diets. A few oils, e.g. redpalm oil contains substantial amount of carotenoids (provitamin A) which can also be found in many vegetables and fruits. Hydrogenated oil (*Vanaspati*) now popular in India as a cooking medium, does not normally contain vitamins. Vitamin A used to be added to *Vanaspati* oil at a level of 50 IU/g and it was mandatory. However, this compulsory requirement is now withdrawn.

Functions of dietary fats: Fats are source of concentrated energy, essential for cell structure and membrane functions,

as a source of essential fatty acids (EFA) (linolenic and linoleic acids), for cell structure and prostaglandin synthesis, as a vehicle for oil soluble vitamins and essential for control of blood lipids. In addition, fat contributes to the palatability of food and is important in cooking and food processing. Fat in the diet also helps in the absorption of beta-carotene and other fat soluble vitamins. While a minimum amount of fat has to be present in the diet to meet the requirement of two unsaturated EFAs (linoleic and linolenic acid), excess of fat in the diet is considered harmful. Hence, the minimum level, the desirable level, and the safe upper limit of fat intake has to be considered.

Visible and Invisible Fats—Consume Moderately

Visible fats are those which have been separated from animal tissues, milk, oil seeds, nuts or other vegetable sources, e.g. butter, ghee, groundnut, mustard, coconut and sunflower oils. They are used to produce shortening, margarine, salad oil, butter, etc. Visible fats are largely triglycerides, the common fatty acids present in visible fats are palmitic acid, stearic acid, oleic acid and linolenic acid.

Invisible fats are fats present as integral components of food or those which have not been separated from their original source and are therefore consumed as part of the tissues in the diet principally as meat, fish, poultry, dairy products, cereals, pulses nuts and vegetables. Invisible fats in diets are around 60% or more. Invisible fats of plant foods are good sources of oleic acid, linoleic acid (LA) and α-linolenic acid (ALA). While in most foods LA predominates, legumes, green leafy vegetables and spices contain high proportion of ALA. The invisible fats from pulses and cereals alone contribute as much as 6 energy% or 16 g of invisible fat.

Quality of Fats and Safety Levels of Consumption

Daily intake of fat should be such that it contributes not more than 20% of energy/calories in the diet. Considering the EFA requirements of different groups and knowing that the invisible fat in a cereal-based diet can meet more than half the linoleic acid requirements of an adult, a minimal intake of 20–40 g visible fat is recommended for adult male and female per day with higher levels of 25–30 g and 35–50 g for young children and adolescents and 30 g visible fat per day for pregnant and lactating women, respectively. It should be in the form of an oil containing at least 20% of linoleic acid. Apart from providing the essential fatty acid, visible fat in the diet has other desirable functions, such as improving the palatability and increasing the caloric density of the diet. A higher caloric density in the diet is essential for feeding young children so as to provide the needed calories.

Mustard oil (*Brassica* oil) contains erucic acid which should be reduced by blending with other oils. Reuse of refined oil over and again in deep frying operation makes it harmful due to release of certain toxic substances.

Saturated fatty acids (SFA): Stearic acid and short-chain fatty acid.

Unsaturated fatty acids: Lauric and myristic acids. These raise the level of cholesterol, however, stearic acid and some short-chain fatty acids do not raise the level of cholesterol.

Monounsaturated fatty acids (MUFA): Oleic acid. Oleic acid is monounsaturated fatty acid. It lowers blood cholesterol as effectively as essential fatty acid—linoleic acid. It also lowers serum triglycerides (VLDL).

Polyunsaturated fatty acids (PUFA) are linolenic and linoleic acids. These lower blood cholesterol level.

Quality of Fat (Essential Fatty Acids)

Besides being a concentrated source of energy, fats are also a source of essential fatty acids (EFA). Fats are made-up of fatty acids which include saturated fatty acids like palmitic and stearic, monosaturated fatty acids like oleic and polyunsaturated fatty acids (PUFA) like linoleic (Lin) and linolenic (Len). The latter two cannot be synthesized in the body and have to be supplied through dietary fats. These are known as essential fatty acids (EFA). Dietary fats with an appropriate proportion of saturated, monosaturated, and polyunsaturated fatty acids (PUFA) components have been considered as most desirable—1.0:1.5:1.0 [NFI-21(4), Oct., 2000]. EFA lowers the levels of cholesterol and triglycerides and hence protective against cardiovascular diseases. It raises the levels of protective lipids (HDL) and lowers the levels of dangerous lipid (LDL). Soya bean oil is high quality vegetable oil which contains EFA with cholesterol lowering function. A moderate consumption within the recommended dietary fat intake levels provides optimum health benefits. EFA also decreases thrombotic tendency of blood platelets. Fats like ghee, hydrogenated fats (vanaspati) and coconut oil are saturated and are poor sources of EFA. Other edible oils (rice bran and soya bean) are better sources of EFA. Donot depend upon one oil, use combination of oils and limit use of butter and Ghee as illustrated in food pyramid.

The *invisible fats* present in many Indian food materials have a high linoleic acid content. The average Indian diet predominantly based on cereals and some pulses including the diets of poor income groups carry sufficient linoleic acid levels and a proportion of linolenic acid as well. Although their diet may contain very low amount of visible fat, the quantity of EFA and the levels of invisible fats compensate for the lack (Table 5.3).

Fat Intake in India

Actual daily intake of visible fat varies from 6 to 22 g/day per consumption unit in rural India. In many states, as much as quarter of population may not have any visible fat at all in their diets. In urban area, in middle and upper income group, fat intake ranges from 22 to 45 g which is much

Table 5.3: Linoleic (Lin) and linolenic (Len) acids content of edible oils (g/100 g)

Oil	*Lin*	*Len*	*Total EFA*
Ghee/oil	1.6	0.5	2.1
Coconut oil	2.0	–	2.0
Vanaspati oil	3.4	–	3.4
Palmolein	10.3	0.3	10.6
Rape/mustard oil	18.1	14.5	32.6
Groundnut oil	29.9	–	29.9
Rice bran oil	34.3	1.4	35.7
Sesame (Til) oil	44.5	–	44.5
Cotton seed oil	50.9	–	50.9
Corn oil	57.4	–	57.4
Sunflower oil	66.2	Trace	66.2
Soya bean oil	50.7	6.5	57.2
Safflower oil	73.5	–	73.5

higher than rural area where per capita availability of fat is worked out to be 15–17 g/day.

Upper Limit of Fat

Although a minimal intake of 12 g of visible fat can meet the requirement of EFA, a higher level of intake of 25 g/day is desirable to provide energy density and palatability to the diet. Fat intake above a certain level is also undesirable, being associated with hazard like cardiovascular diseases and obesity.

Even a predominantly cereal-based diet would contribute 15 g invisible fat, 50% of which would be EFA. This with 20–40 g of visible fat, should meet EFA requirement of all age groups. However, the upper limit of fat in the diet should not exceed 30% of calories—about 60 g/day. Total calories from visible fat should not exceed 10%.

Trans Fats (Hidden Fat)

Trans fat in commercially fried and processed food is more hazardous than dietary cholesterol. Trans fat is formed from chemical process known as 'partial hydrogenation of vegetable oils' used to convert liquid oils into semi-solid form. The body is unable to breakdown trans fat causing it to accumulate in the body. Transfat has been part of the urban diet for decades, enhancing the taste and shelf-life of popular packaged food products. The cheap and harmful oil is used in most processed foods, such as biscuits, instant noodles to deep fried *samosas* and *french fries*; *fried chickens*, frozen food cookies and candy, cake and pancake mixes, hard margarine is loaded with trans and saturated fats. While saturated fat—found in butter, cheese, red meat, and coconut and palm oil—raises cholesterol levels, transfat harms you further. It increases low density lipoprotein (LDL or bad cholesterol) and lowers heart protecting high density lipoprotein (HDL or good cholesterol). WHO recommends that trans fats should not be consumed at all. From September 1, 2007 the use of trans fats will have to be clearly listed on the food labels of all products manufactured in India. Survey on trans fatty acid conducted by FSSAI shows that India is set to achieve elimination of industrial processed trans fats by 2022.

Vitamins and Minerals

Vitamins and minerals are protective nutrients and have specific metabolic functions in the body. They do not provide energy. Daily RDA of vitamin A (retinol), vitamin D, thiamine (B_1), riboflavin, (B_2), nicotinic acid (niacin), pyridoxine (B_6), vitamin B_{12}, vitamin C are given in Table 5.1. Important mineral/metals include—calcium, phosphorus, iron and magnesium and trace elements are—iodine, zinc, copper, chromium, cobalt, manganese, arsenic, fluoride and molybdenum. Pantothenic acid is vitamin B_5 required for synthesis of corticosteroids.

Competency addressed: The student should be able to:
CM 5.4: Plan and recommend a suitable diet for the individuals and families based on local availability of foods and economic status, etc. in a simulated environment.

How? The learner carries out socio-economic, nutritional assessment and dietary survey of family to assess qualitative and quantitative dietary intakes, ascertains cooking practices and then recommends suitable diet.

Objective: Learning objective is to improve the diets/dietary practices of vulnerables.

Characteristic of an Average Indian Diet

The Indian diets are highly cereal-based, particularly of the weaker economic sections. In the case of majority of population, cereals form almost the bulk of diet and constitute the major source, if not the only source of nutrients and provide 80% of energy. These diets are deficient in pulses, green leafy vegetables, oils and fats as also fruits. Most staple used are—rice in Southern parts and wheat in North India but the trend of mixed cereals consumption is emerging. The diets of even poor people which consist of predominant cereals and have little or no visible fats consist significant quantities of invisible fats. The invisible fat from cereals and pulses alone contributes as much as 6 energy % or 16 g of invisible fat in adult diet—that provides 2710 kcal. In average, Indian diet in many parts of the country, the total visible plus invisible fat contributes about 15% of the dietary energy. Cereals are deliberately withheld from the diets of infants and young children or given in small quantities (inadequate amounts). Varied kinds of dietary beliefs and practices are prevalent in the community which lead to malnutrition in young children besides widespread infections due to bad environments and poor personal hygiene.

Planning Suitable Diet for Individual and Family

Before planning suitable diet nutritional assessment and dietary survey of family and most vulnerable groups are conducted to know the dietary intakes in terms of quantity and quality. This exercise enables us to ascertain adequacy or inadequacy of dietary food intakes. These diets can be improved by eating healthy diets—mixed cereals or by adding coarse cereals (millets) as also locally grown leafy vegetables, butter milk and increased use of pulses and local fruits. Cheap flesh foods if available locally (such as fish) can be encouraged. Cost of balanced diet is prohibitive. Use of health facilities to supplement iron and folic acid as also vitamin A nutrient and supplementary feeding through ICDS, *Anganwadi* can help to some extent but the people have to develop self-reliance to improve their diets, while government ensures food security.

Another improvement which can be effected is improvement of cooking practices, not to discard cooking water. It is advisable to use minimum quantity of water or to utilize cooking liquor in either soups or gravies. It is not advisable to peel and cut the vegetables long before they are ready for boiling. Excessive washing of rice should be avoided to save vitamin B (thiamine). The rice conjee, which is strained away after cooking also carries with thiamine and nicotinic acid. Tamarind when added to cooking water preserves vitamins.

Methods of nutritional assessment and dietary survey (*see* Pages 151 and 180).

Balanced Diet

We need the right kind of food in adequate amounts for proper growth, development and functioning of our body. This can be achieved by consuming a balanced diet. A balanced diet is a wholesome diet which provides essential nutrients (carbohydrates, fats, proteins, vitamins, minerals, and water) from all food groups in the proper amounts to maintain good health. In addition, a balanced diet also provides dietary fibre.

The quantity of food needed to meet body requirements varies according to the age, gender, body composition, physical activity and physiological status (pregnancy/lactation, etc.). For example, those who engage in heavy work activities require to eat more, as compared to those who do not do much activity. Similarly, a pregnant woman needs more calories for growth of foetus and maternal tissue expansion (weight gain of 9–11 kg during pregnancy) as compared to a non-pregnant woman, infant and young children grow rapidly require relatively more nutrients/food, lactating mothers require more food to produce breast milk—700 ml per day.

We know that no single food can meet all the nutrient requirements. Even milk, which is often considered as a wholesome food, is deficient in some nutrients (like iron and vitamin C). Therefore, to achieve a balanced diet, a combination of different foods should be included in the diet. Based on the major nutrients present in foods, and their functions, different foods have been grouped under four

Table 5.4: Food composition and nutrient content value of balanced diet for moderate active man

Food composition	*Amount (g/day)*	*Nutrient*	*Vegetarian diet*	*Non-vegetarian diet*	*EAR*	*RDA*
Cereals and millets	360	Energy (kcal)	2690	2650	2710	–
		Protein (g)	87.5	81.7	43	54
Pulses (legumes)/flesh foods[1]	120	Visible fat (g)	35	35	30	30
Green leafy vegetables	100	Calcium (mg)	1084	1054	800	1000
Other vegetables	200	Iron (mg)	33.3	31.1	11	19.0
Roots and tubers (excluding potatoes)	100	Zinc (mg)	16.3	15.9	14.0	17
Fruits	150	Magnesium (mg)	968	891	320	440
Milk	300	Vitamin A (µg)*	1802	1796	460	1000
Fats and oils	30	β carotene	9842	9779	2760	6000
Oil seeds and nuts (gingely seeds and pea nuts)	30	Thiamine (mg)	2.0	1.9	1.5	1.8
		Riboflavin (mg)	1.9	1.9	2.1	2.5
		Niacin (mg)	19	20.0	15	18
		Vitamin B_6 (mg)	2.4	2.4	2.1	2.4
		Vitamin C (mg)	209	209	65	80
		Total folates (µg)	559	491	250	300
		Vitamin B_{12} (µg)[2]	1.5	2.4	2.0	2.2

[1]Protein quality depends on the type of food. EAR—Estimated average requirement
[1]Pulses can be replaced with animal foods (egg, meat, fish and chicken) for non-vegetarians to meet the requirements.
[2]Only 60% of the RDA of vitamin B_{12} can be met by the vegetarian diet.
* Retinol derived from β carotene from diet was also added to the total.
For cereals and millets, it is recommended to consume 50% as whole grains.
For green leafy vegetables (GLVs), it is recommended to consume 150 g of GLVs, especially drumstick leaves, amaranth and bathua leaves to meet the requirements of all the vitamins and minerals.

major food groups. These are cereals and pulses, vegetables and fruits, milk and animal products, fats and oils/sugar and nuts (*see* food pyramid). In balanced diet, 60% of energy should be derived from carbohydrates, 20% from proteins and 20% from fats.

Eating a variety of foods from each food group and including foods from all food groups is called **Dietary Diversity.** It means that foods from all the basic four food groups, should be eaten in proper quantities. Let us now understand how much food from each of these food groups should be included in our diet to achieve a balanced diet. We can understand this better through the 'Food Pyramid' and Table 5.4.

Food Pyramid

The food pyramid is a guide to be used by the healthy population for the amount and types of foods to be included in the daily diet in order to stay healthy. It is a pictorial representation of different food groups and the quantity in which they should be consumed. It helps in planning a balanced diet. It is made in the shape of a triangle (pyramid) and is broadly divided into four separate levels based on the nutrients provided by each food group.

- The base of the pyramid is made up of foods that should be the bulk of a healthy diet. It represents cereals, millets, pulses, and legumes, which should be consumed **adequately**.
- The second level represents fresh, seasonal, locally available fruits and vegetables, which should be consumed **liberally**.
- The third level shows non-vegetarian foods/animal products, milk and milk products and oils which should be consumed in **moderation**.
- The tip of the pyramid has all processed, refined foods, which have high fat, salt and sugar content like sweets, fried foods, bakery items, etc. which should be consumed **sparingly**.
- The food pyramid also guides us to avoid drinking alcohol and consuming tabacco and encourages individuals to exercise regularly and to be physically active (Fig. 5.2).

Expected outcome: After assessing the nutritional status and conducting dietary survey the student recommends a suitable, affordable and acceptable diet for most vulnerable in the family or at Anganwadi centre.

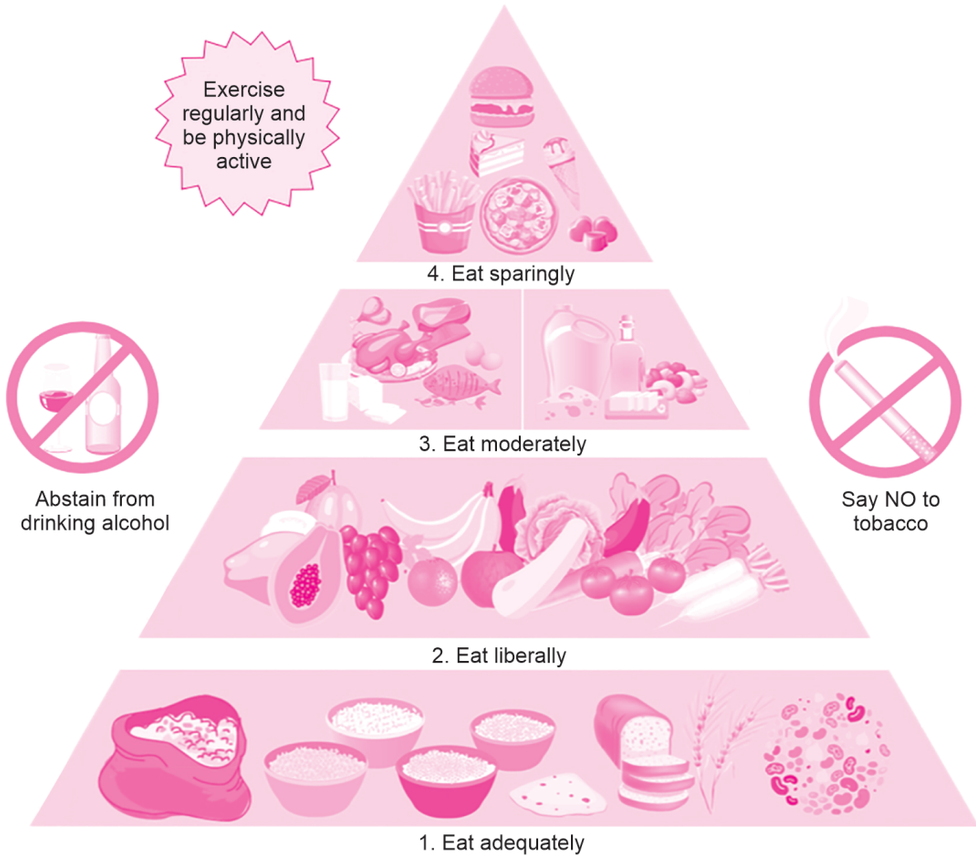


Fig. 5.2: Food pyramid and foods placed at each level

Source: Adapted from dietary guidelines for Indians, National Institute of Nutriton, 2011

Common Dietary Beliefs and Practices in Infants, Young Children, Pregnant and Lactating Mothers in India—A Case Study Related to CM 5.5

People classify foods as hot, cold, heavy, light, and windy foods. Use people's classification to improve diets/nutrition.

Many dietary beliefs and practices are strongly held by individual, family and community, in almost all the regions or different parts of the country. Some of these beliefs and practices are detrimental or harmful and produce malnutrition in young children, pregnant women and lactating mothers. Some of the dietary beliefs and indigenous practices are good, and beneficial hence need to be promoted. Some of the common prevalent dietary beliefs and practices are being elaborated:

- The concept of 'hot and cold' foods is widely prevalent, similarly some foods are considered 'heavy' and others as 'light'. These concepts and beliefs affect food choices and many dietary restrictions are imposed on the diets of young infants, children, pregnant women and lactating mothers and consequently the undernutrition or malnutrition develops in vulnerable groups.
- Jaggery, sugar, halwa, groundnuts, almonds, coconut, raisins, palm dates, fried foods, mangoes, millets, maize, eggs, and meat are believed to be 'hot' and heat producing foods and related with occurrence of abortion, hence avoided by pregnant women. Papaya is strongly suspected to cause abortion, hence not touched by any pregnant women. Buttermilk, curd, milk, green grams, green leafy vegetable, barley flour, and apple are labelled as 'cold' foods hence encouraged during pregnancy.
- Black grams, beans, halwa (sweetened wheat porridge), whole buffalo milk and ghee (animal fat) are generally believed to be 'heavy' foods, being associated with indigestion and colic hence avoided by mothers and discouraged during illness like fever, diarrhoea and respiratory infections. Rice + green gram dal, curd, wheat porridge (dalia), sago porridge, bread slices, diluted milk, butter milk are believed to be 'light' foods hence encouraged during pregnancy and ailment like diarrhoea, fevers and respiratory infections.
- Rice, potatoes, cauliflower are commonly believed to be 'wind' producing foods and for that reason are seasoned with variety of condiments to the likes of individual and family. Cucumber, and watermelon are considered to be cold and windy foods and suspected to cause joint pains, body aches, etc. Such strong beliefs are entertained by most families over generations and have become way of life.
- Desi ghee is valued as most nutritious and encouraged in the diet of adults and working men, while cereals, ghee and green leafy vegetables are considered bad for young children and believed to be associated with, cough, protuberance of abdomen, and bad for liver, hence avoided or given in very small quantities. Parents believe that young child cannot **digest** cereals and green leafy vegetables. Whole milk is diluted several times as it is thought to be **heavy** for young children. It is a common practice to add four parts of water to one part of milk. Several dietary restrictions are imposed during diarrhoea, fever and respiratory infection. Similarly, nursing mothers are forbidden to eat pulses, green leafy vegetables, Bengal grams, cereals and milk for variable period. Ghee, sugar and jaggery and coconut are encouraged with the belief that these foods help in evacuation of secretions of uterus and helps involution of uterus.

It must be realized that many of these beliefs and practices are deep rooted, and it may not be possible to fully modify the attitudes and change the behaviours in a short period of time. Under the circumstances, we can achieve the desired objectives to a large extent if we build on these beliefs and practices and incorporate positive messages without any cultural conflict.

By suggesting suitable combination of the so-called 'hot food' with 'cold food' and of 'heavy food' with 'light food' in desired proportions, we could overcome the usual objections.

Seasoning and substituting of so-called cold foods with condiments like cumin, ginger, onion, dalchini, pepper, cloves and cardamom, was exploited fully to reduce the effect of 'cold' and 'windy' foods. Mothers did not hesitate to try such food combinations. Use of curd, rice and green gram dal (*Khichri*) is acceptable during acute watery diarrhoeal episodes and we promoted its use to prevent and treat dehydration. Mothers agreed to give plenty of water and use ORS solution as also weak tea during diarrhoea.

Knowing these dietary beliefs and practices helps to effect changes in behaviour by nutrition education programme. Encourage foods which are liked most. Since most families and mothers believe that diarrhoea occurs due to teething problem and associated with hot and cold weather, one should act and advice accordingly. Curd, butter milk and light foods (rice + green grams) which are culturally acceptable must be encouraged. One must respect culture, beliefs, traditions and effect minimum changes to improve the nutrition of young children, pregnant women and lactating mothers. Good dietary practices, such as breastfeeding, eating mixed cereals, consumption of green leafy vegetables by pregnant women should be promoted. Indigenous recipes must be encouraged as these are time tested and most nutritious. Knowledge of dietary beliefs, practices, taboos helps to formulate a better nutrition education programme. Food distribution within family is important factor. Male adult earning member gets adequate quantity and quality food, eat first of all, women eat least and last of all. Boys often get high priority over girls, health seeking behaviour is in favour of boys.

(*Source*: Lal S. Nutrition—A Quarterly Publication of NIN, Vol. 18 No 4 October 1984).

Junk Foods (Processed/Ultraprocessed Foods)

Globalization has brought a lot of changes in food habits of children and adolescents, 'Junk food' refers to 'empty calories' lacking in ideal nutrients and mainly consists of excess of sugar, salt and fats. Most urban population, youth in particular thrive on junk foods, which are refined carbohydrates rich in calories, low in vitamins and dietary fibre. These foods contain lot of calories and lot of saturated fat. Salted snack food, candy, gum, most sweet desserts, fried fast foods and carbonated beverages are considered by most as junk foods.

Junk foods and fast foods are not only calorigenic but leads to obesity and rise of low density lipids and fall of high density lipids (or good cholesterol). The centre has recently asked state governments to ban the sale of junk foods and carbonated drinks on the school premises. Good quality foods like dal, roti, sprouts and green leafy vegetables should be promoted as mid-day meal.

UNDERNUTRITION DURING INFANCY AND ITS PREVENTION

A. Birth weight: The first weight of the fetus or newborn obtained after birth.[3]

- **Low birth weight (LBW):** Less than 2,500 g (up to and including 2,499 g).
- **Very low birth weight:** Less than 1,500 g (up to and including 1,499 g).
- **Extremely low birth weight:** Less than 1000 g (up to and including 999 g).

The prevalence of low birth weight in India in 2017 was 21.4% (Lancet child adolescent health September 2019). However data on LBW in India is inadequate and poor despite 89% of institutional births. According to NFHS-3 data 22% of babies born in India were of low birth weight, while according to UNICEF (2019) report 22% of births were underweight at birth (Table 5.5). Those babies have a poor start of life cycle and are exposed to the risk of morbidity and mortality. Average birth weight in India has not much improved. In India, an average birth weight ranges from 2.7 to 2.9 kg.

Table 5.5: Percentage of infants with low birth weight*

South Asia	*1994*	*2010–2019*
Bangladesh	50	28
India	33	22
Nepal	26	22
Pakistan	25	–
Sri Lanka	25	16

*Human development report: UNDP Oxford University Press, 1994 and the State of World Children 2021 (UNICEF).[3,4]

The problem of LBW in India is widespread and multifactorial. A newborn baby can be LBW because of two reasons:

- Preterm—born before 37th weeks of gestation.
- Intrauterine growth retardation (IUGR)—small for gestational age (SGA).

Intrauterine growth retardation (IUGR) is a problem of great magnitude. Over two-thirds of babies are *small* for *gestational age* (SGA), i.e. they are full term babies, from 37 completed weeks to less than 42 completed weeks (259–293 days) of gestation and remaining one-third are born *pre-term*, i.e. less than 37 completed weeks of gestation (less than 259 days).

The first important cause of malnutrition is—low birth weight itself—a form of malnutrition, which began in mother's womb. Low birth weight is associated with poor growth during infancy and thereafter throughout childhood period.

Retrospectively, low birth weight reflects poor nutritional and health status of women during pregnancy, adolescence and during childhood period.

Causes of LBW

i Adolescent and maternal undernutrition (anaemia)
ii Early marriages and teenage pregnancies
iii Less spacing between births
iv Higher birth orders
v Lack of antenatal care, inadequate diet and IFA supplements
vi Twin births.

Delayed initiation of breastfeeding and inappropriate feeding in newborn period and first year of life exacerbate undernutrition in infants.

Low birth weight is reflection of maternal and foetal malnutrition. The problem of LBW is multidimensional.

Goal: National Nutrition Mission's 2022 Targets: To reduce prevalence of LBW 2% point annually from 2017 to 2022; however WHO and UNICEF target by 2030 is 30% reduction in prevalence from base year 2015.

Prevention of LBW: Public health interventions to reduce the incidence of LBW are—avoid teenage pregnancies, improve the nutritional status of girls, correct anaemia in pregnancy, full antenatal care, rest during pregnancy, malaria prophylaxis and treatment in endemic areas besides improving literacy, spacing births at least 3 years apart and limiting the size of family. Ensure implementation of India's Newborn Action Plan.

Needs of infant (0–6 months of life): Survival, adequate growth and development and prevention of infections.

Strategies for prevention of malnutrition during infancy: Exclusive breastfeeding up to 6 months of age, complementary feeding, immunization, growth monitoring and integrated management of illness.

Exclusive breastfeeding: Promotion of universal exclusive breastfeeding is the national policy and it has

been incorporated in reproductive and child health (RCH) programme as also in integrated child development services (ICDS). WHO in its guidelines recommends exclusive breastfeeding for the 6 months rather than the first 4–6 months.

Promotion of exclusive breastfeeding until the age of 6 months in developing countries through existing primary healthcare services is feasible, reduces the risk of diarrhoea and does not lead to growth faltering. In India 63.7% of babies were breastfed exclusively till 6 months of age.

WHAT IS EXCLUSIVE BREASTFEEDING?

Exclusive breastfeeding implies giving newborn infants no food or drink other than breast milk (including milk expressed or from wet nurse). It allows the infant to receive drops, syrups (vitamins and minerals, medicines). It does not allow the infant to receive anything else.

Breastfeeding Promotion

International code of marketing of breast milk substitutes was adopted by WHO in 1981 and subsequently Indian National Code for protection and promotion of breast-feeding was evolved by Government of India. These codes aimed at provision of safe and adequate nutrition to infants by protection and promotion of breastfeeding and by ensuring proper use of breast milk substitutes when these are necessary. The code applies to the marketing and practices related thereto of following products:

Breast milk substitutes including infant formula, other milk products, foods and beverages, including bottle fed complementary foods; feeding bottle and teats.

In India, the breastfeeding is 'universal practice'. Let it be promoted and preserved. It is the best practice and offers the young infant best feed. Most mothers in India continue breastfeeding up to 2 years or even beyond it; is also best practice for child survival and adequate growth.

From Universal Breastfeeding to Universal Exclusive Breastfeeding

Exclusive breastfeeding in Indian culture is nothing new. It was advocated by UNICEF and WHO in 1989 and thereafter in 1992 by Baby Friendly Hospital Initiative (BFHI) and subsequently World Health Assembly (WHA 54:2;18) May, 2001 adopted the resolution to approve exclusive breastfeeding for first 6 months.

Benefits of Exclusive Breastfeeding

- Breastfeeding within an hour of birth prevents 20% of newborn deaths.
- It ensures intake of colostrum.
- Provides optimal and adequate nutrition.
- No water supplementation is required.
- Reduces risk of various infectious and non-infectious diseases.
- Contributes to better intelligence.
- Promotes emotional development between mother and baby.
- Prevents breast problems in mothers.
- Reduces risk of breast and ovarian cancer; iron deficiency (anaemia).
- Helps in birth spacing.

Goals of Infant and Young Child Feeding

- Enhance early initiation of breastfeeding (**colostrum** feeding) from the current level of 42 to 80%.
- Enhance the exclusive breastfeeding rate for children up to age of 6 months from the current rate of 64 to 80%.
- Enhance the complementary feeding rate at 6 months from the current level of 46 to 75%.

Infant Feeding Practices in India

Recently the NFHS-5 (2019–21) data provided cardinal information on breastfeeding practices in India.

Breastfeeding initiation: Breastfeeding is 'life line' for newborn babies, should be started immediately after birth. In our culture, several ceremonies are performed, these should be performed quickly and breastfeeding should be commenced immediately after birth.

Exclusive Breastfeeding: Recent Report[5]

Nearly 42% of mothers initiated breastfeeding within 1 hour after birth. In India, 64% of children till 6 months of age were exclusively breastfed and the remaining children (36%) received breastfeeding plus fluids and supplementary feeds. As 64% of children were exclusively fed on breast at 6 months of age and thus over 36% of children were exposed to the risk of infections—predominant being diarrhoeal diseases. The introduction of supplementary foods before 6 months of age may put infants at risk of malnutrition because other liquids and solids are nutritiously inferior to breast milk. Consumption of liquids and solid mashed foods at an early age also increases children's exposure to pathogens and consequently puts them at a greater risk of diarrhoea (NFHS-5).

Bottle Feeding

Practice of bottle feeding is prevalent in 16% of mothers this is also a risk factor for diarrhoea and malnutrition in young children.

Feeding Low Birth Weight (LBW) Babies

Mother's milk is the best food for low birth weight babies. The borderline, term, and growth retarded LBW babies can suckle fairly well at the breast and should

be fed on demand. Breast milk saves the lives of LBW babies and ensures growth and development. Mothers need to be adequately supported and even weak babies can suck and can be optimally fed on breast. Breast milk is enough for their requirement, no supplementary foods are needed. However, LBW and other high-risk infants who cannot suckle should be given expressed breast milk in preference to formula feeds by appropriate techniques. Mothers can be helped to express their milk every 3 hours and feeding the expressed milk to the baby with a cup and spoon or if necessary by nasogastric tube, helping the baby to suckle at mother's breast, which helps the babies to develop the ability to suck besides stimulating maternal milk production. Keeping LBW baby with mother 24 hours a day and breastfeeding regularly have been quite helpful (Kangaroo mother care). Breast milk offers nutritional advantage to LBW babies because of its higher proteins, essential fatty acids and electrolyte concentration helps increase in weight. Formula foods are no better for LBW babies.

Ten Steps to Successful Breastfeeding (WHO, UNICEF and BFHI)[6]

Box 5.1: Ten steps to successful breastfeeding (revised 2018)

Critical management procedures

1. a. Comply fully with the International Code of Marketing of Breast-Milk Substitutes and relevant World Health Assembly resolutions.
   b. Have a written infant feeding policy that is routinely communicated to staff and parents.
   c. Establish ongoing monitoring and data management systems.
2. Ensure that staff have sufficient knowledge, competence and skills to support breastfeeding.

Key clinical practices

3. Discuss the importance and management of breastfeeding with pregnant women and their families.
4. Facilitate immediate and uninterrupted skin-to-skin contact and support mothers to initiate breastfeeding as soon as possible after birth.
5. Support mothers to initiate and maintain breastfeeding and manage common difficulties.
6. Do not provide breastfed newborns any food or fluids other than breast milk, unless medically indicated.
7. Enable mothers and their infants to remain together and to practise rooming—in 24 hours a day.
8. Support mothers to recognize and respond to their infants cues for feeding.
9. Counsel mothers on the use and risks of feeding bottles, teats and pacifiers.
10. Coordinate discharge so that parents and their infants have timely access to ongoing support and care.

What we have Done in India?

Baby Friendly Hospital Initiative (BFHI), launched by UNICEF and WHO now recommends that infant should be given only breast milk for first 6 months of their life. Most babies do not require any other foods or liquids during this period. Water supplementation or prelacteal meals are unnecessary and dangerous. Use of non-nutritive liquids is associated with decline in breast milk intake.

India has a written policy on infant feeding (National Guidelines on Infant and Young Child Feeding). However, policy on infant and young child feeding has been revised in 2004 which advocates exclusive breastfeeding for first 6 months, and continuation of breastfeeding up to 2 years of age or beyond and promoting feeding of colostrum.

Government of India has taken positive and effective legal measures to protect breastfeeding from the commercial influence and support women at work. The infant milk substitutes, feeding bottles and infant foods (regulation of production, supply and distribution) Act, 1992 (Infant Milk Substitutes Act) and Cable TV Network Amendment Act, 2000 and revised Maternity Benefit Act 2016 provides of 26 weeks of maternity leave are the examples of supporting women and promoting exclusive breastfeeding. Infant, Milk Substitute (IMS) Act has been further strengthened through 'IMS Amendment Act, 2003' enhancing the protective level and prohibiting advertising baby milk foods.

Mother Absolute Affection (MAA) Programme

This programme focuses on promotion of optimum infant and young child feeding (IYCF) practices including early initiation of breast feeding within one hour of birth, exclusive breast feeding up to 6 months of age and complementary feeding after 6 months and complementary and breast feeding up to 2 years and beyond through capacity building of health workers and IEC campaign.

Breastfeeding during Illness in Young Children

Breast milk is most easily digestible food for an ill baby. Breastfeeding is beneficial in common infantile ailments including diarrhoea and acute respiratory infections. Breastfeeding should be continued during such illnesses. The child may suckle less vigorously or for a shorter time and should receive the feed at more frequent intervals. Exclusive breastfed babies have least chances of developing diarrhoea.

Maternal Illness and Breastfeeding

Most common maternal illnesses do not require discontinuation of breastfeeding. Breastfeeding is recommended even with mastitis, breast abscess and other infections, illnesses including urinary tract infections, tuberculosis, HIV positive mothers, hepatitis and other viral illnesses. If initiation of breastfeeding is delayed for 1 or 2 days, it

can result into breast abscess because of milk stasis. Initiation of breastfeeding immediately after birth is important and helpful and benefits both mother and infant. As soon as the infant starts suckling at the breast, the hormone oxytocin is released, resulting in uterine contraction that facilitates expulsion of the placenta and reduces the risk of postpartum haemorrhage. It also helps in faster involution of uterus.

Colostrum: First milk is rich in nutrients. It is recommended that first breast milk (colostrum) should be given to the child rather than squeezed from the breast and discarded because it provides natural immunity to the child.

Breastmilk Substitutes

If a mother for some reason exclusively cannot breastfed her young child below 6 months, e.g. a working mother, her expressed milk should be given to the child in preference to formula milk. If it is unavoidable to give non-human milk during first 6 months of life, undiluted milk normally consumed by the family should be utilized. Of course such situations rarely arise. For infants, part of excessive fat in buffalo's milk should be removed by separating the cream from milk after boiling and cooling to room temperature.

Breastfeeding and Fertility

Breastfeeding helps spacing children and it is known to the mankind since ancient times. Full and exclusive breastfeeding for first 6 months serves as contraceptive: This method may not have absolute efficacy but it does play an important role in spacing births and preventing pregnancies. Cu-T is highly advisable contraceptive in the postpartum period.

Continue Frequent Breastfeeding up to 2 Years of Age or Beyond

In India, in addition to exclusive breastfeeding till 6 months, continued breastfeeding beyond 6 months up to 2 years or beyond along with other good practices like addition of safe, hygienic adequate and timely complementary food is important to prevent malnutrition in young children. Breast milk provides 413, 379 and 346 kcal/day at 6–8, 9–11 and 12–23 months of age. Since, NFHS-2 indicates that 15.6% of infants are underweight at 0–6 months, 43.3% at 6–11 months and 63.4% at 12–23 months hence breastfeeding is a saviour and prevents malnutrition by providing additional energy.

The global strategy on infant and young child feeding has been adopted by World Health Assembly Resolution (55.25/May 2002) which endorses exclusive breastfeeding and urges the nations to evolve policy on infant and young child feeding and action plans.

Exclusive breastfeeding for first 6 months is a strategy to lower 20% of neonatal and postneonatal infant mortality and this strategy assumes significant for LBW as most LBW babies survive with exclusive breastfeeding and more would die if exclusive breastfeeding was not there—Breastfeeding and Promotion Network of India (BPNI).

WHO Indicators of Breastfeeding Practices

These include:

- Ever breastfed rate, exclusive breastfeeding rate and the timely complementary feeding rate. The exclusive breastfeeding rate is defined as proportion of infants under age 6 months who receive only breast milk.
- Timely complementary feeding rate is the proportion of infants aged 6–9 months who receive both breast milk and solid or semisolid food.
- The continued breastfeeding rate through 1 year of age is the proportion of children aged 12–15 months who are still breastfed. Continued breastfeeding rate until 2 years of age is proportion of children aged 20–23 months who are still breastfed.
- The bottle feeding rate is proportion of infants who are using a bottle with a nipple.

HIV and Breastfeeding

The increasing threat of perinatal transmission resulting in an alarming incidence of pediatric AIDS cases is posing a challenge globally. HIV in industrialized countries is a clear contraindication to breastfeeding. An update review of incidence of mother to baby transmission of HIV through breastfeeding in 1997 estimates that the risk is only 12–14%. In a developing country like ours where the hazards of bottle feeding with formula milk have been well documented including repeated diarrhoeal episodes and consequent malnutrition and deaths during infancy. All mothers should be explained this risk and decision after informed choices should rest with the mother. When children born to women with HIV/AIDS can be ensured uninterrupted access to nutritionally adequate breast milk substitutes that are safely/hygienically prepared and fed to young children are at less risk of disease and death (UNICEF and WHO) if they are not breastfed. More research is needed on this subject.

Protecting, Promoting and Supporting Breastfeeding

Protection means having legal framework and protecting breastfeeding women from commercial influence. Promotion means giving full information to women and families about benefits and advantages of breastfeeding and support means women receive skilled support of health workers, community workers and community.

Health workers should focus on exclusive breastfeeding for first 6 months and continued breastfeeding for up to 2 years along with appropriate and timely complementary foods that are started at the age of 6 months. Mothers need

information support during antenatal, delivery and postnatal period. All contacts during these stages should impart information on breastfeeding and prepare mothers for the act of breastfeeding. Home visits, clinic visits and hospital situations should promote information on breastfeeding. These steps would translate UNICEF and WHO initiative of 1989 to protect, promote and support breastfeeding globally into meaningful action. MAA programme of 2016 further supports this initiative.

National Guidelines on Promotion of Infant and Young Child Feeding (2004)[7]

These guidelines have been prepared by food and nutrition board of the department of women and child development based on the global strategy on infant and young child feeding adopted during the 55th World Health Assembly. The definition of optimal infant and young child feeding practices include:

i Early initiation of breastfeeding within one hour of birth.

ii Feeding of colostrum (first milk).

iii Exclusive breastfeeding for the first 6 months. No other milk, water, sugar, honey to be given during first 6 months of life. No infant milk substitutes unless medically indicated.

iv Continue breastfeeding up to the age of 2 years or beyond.

v Adequate, safe and appropriate complementary feeding at 6 months of age along with breast milk.

vi Staple cereal of the family should be used to make the first food for infant.

vii Encourage time tested traditional family foods (*Khichdi, Dalia, Kheer, Upma, Dokhla,* etc.).

viii Encourage foods which are routinely cooked in the family.

ix Energy density of infant foods should be increased by adding teaspoonful of oil or ghee or butter in every feed or by adding sugar and Jaggery.

x Infant and young child should be fed 5–6 times a day.

xi Appropriate feeding during and after illness.

xii ***HIV and breastfeeding:*** The absolute risk of HIV transmission through breastfeeding for more than 1 year is 10–20%. HIV positive mothers should receive counselling on risk and benefits of various feeding options.

xiii Growth monitoring and promotion.

xiv Feeding in difficult circumstances.

5

Competency addressed: The student should be able to:
CM 5.3: Define and describe common nutrition-related health disorders including protein energy malnutrition (PEM).

COMMON NUTRITION-RELATED HEALTH DISORDERS, THEIR CONTROL AND MANAGEMENT

Preschool children are most vulnerable to the effect of undernutrition because of rapid growth and thus their nutritional status is considered to be sensitive indicator of community health.

In South Asia region, the problem of undernutrition is widespread.

FAO estimates that worldwide 800 million children, women and men are undernourished and malnourished. Over 2 billion suffer from 'hidden hunger'.

MACRONUTRIENT DEFICIENCY DISORDERS OR PROTEIN ENERGY MALNUTRITION (PEM)

India has achieved marvels in food production—achieving self-sufficiency, yet India is home to over one-third of the stunted/wasted children of the world who have protein energy malnutrition manifested by: (i) Underweight—less weight-for-age, (ii) stunted—short for their height, and (iii) thin or wasted—low weight-for-height or acute undernutrition.

The Global hunger index (GHI) released annually since 2006 combines three equally weighted indicators into one index: (a) under-nourishment (inadequate feeding), (b) child wasting and stunting and (c) child mortality. Number of starving people has shot up from 135 million to 224 million out of total 828 million globally.

India ranked lowly at 101 among 107 nations in the global hunger index (GHI) in 2020 and was placed in the "serious" hunger category. About 16.3% of India's population was under-nourished. India's rank was at 107 out of 121 countries in 2022. The 2021 GHI shows alarming situation of hunger as 2.37 billion people were without access to adequate food.

Since 2000 India has made substantial progress as India's GHI score has decreased from the 2000 score of 38.8 points—Classified **alarming** to a 2022 GHI score of 29.1—Considered **serious**.

EPIDEMIOLOGY OF PROTEIN ENERGY MALNUTRITION

Prevalence

Recent National Family Health Survey 5 reveals that 32.1% of under-5 children are **underweight**, 35.5% are **stunted** and 19.3% are acutely malnourished (**wasted**). India's child wasting rate at 19.3% being the highest in the world. More importantly 7.7% of children suffered severe acute malnutrition (SAM). CNNS 2016–18 gives almost same prevalence rates (Table 5.6).[5] 2% of children under five were overweight or obese. NFHS-5 indicates that 3.4% of children were overweight or obese up from 2.1% in NFHS-4 due to consumption of junk foods.

Table 5.6: Trends in prevalence (%) of underweight, stunting and wasting in children below 5 years of age in India

Indicator	*NFHS-1 (1992–93)*	*NFHS-2 (1998–99)*	*NFHS-3 (2005–06)*	*HUNGaMA (2011)*	*NFHS-4 (2015–2016)*	*CNNS* (2016–18)*	*NFHS-5 (2019–21)*
Weight-for-age (current and past malnutrition)							
Underweight < –2SD	51.5	42.7	43	42.0	35.7	33.4	32.1
Severely underweight < –3SD	20.6	17.6	15.8	16.4	–	10.1	
Height-for-age (chronic malnutrition)							
Stunted < –2SD	52.0	51.0	48	59.0	38.4	34.7	35.5
Severely stunted < –3SD	28.9	27.7	22.0	34.0	–	13.2	
Weight-for-height (Acute malnutrition)							
Wasted < –2SD (MAM)	17.5	19.7	20	11.4	21.0	17.3	19.3
Severely wasted < –3SD	3.2	6.7	6.4	3.3	7.5	5	7.7
Severe acute malnutrition (SAM)							
n =	**25578**	**24215**	**26541**	**109093**	**NA**	**38060**	**NA**

Ref: *CNNS—Comprehensive National Nutrition Survey (GOI). MOHFW, UNICEF, and Population Council 2019, New Delhi

Geographical Distribution (NFHS-4 2015–16)

PEM is a widespread problem in all the states of India, however, the worst affected states due to severe PEM are; Bihar, Madhya Pradesh, Rajasthan, UP, Karnataka, Maharashtra, AP, and Meghalya, Uttarakhand, Haryana and West Bengal and Odisha (Kalahandi, Bolangir and Koraput) bear most brunt of PEM). These are the most populous states of the country and all other health indicators are also low in these states; hence special efforts are required in these states to mitigate the problem of undernutrition. As per CNNS and NFHS 5 malnutrition in children continues to be a public health problem (Tables 5.7 and 5.8).

Rural/Urban Distribution

Higher proportions of rural children are suffering from PEM as compared to urban areas. Urban slum areas have as much prevalence of PEM as in rural areas and more often the situation of PEM in urban slum areas may be worse than rural areas because of poor living conditions and presence of all the risk factors for malnutrition.

Gender and PEM

Usually prevalence of severe malnutrition is much more in young girls as compared to young boys below 5 years

Table 5.7: Geagraphical distribution of malnutrition among children 0–4 years (CNSS–2016–18) in India figures in %

States	*Stunting (chronic mal)*	*Wasting (acute malnutrition)*	*Underweight*
Assam	32.4	19.4	29.4
Bihar	42.0	14.5	38.7
Meghalya	40.4	12.9	30.0
Madhya Pradesh	39.5	19.6	38.7
Gujarat	39.1	17.0	34.2
Uttar Pardesh	38.8	18.5	36.8
Rajasthan	36.8	14.3	31.5
Jharkhand	36.2	29.1	42.9
Chhattisgarh	35.4	19.3	40.0
Haryana	34.9	11.7	28.8
Maharashtra	34.1	16.9	30.9
Tamil Nadu	19.7	21.0	23.5
West Bengal	25.3	20.1	30.9
Karnataka	32.5	19.0	32.0
Odisha	29.1	13.9	29.2
Telangana	29.3	17.9	30.8
Andhra Pradesh	31.5	17.1	35.5
Tripura	31.9	12.8	23.8
India	35	17.0	33

Table 5.8: Prevalence of severe acute malnutrition in different states of India in 0–4 years children (CNSS 2016–18) figures in %

Level of SAM in percentage	*States*
1–1.9	Arunachal, Sikkim, Uttrakhand
2–4.9	Bihar, WB, Meghalya, Karnataka, Delhi, HP, Manipur, Rajasthan, Haryana, Punjab, Odisha, Mizoram, Kerala
5–8	Tamil Nadu, Gujarat, Andhra, Tripura, Assam, Maharashtra, MP, Chhattisgarh, Jharkhand, Telengana, Goa, Jharkhand, UP

Highest severe acute malnutrition was observed in Tamil Nadu (8.1%), Assam (7.8%), Gujarat, Jamu and Kashmir (6.9%) Madhya Pardesh (6.6%) and Jharkhand (6.4%), respectively.

of age. This is due to differential child rearing practices observed including feeding and healthcare seeking behaviour.

Age Group Affected and Feeding Practices

It has been observed that the prevalence of PEM is lowest in children below the age of 6 months. The prevalence levels are at peak in age group 12–23 months and thereafter it is maintained around that level. Critical age at which undernutrition starts is around 6 months and growth faltering is at peak in second year of life, hence growth monitoring programme which aims at prevention of undernutrition must cover these children at home and discuss with mother the growth of respective child. Growth monitoring should be integrated with routine outreach sessions of immunization.

Reasons for this are quite obvious. Up to 6 months, the babies thrive well on breast milk which is adequate for normal growth and development, thereafter the baby needs supplementary feeds in addition to breastfeeding. Most mothers delay the weaning (giving complementary or supplementary foods) in young children and secondly the quantities of foods given are quite inadequate for normal growth and development. Cereals are deliberately not encouraged or are given in very small quantities due to wrong beliefs, customs and misinformation.

Seasonal Variations

Malnutrition is maximum when children are less cared for or left under the care of mother substitutes during peak harvesting period—April and May, or September–October when mothers are away for long hours of work in the field. In North India, malnutrition is maximum during summer and that is the peak season for diarrhoeal diseases as well. Diarrhoea is one of the most important nutritional leak; it drains away fluids and nutrients from the body. Withholding of foods and liquids worsens the nutritional status and exposes the children to high mortality.

Literacy and Castes

Undernutrition in children below 4 years is higher in economically weaker sections (scheduled castes and scheduled tribes). There is strong correlation between the educational level of the mother and the child's nutritional status.

Secular Trends of PEM

Severe forms of PEM have diminished. The NNMB data shows declining trends of prevalence of PEM (underweight and stunting) including severe underweight—below 3SD. There is almost 1% decline per annum. NFHS and ICDS data also have shown declining trends of undernutrition. However, prevalence of wasting and severe wasting has stagnated overtime at 19.3% and 7% respectively (Table 5.5).

Small remains small: Stunted children, severely malnourished and low birth weight babies may grow as stunted adults thus poorly contributing to the economy and low levels of scholastic attainment and poor work capacity.

Mortality due to PEM

Malnutrition is considered to be underlying cause of 36% of all deaths in young children. Those who are severely malnourished have 15–20% more chances of dying as compared to well-nourished children.

Poverty

Undernutrition has no correlation with per capita income. 21.9% of people in India live below poverty line but level of undernutrition in India is much higher at 36% or over. Poverty alone cannot explain this level of malnutrition. Even poorest of poor have enough of grains for young children, e.g. breastfeeding and 50 to 120 g of cereals per young child per day is affordable. Economic intervention or giving employment to below poverty line to raise their income is necessary but not sufficient.

Household Food Security

Similarly increasing food production and availability of food at household level is essential but not sufficient to improve nutrition. Food grain production has risen from 89 million tonnes in 1965 to 316 million tonnes in 2021–22 and in the past we had enough of buffer stocks of 60 million tonnes. Every home has enough of grains but brains **(best practices)** are essential for food distribution within the family and improving dietary practices. Best of food is available in home and farms hence promote indigenous foods. Government of India spends 24000 crores for subsidized food grains for below poverty line people through Targeted Public Distribution System. Food production and distribution is no guarantee for good nutrition.

Food availability at the household level is seldom a problem. A young child requires 120 g of complementary food (rice or cereal) to obtain enough of calories and

nutrients. Problem is that cereal-based complementary foods are bulky and it needs to be made energy dense by addition of oil and ghee and frequency of feeding should be 5–6 times per day.

Minimum dietary diversity (food from 5 or more food groups), minimum meal frequency and minimum acceptable diet are necessary for young child feeding.

Causes of PEM: Inadequate Feeding and Infections

(a) Inadequate Feeding and Delayed Weaning or Starting of Complementary Food PEM is Primarily due to Food Gap or Food Deficiency

Exclusive breastfeeding should be adequate for a child up to 6 months of age. Data on growth monitoring indicates that the growth of many children falters earlier, reflecting either inadequate or partial breastfeeding practice (inadequate feeding and less frequency, inadequate diet of lactating mother and introduction of non-nutritive food through bottle or other means which decreases the flow of breast milk). Most mothers do not give adequate quantities of food to their young children beyond 6 months of age. NFHS-5 data indicates that nearly 64% of breastfed children aged 6–8 months received solid or semisolid food. For first 6 months infant needs 550 calories per day and 670 calories from 7–12 months of age.

(b) Infections and Environments

Unclean food, utensils and dirty hands, unsafe water and unsafe excreta disposal leads to infections and most common being diarrhoea and worm infestation. Repeated attacks of diarrhoea and acute respiratory infections are important nutritional leaks which lowers the nutritional status. Continuing feeding during illness and more diet during convalescence period is essential for catch-up growth. Adequate eating during illness reduces the severity of illness and gives energy to the body, leading to fast recovery.

High Fertility: Low Birth Interval

India has reduced its TFR to 2, Large-sized families and closely spaced births and higher birth orders are exposed to the risk of low birth weight babies and more malnutrition of women in child-bearing age because of repeated pregnancies on account of early marriages and non-acceptance of contraception.

Spectrum of PEM

The spectrum of protein energy malnutrition is quite wide. It begins with inadequate birth weights (22–28% of newborns have birth weight below 2.5 kg), passes through the period of growth faltering or inadequate weight gains during infancy and in second and third year of life. Inadequate growth and growth faltering is the earlier sign and mothers can best judge this and if this is supported by growth monitoring programme, the growth faltering can be detected at the earliest. The advanced stages of malnutrition like marasmus or typical kwashiorkor (which is now rare) is the end spectrum of PEM.

By the time, the overt clinical signs of malnutrition appear it is too late a stage of undernutrition. Marasmus is just the tip of the 'iceberg' of overall prevalence and problem of undernutrition.

Competency addressed: The student should be able to:
CM 5.2: Describe and demonstrate correct methods of performing a nutritional assessment of individuals, families and community by using the appropriate method.

Objective: The Learning objective of this skill is to assess the extent of malnutrition in an area and nutritional status of person.

How? The learner weighs, measures height, mid-upper arm circumference of at least 2 under five children, plots weight on growth chart, interprets and explains actions to mother/care giver. Student also carries out dietary survey, collects information on dietary diversity, meal frequency and a minimum acceptable diet for 6–23-month age children.

CORRECT METHODS OF PERFORMING A NUTRITIONAL ASSESSMENT OF INDIVIDUALS, FAMILIES AND COMMUNITY BY USING THE APPROPRIATE METHOD

A. Anthropometric measurements are the mainstay of assessment of PEM or undernutrition or overnutrition. WHO, ICDS, NNMB, NFHS and CNNS all have used anthropometric measurements. Commonly used measurements are:

1. Weight-for-age to assess degree of 'underweight'—an indicator of acute malnutrition.
2. Height-for-age to assess degree of 'stunting'—an indicator of chronic malnutrition.
3. Weight-for-height to assess degree of 'wasting'—an indicator of current malnutrition.
4. MUAC measures acute severe malnutrition.
5. Waist circumference.

Each of the four nutrition indicators is expressed in standard deviation units (Z scores) from the median of reference population.

In April 2006, the WHO has released the WHO Child Growth Standards replacing NCHS standards. These standards establish breastfed infants as the normative growth model. The weight-for-age measurement can be viewed as summary indicator of a child's nutritional status and a composite of both wasting and stunting.

B. Clinical Signs of Malnutrition

Deficiency signs appear late and can be recognized by health workers. Most important signs are anaemia, goitre, vitamin A deficiency (Bitot's spots), angular stomatitis, signs of rickets, oedema of the feet, and marasmus or wasting and obesity.

C. Subclinical Malnutrition

Biochemical changes can be detected by laboratory tests. Haemoglobin estimation, serum level of retinol, iron,

vitamins, urinary iodine can be estimated. These tests are done for specific purposes. Laboratory facilities require trained manpower and usually these facilities are not available.

D. Dietary Surveys in Family and Community

Dietary surveys are done to assess the dietary intakes; qualitatively and quantitatively with a view to improve the dietary practices and improve the diets of family and most vulnerables (*see* page 180 for detail).

Assessment of Nutritional Status by Anthropometric Measurements

The most commonly used measurements are body weight, height or length and mid-upper arm circumference and fat fold at triceps.

Weight-for-age by Salter Scale/Digital Seca Scales

Weight-for-age is the robust parameter, most widely used and practical method to monitor growth and assess the nutritional status of young children. It is most sensitive and simple measurement which indicates improvement or deterioration of nutritional status. Weight-for-age measures current as well as past nutritional status. Single measurement is not sufficient to decide the nutritional status, it is much better to have serial weights at an interval of 1 month during first 3 years of life and thereafter once in 3 months. It is the direction of growth which matters most. Weighing children and putting it on growth charts make the invisible malnutrition visible much before the clinical signs of malnutrition become visible. The system of ICDS which is world's largest outreach programme for mothers and children is using growth charts for growth monitoring and promotion.

Height-for-age (HFA)

Height of an individual is determined by genetic and environmental factors (adequate diet and infections). Height once gained is not lost. Height-for-age measures chronic malnutrition (stunting) or long standing malnutrition. If the height-for-age is low the child is called *stunted*. This has been included in ICDS Growth charts now. Mobile team under RBSK measures height of children at *Anganwadi*.

Weight-for-height

This measurement is useful to assess current nutritional status or *wasting.* This is age independent measurement. Weight-for-height chart has been added in MCPC Jointly prepared by MOHFW and MOWCD.

Absolute Mid-upper Arm Circumference (MUAC)

MUAC is age independent measurement to assess the acute malnutrition. It is simple, does not require any sophisticated equipment and is acceptable. MUAC can be measured by fiberglass tape) or by tricolour tape. The cut-off level is 12.5 cm. Children in age group 6 to 59 months who have MUAC of 125 mm or above are considered as normal. Children having MUAC between 115 mm and 125 mm are classified as moderately malnourished while those below 115 mm are classified as severely malnourished. Recently, it has been suggested that MUAC of less than 115 cm should be used to pick-up severely acute malnourished children. MUAC is used to screen malnutrition or nutritional status rapidly by paramedical workers, AWWs and even by mothers.

Classification of Degree of PEM (Fig. 5.2)

Underweight: Means children aged 0–59 months who are below minus two standard deviations and severely underweight means below minus 3SD from median **weight-for-age** of WHO child growth standards, 2006.

Stunting: Children aged 0–59 months who are below minus two standard deviations from median height-for-age of the WHO reference population are called *stunted* and those who are below minus three standard deviations from median height-for-age are called *severely stunted*.

Wasting: Children aged 0–59 months who are below minus two standard deviations from median weight-for-height of the WHO reference population are called *wasted* and those who are below three standard deviations from median weight-for-height are called *severely wasted* children [severe acute malnutrition (SAM)] Fig. 5.4.

Expected outcome: The student assess the nutritional status of young child and carries out dietary survey in allotted family or in anganwadi centres.

PREVENTION, CONTROL AND MANAGEMENT OF PROTEIN ENERGY MALNUTRITION

The first 1,000 days—from the point of conception to child's second birth day are crucial for nutrition intervention.

The problem of protein energy malnutrition is a complex problem and involves many sectors, i.e. the people, households, the governmental and non-governmental organizations. Essentially, it involves the following.

Nutrition Education: Behaviour Change Communication to Prevent Malnutrition

i Adequate eating or enough food for young children at home, improving dietary and hygienic practices in young children by nutrition education under 'Poshan Abhiyan'.
ii Prevention and control of common infections in children.
iii Use of iodated salt only by all and specific nutrients.

Essentially, integrated approach is required to mitigate malnutrition. Mother holds the key position for prevention and improvement of nutrition of young children.

Prevention and Control of PEM

To begin with we laid heavy emphasis on 'proteins' (protein fiasco) to tackle the problem of PEM, but soon

we realized that the major issue was 'food gap' or energy gap for PEM and hence emphasis shifted from 'protein' to adequate or sufficient eating of food to mitigate the problem of PEM.

1 ***Breastfeeding:*** Initiation of breastfeeding soon after delivery, exclusive breastfeeding for first 6 months of life and continuation of breastfeeding up to 2 years or longer prevents malnutrition and ensure adequate growth and development. In India, steps have been taken for protection and promotion of breastfeeding by implementation of Infant Milk Substitutes Act, 1992 and MAA (Mother's Absolute Affection 2016) programme.

2 ***Complementary feeding:*** At 6 months, in addition to breastfeeding, adequate complementary food should be introduced to meet the nutritional requirements for adequate growth. Food cooked at home should be given to young children. Best nutritious foods are available in home and farm. Sufficient household food security exists in family. Infant and young child feeding guidelines should be followed in letters and spirit. Minimum dietary diversity—consuming 4 or more food groups in a day, minimum meal frequency of solids and semisolids 2–4 times and minimum acceptable diet must be ensured to meet the requirement of 1010 calories per day for 1–3 year age group children.

3 ***Growth monitoring (GM):*** GM is a preventive strategy it should begin soon after birth or even before birth.

4 ***Immunization:*** Children should be given all immunization at right age. Measles immunization prevents malnutrition and first mega dose (1 lakh IU) of vitamin A should be given along with measles immunization.

5 ***Control of infections:*** Hygienic practices, like washing hands, clean food; use of safe drinking water and safe disposal of human excreta prevents diarrhoeal diseases and worm infestation and thereby it prevents nutritional leaks in young children. If the child develops diarrhoea, the first response should be enough of home available fluids and ORS and continuation of breastfeeding. Feeding in young children will prevent deaths and this also prevents malnutrition and ensures early recovery. Feeding during diarrhoea should continue. Increased frequency of feeding after diarrhoea helps catch-up growth in young children. Periodical deworming in young children is being done on National Deworming Day to cover 1–19 years old to reduce worm load.

6 ***Supplementary feeding programmes:*** Home foods are best foods. Supplementary nutrition programme for children, pregnant and lactating mothers and adolescent girls are there under integrated child development services (ICDS). These foods are supplementary only, unless the child eats enough food at home the supplementary feeding at *Anganwadi* will not help. Severely malnourished children get double the amount of supplementary food from *Anganwadi* (therapeutic feeding). Supplementary feeding programme of ICDS has extensive coverage of children under 6 years of age, but it is difficult to say if it leads to improvement of malnutrition in young children. Targeted supplementary nutrition and therapeutic nutrition to most vulnerable children and poor section of people or below poverty line families can be helpful. Supplementary nutrition programmes (SNPs) have been used as 'Spring board' to attract children and mothers to increase the attendance, to develop other activities like non-formal education and creative activities, growth monitoring, developing good habits like washing hands and brushing teeth, and to educate mothers.

7 ***Specific nutrient supplementation—national iron plus initiative (Iron and folic acid and vitamin A prophylaxis):*** Helps to mitigate micronutrient deficiency in children, pregnant and lactating women and adolescent girls.

Competency addressed: The student should be able to:
CM 5.5: Describe principles of nutrition rehabilitation.

HOW? Students should visit NRC.

8 ***Management of children with severe acute malnutrition (SAM):*** SAM can be categorized into: SAM with medical complications and SAM without medical complications.

Nutrition rehabilitation centres (NRCs): Inpatient management of SAM with complications can reduce the mortality in young children. NRCs have been set up at District and FRU/CHC level. Therapeutic nutrition is provided to such children and mothers are educated/trained. Complications are managed and after the child attains 15% of weight gain he or she is discharged. However, NRCs cannot handle 8 million load of SAM of which 85–90% do not have medical complications. Hence, community-based programme for management of SAM should be in place where home and family takes responsibility[8] (*See* 'Sneha Shivirs' under ICDS). If child is 6 months or older with no medical complications offer ready-to-use therapeutic food (RUTF) for conducting appetite test.

9 ***Nutrition of adolescents, pregnant women and lactating mothers:*** Malnutrition have intergenerational effects. Improving nutrition of adolescent girls and boys should become prime concern and it should be considered as good investment. Adequate nutrition to young girls is of paramount concern to prepare them for safe motherhood. Nutrition education and supplementation of iron and folic acid to adolescents is essential to prevent and treat

anaemia and to ensure good reproductive health. Right age of marriage and adequate nutrition of pregnant women will prevent low birth weight babies and also lower the maternal morbidity and mortality. Adequate nutrition of lactating women ensures adequate breast milk, so essential for child survival, growth and development. Women nutrition and women development ultimately helps healthy child growth.

10 ***Food production and distribution:*** India has achieved marvels in food production, to achieve not only self-sufficiency but have adequate buffer food stocks, through green revolution, white revolution and blue revolution. Food grain production of over 316 million tonnes during the year 2021, ensures reasonable food security at national level and the programmes of poverty alleviation and targeted public distribution system further ensure food security at 'household level' through increased purchasing power and access to highly subsidized food grains. Thus, graduating from 'food security' to 'household food security' to 'nutrition and health security' of all and more so of vulnerable becomes a prime task and agenda.

11 ***Public distribution system and targeted public distribution system (Food Security Act, 2013):*** Public distribution system (PDS) has become targeted public distribution system (TPDS) and covers below poverty line families. With a network of 4.62 lakh fair price shops (FPS) distributing commodities and spending more than 30,000 crores annually to reach about 160 million families. The PDS in India is perhaps the largest distribution network in the world. TPDS provides 25 kg of rice or wheat per month at 50% of economic cost (₹ 3/kg for rice and ₹ 2/kg for wheat). Besides this 35 kg of food grain is provided to the poorest of poor families under the *Antyodaya Anna Yojna* at a highly subsidized rate. Coarse grains will be provided at ₹ 1 per kg.

Annapurna Yojna: Under this scheme, old destitute individuals who are not receiving old age pension are entitled to 10 kg of grain per month free of cost.

Though the government has taken all possible steps to make available food grains to the poorest of poor, it has however been observed that off-take of food grain under BPL category has not gone beyond 55% during the preceding 2 years. On one hand, we have one of the largest public distribution system in the world with government spending over ₹ 30,000 crores on food subsidy, yet many people are going without adequate food and 36% young child population (0–5 years) suffer from malnutrition. This is a paradoxical situation, which speaks of 'poverty' in 'plenty'. Many of the states are unable to lift the food stocks collected by the central government due to their poor financial health and political will. Thus, the record production of food grains and adequate buffer stocks are no guarantee against malnutrition.

12 ***Mahatma Gandhi National Rural Employment Guarantee Act and Scheme:*** To increase food security and purchasing power as per Act any adult in rural area who applies for work is entitled to being employed on public works within 15 days. The work guarantee is limited to 100 days per household per year.

13 ***Fight against hidden hunger (micronutrient deficiency)*** should focus on food-based approach. Fighting micronutrient deficiency through food fortification technology is yet another gimmick to divert the attention of common man to obtain micronutrients through fortified foods rather than promoting local initiatives. It is killing of local initiatives and capacity to fight the scourge of anaemias, vitamin A deficiency, through consumption of green leafy vegetables and locally grown fruits and vegetables. Delivering micronutrients through lozenges, sugar, oil, wheat flour, and other ready to eat foods appears to be a trap to eliminate local capacities and initiatives in a systematic manner, apart from changing dietary habits of people and promoting a particular product, which may have deleterious effect in the long run. Micronutrients supplementation programme of vitamin A and IFA should be focused and targeted to children in age group of 1–3 years and universal iodized salt consumption should be strived at.

14 Though we have world's reputed National Institute of Nutrition in India, universities, food and nutrition board, home-science colleges and medical colleges, district training centres apart from regional training centres and NIPCCD to train manpower on nutrition and health, enough of ready-made nutritionists, besides information technologies like mass media and print media and evidence/database on nutrition, but still we are not able to **communicate effectively** with the mother or household who ultimate need our help to translate nutrition knowledge into action.

15 ***Population control and stabilization:*** India was the first country in the world to formulate a National Family Welfare Programme in 1952. The objective of the policy was 'reducing birth rate' to the extent necessary to stabilize the population at a level consistent with the requirement of national economy. National population policy 2000 agenda is being pursued speedily. Birth rate has decreased to 19.5 per 1000 in 2020. Unless we control the numbers, the problem of malnutrition will continue.

Having fewer number of children, spacing births at least 3 years apart will prevent low birth weight babies and improve the nutritional status of women and their quality of life as also quality of life of children. Every

household has voluntarily to decide the number of children they wish to have.

16 The **National Nutrition Policy** adopted in 1993 advocated comprehensive intersectoral strategy for alleviating the multifaceted problem of malnutrition. National plan of action on nutrition launched in 1995 has not resulted into actions on the ground level and most of the sectoral commitments are on paper.

***Goal of 12th plan*:** Reduce malnutrition among children of age group 0–3 to half of its present level.

Our response to malnutrition and undernutrition: Right from the beginning we heavily relied on feeding programmes and over-emphasized on 'protein component' but the wisdom soon prevailed and we realized that the real culprit was 'food gap' rather than protein gap. Our energies and resources got diverted towards growing and producing more of animal's and vegetable proteins; through applied nutrition programme. Standard teaching and training programmes also adhered to protein protocol. Subject of nutrition drew the attention of planners in successive 5-year plan and it was considered as an important area of 'minimum need programme' under Fifth 5-Year Plan. Food and nutrition was embodied as one of the essential elements of primary healthcare.

Competency addressed: The student should be able to:
CM 5.5: Describe the principles of nutrition education in the context of socio-cultural factors.

HOW? The students should observe growth monitoring and nutrition education session at Anganwadi centre and prepare nutrition education messages.

Principles of Nutrition Education

The whole science of nutrition is based on effective communication strategy for behaviour change. Invariably, too much of technical knowledge and all book recipes are handed over to mothers for improving dietary practices which are in conflict with the cultural and economic conditions of family hence seldom acted upon. Local workers can communicate best of nutrition messages provided, they are imparted good training in their locale. Learning resource and communication material on nutrition is so much variable that there are conflicting messages and contents thereof. Standard communication material on nutrition needs to be evolved and acted upon as part of curriculum of all categories of professionals and workers. Local data and worker's own data and information must be put to use to increase the ownership and measure the success of **best practices adopted at local level/household level and success must be attributed to mothers/parents/care givers**.

Malnutrition is to be fought through integrated health, nutrition and educational activities focused on vulnerables and BPL families. Convergence of services at village level through integrated child development services and self-help groups of women and village *Panchayats* holds much more promise. Building capacities of mothers and women at household level through integrated efforts can enhance the nutritional status of women and children. *Promotion of breastfeeding, exclusive breastfeeding up to 6 months of age, adequate home available complementary feeding along with breastfeeding, eating clean along with washing hands and immunization at right age and household response to diarrhoea and acute respiratory infections can ensure adequate nutrition, growth and health of young children.*

ICDS programme laid more stress on detection and reporting of malnutrition by weighing children, rather than preventing malnutrition through supporting mothers and building their capacities at household level. Wherever the *Anganwadi* workers adopted this strategy the results were obvious and success was sure. Mothers and *Anganwadi* workers together were winner to ensure healthy growth of young children. Mothers attributed the success to adequate feeding and adequate household response to illness, along with utilization of health services.

Key Principles

- Mothers hold the key for improvement of nutritional status of young children. They must be supported, educated and empowered by the health/ICDS system.
- Native workes such as AWWs, ASHAs can deliver best nutrition education messages and involve mothers in growth monitoring of young children.
- The nutrition education messages should not be in conflict with local beliefs and cultural practices.
- Encourage home available cereals pulses and cooked foods rather than special recipes.
- Key messages on health and nutrition be integrated with growth monitoring and primary healthcare.

Assessment of Nutrition Education Needs

Nutrition education needs have been assessed in India by NFHS. Major objectives of nutrition education are:

- Promote early initiation of breast feeding within one hour of birth and feeding colostrum from current level of 42% in 2021 to 80% by 2024.
- Enhance exclusive breast feeding from current level of 63.7 to 80% by 2024.
- Improve adequate diet in 6–23 month old children from 11.3 to 20% by 2024.
- Improve ORS use rate from current level of 51 to 80% by 2024.

- Reduce anaemia prevalence in pregnant women lactating mothers adolescent girls and children at the rate of 3% per annum by dietary improvements.
- Reduce underweight, stunting and wasting and LBW at the rate of 2% per annum by dietary interventions. Nutrition education messages are being beamed at pregnant, and lactating mothers through, KILKARI, MCTS, and ANMOL programme.

Nutrition Education Messages

- Initiate breastfeeding within one hour of birth.
- Exclusive breastfeeding is complete food for child up to 6 months of age.
- Colostrum feeding is beneficial, it provides ready made antibodies/immunity.
- Adequate, safe complementary feeding at 6 months of age along with breastfeeding, continue breastfeeding up to 2 year of age.
- Space births 3 years apart—use spacing methods.
- Wash hands before feeding. Clean food, clean hand, clean utensil and safe water prevent diarrhoea.
- Continue feeding during illness.
- Use ORS/home available fluids to prevent dehydration when diarrhoea strikes.
- Deworming every 6 months (1–19 years of age) and use of sanitary latrines reduces worm load and improves nutrition.
- Traditional family foods cooked routinely at home are best complementary foods (Khichri, dalia, upma idli, Dokhla, wheat porridge, rice and dal).
- Pregnant women should take one extra meal for foetal growth.
- Lactating mothers need to eat one extra meal to produce enough breast milk.

Target Groups for Nutrition Education (NE)

Address key nutrition concerns of target groups: Adolescent girls, pregnant women, lactating mothers and mothers having children below 2 years of age (first 1000 days of life).

Key Persons Responsible for and Frequency of NE

Key persons responsible for nutrition education (NE) are AWWs, ANMs and ASHAs. Once a month every month during growth monitoring session and mothers meetings on 8th and 22nd of every month under Poshan Abhiyan and on 15th of every month at Village Health Sanitation and Nutrition Day besides regular home visits.

Media and Channels for NE

Group meeting with mothers, inter-personal communication (one to one) with mothers during home visits and demonstration of weighing and monitoring growth on weight charts and actual demonstration of feeding children at *Anganwadi*/cooking by mothers, besides TV and radio–audio messages.

Tracking/follow-up

To sustain behaviour change regular contacts with mothers by home visits and on follow-up days of growth monitoring are essential.

Evaluation

Workers themselves evaluate the results of sustained nutrition education activities/sessions by:

- Growth monitoring on growth charts (MCPC), and observing feeding practices during home visits.
- Home based newborn and young child care and post-natal care and
- During annual household surveys to measure outcome/impact of NE.

GROWTH MONITORING (A PREVENTIVE STRATEGY) AND NUTRITION SURVEILLANCE

GROWTH MONITORING

Definition

Growth monitoring means regular weighing and measuring height of young children at agreed upon interval (1 month during infancy, 2 months in second year of life and 3 months thereafter) to measure the growth of young children with a view to detect any deviation at the earliest from the normal path of growth and ensure prompt action.

The growth monitoring is a preventive and promotive strategy. Ideally, it prevents malnutrition and promotes healthy growth. *It makes invisible malnutrition visible.*

Growth monitoring detects the malnutrition at the earliest much before the clinical signs of malnutrition appear. Weight for height charts are now in use at Anganwadi.

Uses of Growth Monitoring

Growth monitoring is a preventive strategy. There are several uses of growth monitoring:

a. To detect the malnutrition at the earliest and correct it by means of suitable intervention or action at home.
b. To monitor the growth pattern of young children over a period of time (from birth to infancy or in second or third year of life).
c. To assess the nutritional status of young children at a given point of time or period.
d. To assess the weight gain pattern in different ages.
e. To select beneficiaries for supplementary and therapeutic nutrition. It is a useful epidemiological tool to study the child on longitudinal basis for prospective studies or cohort studies on growth, morbidity and mortality.

f A useful tool for effective communication for behaviour change (improving dietary practices in young children).

g To demonstrate and observe effectiveness of an intervention or action (supplementary feeding, therapeutic feeding and IFA supplementation and prompt response to illness (diarrhoea, measles, ARI, fever, etc.).

h To promote integrated maternal and child health interventions.

i In the long-run growth, monitoring can be used as a tool for **nutrition surveillance**.

j It helps to identify various risk factors for growth faltering in population and above all it is a mean to establish contact with home, mothers, parents and families.

Periodicity

Growth monitoring (GM) should begin immediately after birth. All births should be weighed, to help families and mothers, for their survival and growth. Immediately after delivery in hospital, all births should be weighed. In home delivery situation, it is to be ensured on the day of birth by home visit. ASHAs and AWWs have been made responsible for home based newborn and postnatal care and weighing of newborns but in practice, coverage is very low. Since *Anganwadi* workers and ASHAs are locally resident workers, it is feasible to weigh all births and ensure appropriate action.

In family—parents and mothers usually do not allow weighing on cultural reasons, but by motivating and preparing families and pregnant women during antenatal care this barrier can be crossed.

Ideally, during first year of life, the infant should be weighed every month and in the second year of life after every 2 months and thereafter once in every 3 months, up to 5 years of age. Severely malnourished children should be weighed every month irrespective of age. Sick children and severely malnourished children should be weighed more frequently. In ICDS, children below 3 years are being weighed once a month and children between 3 and 5 years weighed every 3 months.

Integrated Approach

Growth monitoring has been integrated into mother and child protection card (MCPC) which also includes weight for height measurement. Growth monitoring can be a rewarding experience when it is integrated with primary healthcare and combined with outreach session of immunization at sub-centre or at *Anganwadi*. All pregnant women should also be weighed. Mothers themselves can weigh their children or participate actively in growth monitoring process to ensure all actions for adequate growth. *Anganwadi* workers must encourage all mothers to weigh their children and see the result of growth on the charts and scale. Ideally, growth monitoring should be handed over to mothers. It has been integrated with integrated management of neonatal and childhood illness (IMCI) and monitoring of developmental mile stones to detect development delay at the earliest. Red flag signs of development issues are being identified for early referrals.

Custodian of Growth Charts

Growth charts have been designed for mothers and families. It should be with mother and she should be the custodian. Mothers must understand and they should be educated and helped by *Anganwadi* workers. In practice, the growth charts are kept in a book form safely with *Anganwadi* workers and seldom shown to mothers. During the training of workers, it should be stressed that growth charts belong to child and mother and it should be at home, valued as home-based record such as MCPC.

Tool for Communication/Nutrition Education

Growth charts are means of communication with mother and family and all workers should use this tool to educate mothers and build upon her all preventive and promotive practices, such as spacing between births, exclusive breastfeeding, adequate feeding at right age, clean eating, continue breastfeeding and feeding during illness and early and prompt response to diarrhoea and other illnesses and prevention of illness by accepting immunization. Visible growth on the chart can be demonstrated to mothers or still better is to show the well-nourished and adequately growing children to mothers and convince them the value of adequate feeding. On several occasions *Anganwadi* workers have shown and demonstrated effectively to mothers the growth of same age group children, eating well, eating enough and growing well and some who do not eat enough and do not grow well. How effectively this tool is used depends on how well the workers have been trained and supported by the supervisors on their job functions.

Caution

Growth monitoring should not begin and end-up with data collection and report preparation or just as a medical encounter, it is an opportunity for contact and education of both worker and mother and is an effective **means of communication**. This opportunity should never be missed. Messages on feeding and growth can be effectively communicated at right time to the precise need of mother and child.

System of Growth Monitoring

The largest outreach programme for mothers and children, the integrated child development services (ICDS) has been made responsible for growth monitoring of young children. The key person who does growth monitoring is *Anganwadi* worker who has been trained for 3 months and is being imparted regular on the job training and continuing

education. The health system supports the efforts of *Anganwadi* workers.

Growth Charts (Mother and Child Protection Card) Jointly Prepared by MOHFW and MOWCD

Prevalence of *underweight, stunting* and *wasting* among under-five children is estimated by comparing actual measurement to an international standard reference population. In April 2006, the World Health Organization released the 'WHO Child Growth Standard' to replace the widely used National Centre for Health Statistics/WHO reference population which was based on a limited sample of children from United States, receiving bottle and mixed feeding.[9]

The new 'WHO Child Growth Standards' globally used have unique features as they *provide how children should grow*—how *every child has right to grow and develop,* with her or his basic needs being met in a nurturing environment. They establish breastfed infants as the *normative growth model* and demonstrate for the first time ever that children born in different regions of the world and given the optimum start in life, have the potential to grow and develop within the same range of height- and weight-for-age. They also provide reference values for assessing children obesity and also a unique link between physical growth and motor development. These standards are available for both, girls and boys, below 5 years for weight-for-age, height-for-age, weight-for-height, BMI for age, and six motor development indicators. With these new standards, parents, communities, child care workers, programme managers, health and child care advocates will know when the nutrition and care needs of children are being compromised. The use of this tool enables them to take timely corrective actions at different levels.

In fact, in the new growth charts the cut-off line which demarcates underweight has been shifted downwards and the line which demarcates severely underweight children has been shifted upwards. The implications of new growth charts are:

i Increase in total number of normal weight children.

ii Increase in severely underweight children.

iii Increase in underweight children (moderate and severe) in age group 0–6 months.

The requirement of funds for SNP, centre and state contribution would almost double. The new charts would now help in comparing growth of Indian children within project, districts, states and also other countries.

The Ministry of Women and Child Development in ICDS has adopted 'New WHO Child Growth Standards' and has revised growth monitoring charts as mother and child protection card (MCPC) which describes how children should grow. In the new charts emphasis is on *growth* rather than grades of nutrition (Figs 5.3 to 5.6).

MCPC is resource on Journey of the first 1000 days for communication with pregnant woman and care givers. The revised MCPC include information in an age appropriate pictorial description. The care now specifically includes information on what the child does by a specific age, what the parents should do to stimulate the child and engage with the child. Red flag signs of developmental issues have been developed in new MCPC for early referrals and guidance.

On each growth chart there are three printed growth curves. These are called reference lines or Z scores lines and are used to compare and interpret the growth pattern of child and assess her/his nutritional status. The top curve on the growth chart is the *median*, the second curve is minus two standard deviations of the median and the third curve is minus three standard deviations of the median.

The new growth chart has three coloured tracks rather than earlier classification lines of normal, Grade I, Grade II, Grade III and Grade IV. The children in green track (above –2SD) are normal children. In the new chart Grade I and Grade II have been merged and shown as *yellow track* and children who are plotted in this track would be termed moderately underweight (below –2SD to –3SD). *Below yellow track* there is *orange track* which comprises Grade III and Grade IV and they will now be termed severely underweight (below –3SD of reference median). The weight of a girl and a boy of a same age differs slightly, therefore separate growth charts for boys (light blue) and girls (pink) have been introduced in ICDS.

Process

The correct age of the child is determined—accurate to the nearest month of birth, by use of local events calendar or from birth records. *Anganwadi* workers must register all births and record date of birth of every child this helps to determine the correct age.

Weighing of children should be done with minimum clothing. The weighing scales used: Salter weighing scale or beam balance, should be standardised and its accuracy should be checked against a standard weight.

After weighing, the weight should be plotted at a point where weight and age of that child meet. This step can be learned during training and practice.

Interpretation after plotting of weight is important. Child growth curve should be drawn and interpreted along with mother to ensure prompt action.

Growth

Growth is more important than a single weight of a child at a particular point of time. From a single weight and single point, it is not safe to draw conclusions.

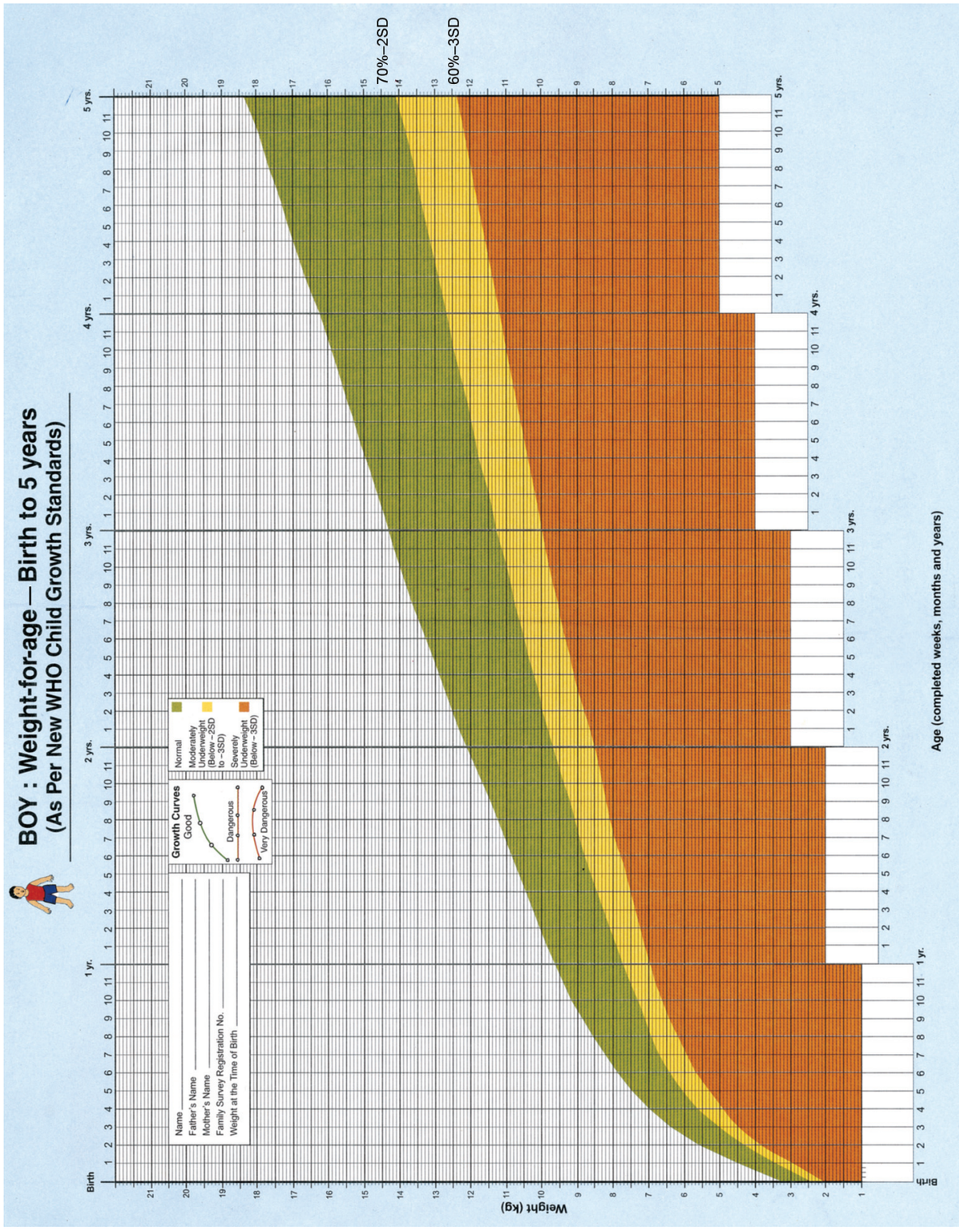


Fig. 5.3: Growth chart used in ICDS programme and in mother and child protection card

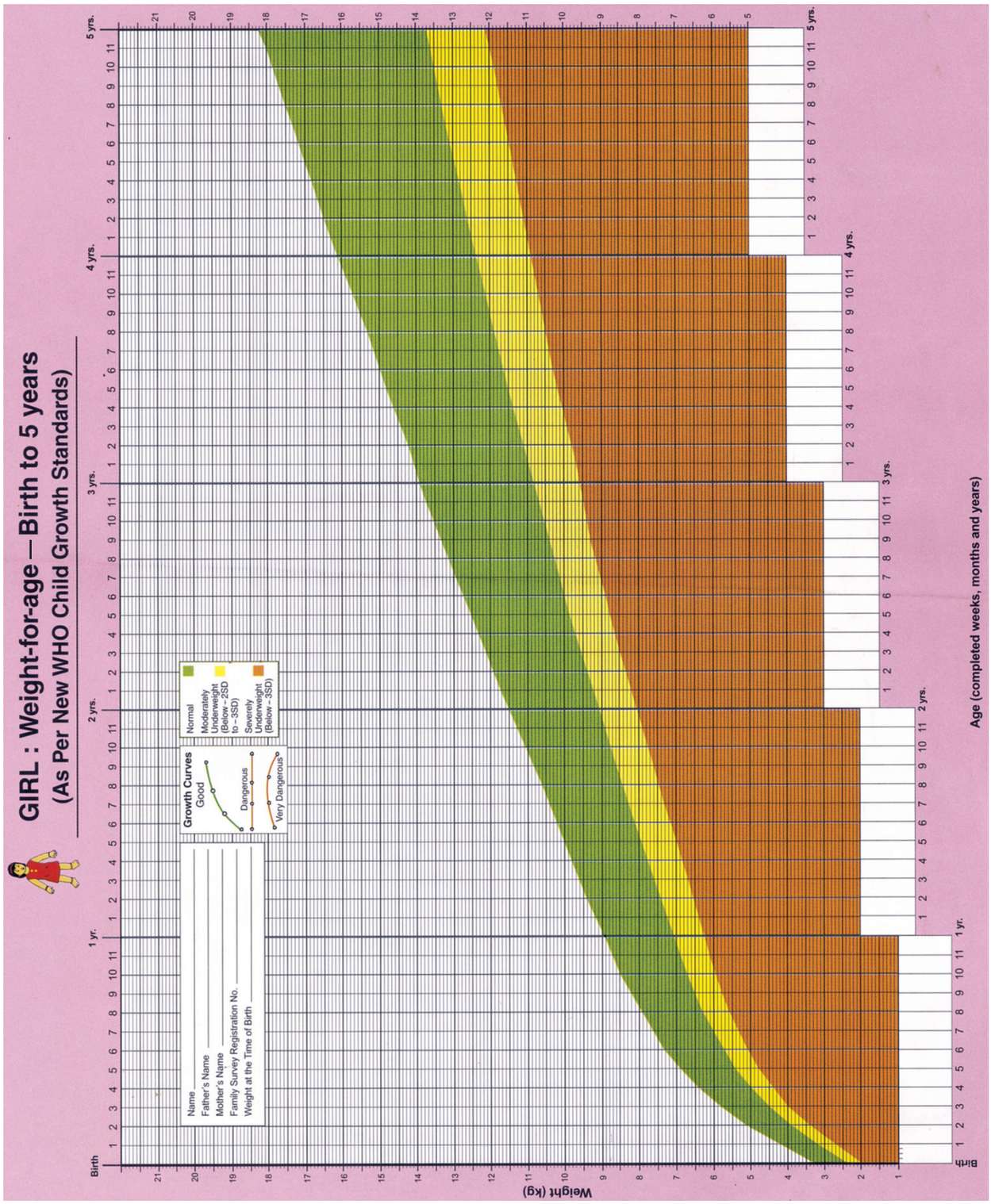


Fig. 5.4: Growth chart used in ICDS programme

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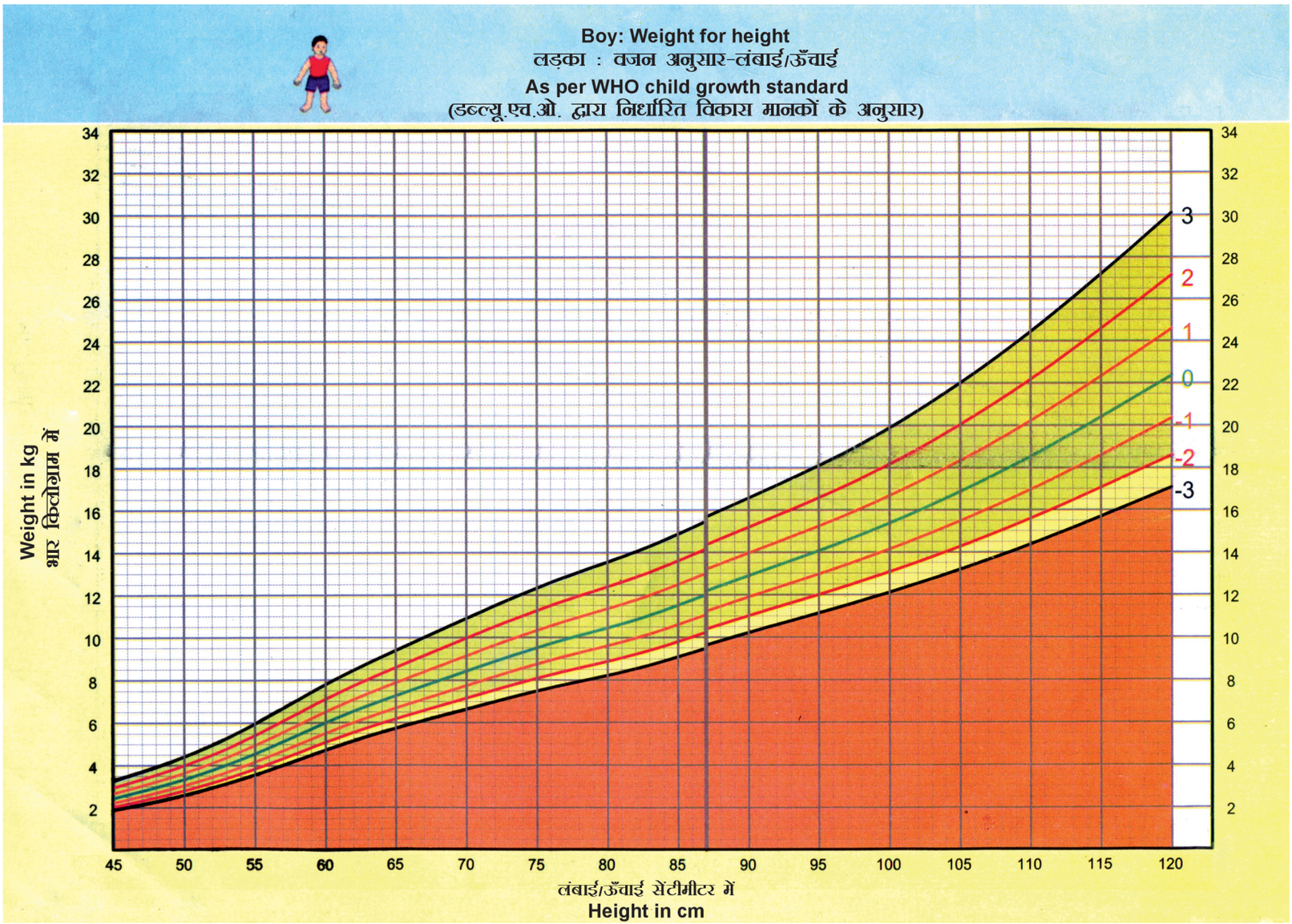


Fig. 5.5: Weight for height chart

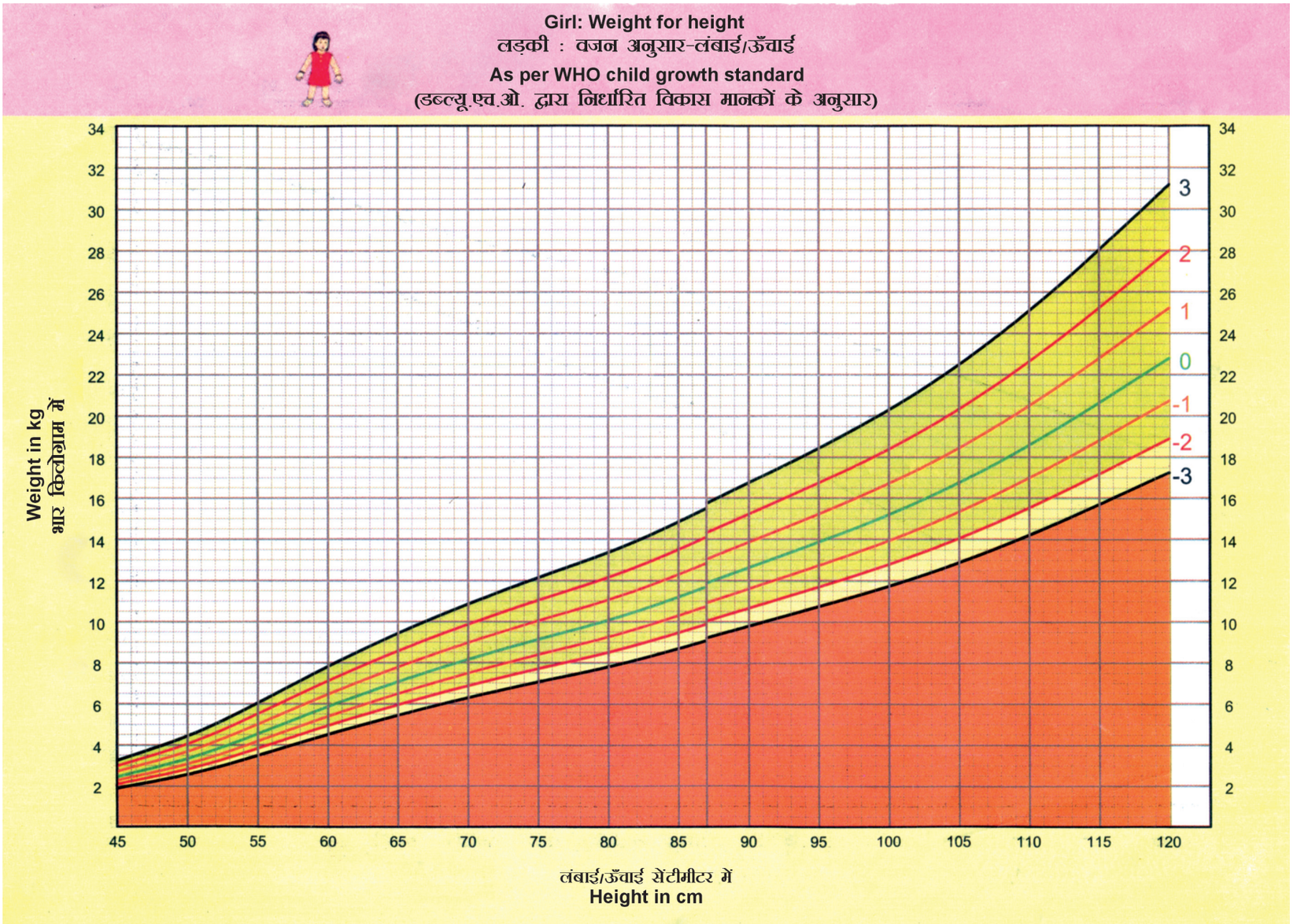
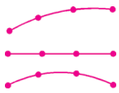


Fig. 5.6: Weight for height chart

The direction of growth is of prime importance. The growth curve can have three directions:

1 Upward — Good
2 Horizontal — Dangerous
3 Downward — Very dangerous



- If the child's growth curve is climbing upwards and follows the direction of reference curve, the child growth is good and mothers should be congratulated to keep the child feeding adequately (breastfeeding or supplementary feeding).
- If the growth curve becomes horizontal, it means the child is not growing and growth has faltered. This is dangerous. The reasons for this growth faltering should be discovered and corrective actions by mother and family should be ensured promptly.
- If the growth curve is moving downwards, it means that the child is losing weight. This should be viewed as very dangerous and child should be helped immediately. The downward curve could be due to acute diarrhoea, withholding of foods and fluids, these must be corrected by prompt rehydration by home available fluids or ORS and breastfeeding and feeding according to liking and choice of mothers. If the downward curve is restored upwards, it means that the action taken was successful. Thus, the direction of the curve is helpful to assess the effectiveness of an action.

Position of Growth Curve

The direction of growth curve matters most than the position of the curve in relation to reference line. Each child grows in his/her own channel or trajectory. If the child is growing below the reference line, is healthy and active and there is no illness then there is no cause of worry and health workers must reassure mothers. Only children whose growth curves are well below the lower curve below 3SD should be reassessed and examined and referred to health facility. These children may have chronic illness. The position of the child's growth curve on the chart alone is not sufficient to feel happy about. If the curve becomes flat or moves downward prompt action should be ensured after rapid investigation. Children who are small at birth will grow in lower trajectory or channel if ensured adequate nutrition and care.

Training of Workers and Logistics

Workers need to be trained. Team training of health workers and AWW is always better. Good weighing machines must be in place as also growth charts. Growth monitoring is time consuming process and its quality depends upon good training and experience. Objectives of growth monitoring must be made clear to the workers, and to mothers. Feedback to mothers and actions are more important than preparing reports or updating of records. Regular growth monitoring programme with high quality can become a very useful tool for national nutrition surveillance programme, which is being done by periodical surveys undertaken by NNMB and results are not area specific and much delayed. On the other hand, growth monitoring is local and ensures local action promptly.

Growth monitoring in ICDS needs to be made more realistic and practical. Focus and priority should be on first 2 or 3 years at the most. Weighing at birth should be encouraged that will improve the component of postnatal care as well which is quite deficient at the moment. Apart from that, it will improve the birth registration for appropriate action.

Competency addressed: The student should be able to:
CM 5.5: Describe the methods of nutritional surveillance.

Methods of Nutritional Surveillance

Nutrition Surveillance System

Nutrition surveillance means data collection and information relevant to nutrition for prompt and appropriate action. This involves setting up of a system in the country/state/district/block to continuously collect data at regular interval or periodicity, compile and analyse data and develop **information for action** and feedback to various levels.

Such a system can help to give warning signal of occurrence of undernutrition well in advance to prepare the system for action in advance. Nutritional surveillance can also be useful for knowing the trend of undernutrition or overnutrition over a long period of time.

Nutritional surveillance also helps in evaluation of impact of various nutritional interventions, it also can identify factors and conditions for good or bad nutrition in a geographical area.

Indicators for Nutrition Surveillance

Wide ranging and common indicators used or collected and analysed at regular intervals are as mentioned in Table 5.9, however, it is advisable to collect only limited and essential indicators which are feasible and available through routine records. Special surveys or rapid surveys are needed to collect some special indicators as mentioned in Table 5.9.

Indicators from Social, Economic and Agriculture Data

These are essential indicators as these determine the adequate production of foods, so essential for adequate nutrition.

Rainfall pattern, crop area, crop yield, food production, household food storage, buffer stocks, crop pests and animal diseases, live stock and its productivity, cost of food, level of unemployment and below poverty line people are some indicators which are helpful in nutritional surveillance.

Nutrition Surveillance in India

- Nutritional surveillance has been entrusted to ICMR. National Nutrition Monitoring Bureau at NIN, Hyderabad, conducts periodic National surveys and results are fed back to the system.
- Similarly, food and nutrition board have conducted surveys and available data has been used for effective planning.
- System of integrated child development services (ICDS) collects data on growth monitoring and nutritional status of young children on regular basis, which helps state, districts and blocks to take appropriate action to improve the nutritional status. From 1975 to 1995, inputs of regular annual surveys done by consultants of ICDS provided useful data on nutritional surveillance of young children. During 12th plan period, it is proposed to strengthen the system of ICDS further to get quality data for action.
- Screening programme of NCDs measures waist circumference is adults above 30 years of age for obesity.
- Recently national family health surveys (NFHS) conducted at 5 years interval has provided wide ranging data on nutritional status of children, pregnant women and feeding practices, but 5 years for surveillance is too long a period and it provides information at state and district level.
- National Sample Survey Organization (NSSO) undertakes economic survey after every 5 years and it provides information on expenditure on food at family level.

Nutrition surveillance system as of now has to depend upon ICDS system and NNMB surveys [(Recent being (CNNS-2018)]. These must be strengthened so as to provide regular data-based information for action. RBSK collects data of 0–18 years children on 4Ds regularly, hence can be used for surveillance.

MALNUTRITION IN ADOLESCENTS (10–19 YEARS)

Adolescents represent about one-fifth of India's population. Adolescence is a period of second decade of life (10–19 years). During this phase of life, significant physical, physiological, psychological and emotional changes occur; which have bearing on the individual, community and the nation. Adolescence marks the beginning of menstrual cycle or reproduction. Healthy adolescence is a goal. Adolescents gain 50% of their adult weight and more than 20% of their adult height in age group 10–19 years, which we call growth spurt. For healthy growth and development of adolescents, adequate diet is essential to provide at least 2220 to 2500 calories per day.

Problem of Adolescent Nutrition

As per CNNS 2016–18, overall 24% of adolescents were thin for their age (BMI for their age less than –2SD) and 5% were overweight and 1% obese.

Undernutrition in teenage girls and boys is the cause of concern in India. Girls do not grow as per norms and their growth potentials are not fully realized.

The situation has not much changed over the years in rural areas. During 2005–06, 11.7% of teenaged married and unmarried girls had height less than 145 cm, and

Table 5.9: Nutrition surveillance indicators

Measurements	*Cut-off level*	*Indicator*	*Agency responsible*
• Birth weight	Less than 2500 g	% less than 2500 g	Health and ICDS
• Weight-for-age	Below –2SD to –3SD	% below or above cut-off	ICDS—regularly and NFHS at 3 years intervals
• Height-for-age	Below –2SD	% above or below the cut-off	and, NNMB
• Weight-for-height (BMI)	Below –2SD	% above or below cut-off	–do–
• Exlusive breastfeeding rate	Up to 6 months	% of practice	Health
• Complementary feeding rate	6–8 months infants	% of practice	–do–
• Bottle feeding rate	–do–	–do–	–do–
• Breastfeeding continuation rate	12–15 months infants	–do–	–do–
• Mild upper arm circumference	12.5 cm	Above or below cut-off level	ICDS and health
• Bitot's spots	0.5%	–do–	–do–
• Haemoglobin level	WHO reference	Above or below acceptable level	
• Use of iodized salt	100% of households using iodized salt	Percentage of households using iodized salt	Health
• Grades of goiter	TGR <5%	Percentage of TGR	Health
• Other biochemical levels, such as serum vitamin A, serum cholesterol, fasting triglycerides, etc.	–	–	ICMR

around 46.8% had body mass index (BMI) below 18.5 indicating that two-fifths of them were undernourished and suffer from the effect of chronic energy deficiency 45% of adolescent girls had BMI less than 18.5 in 2013–14 (RSOC). It indicates high prevalence of nutritional deficiency. In India, this is significant as 23.3% of adolescent girls get married below the age of 18 years and thus teenage marriages result into high-risk pregnancy and consequently outcome are low birth weight babies and high morbidity and high maternal mortality.

Problem of Anaemia in Adolescents

During the year 2016, overall prevalence of anaemia (haemoglobin <12 g%) among adolescent girls was quite high. Over 54% of them were anaemic. High prevalence of anaemia among adolescent girls reflects their poor status of nutrition, and they tend to grow as risky women as their body size and pre-pregnancy weights are low with small size of pelvic bones. Due to chronic deprivation of food particularly during the period of growth and development leads to short stature of girls. Body weights of many girls tend to be less than 45 kg against standard weight of 55 kg.

Malnutrition is a problem that seriously impairs the health of adolescent and adult women and has its roots in early childhood. The causal relationship between anaemia and low birth weight, prematurity, perinatal mortality and maternal mortality has been extensively studied and established. Improvement in health and nutritional status of adolescent girls has an intergenerational impact.

Plan of Action

Adolescent's reproductive health and nutrition has been identified as underserved area under reproductive and child health (RCH) programme, and under National Population Policy, 2000.

1. Out of school adolescent girls belonging to economical weaker sections of society have been covered in ICDS programme for supplementary nutrition services besides vocational training. *Kishori Shakti Yojna* takes care of health, nutrition and development of adolescent girls in the age bracket of 11–18 years.
2. Under national nutritional anaemia control programme, and RMNCH + A, adolescent boys and girls have been covered for IFA supplements.
3. Adolescent girls will be reached through effective school health and nutrition programme. Adolescent to adolescent programme in school can be most effective for peer group education on nutrition and health.
4. **Legal framework:** Enforcing the Child Marriage Restraint Act of 1976 to reduce the incidence of teenage pregnancies. Preventing the marriage of girls below the legally permissible age of 18 should become a national concern. Let all girls first attain womenhood, and cross 18 years of life and attain full physical maturation so that their body size and pelvis and reproductive organs are fully developed. Bill of raising age of marriage from 18–21 year in girls is pending in parliament.

EMERGING EPIDEMIC OF OBESITY

Among adolescents because of changed lifestyles and changed dietary practices problem of obesity is emerging as an epidemic. One in ten adolescents and young adults is clinically obese. The time trends data of NNMB indicate increase in body weight, height and triceps skin fold thickness of adolescents and it is suggestive that obesity is emerging in adolescents and adult women. Among the middle and high income groups schools of Delhi about 30% of adolescents were overweight. NFHS data also indicate the around 25% well to do urban women in India have BMI of 25 or more and 6–7% have BMI of 30 or more, which include adolescent girls also. Similarly, NNMB data in adult women indicates overweight of 7–12%. In Delhi and Punjab, more than 30% of adult women have BMI more than 25 (*see* Chapter 8).

The reasons for obesity in adolescents are current dietary trends and physical inactivity. Obesity is also being observed in younger school children, which is a sign of warning for the future (*see* Chapter 8).

MALNUTRITION IN ADULTS CHRONIC ENERGY DEFICIENCY (CED) ASSESSMENT OF ADULT NUTRITION

Chronic energy deficiency in adults can be measured by body mass index (BMI); which is defined as weight in kg divided by height in square metre (kg/m^2). The BMI of 18.5 in adult men and women is considered to be normal (Table 5.10). The normal BMI ranges are 18.5–25. BMI of less than 18.5 is classified as underweight, <16.00 is severe, ranges from 16.00 to 16.99 moderate, and from 17.00 to 18.49 is considered as mild chronic energy malnutrition (thinness), respectively (Table 5.10).

Table 5.10: The international classification of adult underweight according to BMI

Classification	*BMI kg/m^2 principal cut-off points*	*Additional cut-off points*
Underweight	**<18.50**	**<18.50**
Severe thinness	<16.00	<16.00
Moderate thinness	16.00–16.99	16.00–16.99
Mild thinness	17.00–18.49	17.00–18.49
Normal range*	**18.50–24.99**	**18.50–22.99** **23.00–24.99**

Source: Adapted from WHO 1995, WHO 2000 and WHO 2004.
*NIN in India recommend normal range of BMI-18.5–23

One-sixth of adult population (16–19%) were having various grades of chronic energy deficiency while 61% were normal, over 22.9 to 24% constituted obese grade of BMI (Table 5.11). The effects of undernutrition of childhood are carried over to adolescents, adults and the adult population manifests chronic energy deficiency. Work capacity of adult goes down due to chronic malnutrition of long-standing.

The chronic energy malnutrition in adult men and women is on the decline; from a high level of 35.5% in 2006, it has been reduced to 16–19%. The obesity shows a rising trend from 12.6% in 2006 to 23–24% in 2019–21 even in slum areas, indicating signs of prosperity even in urban slums (Table 5.11).

Table 5.11: Prevalence of CED in adults NFHS-5 and NFHS-4*

BMI value	*NFHS-5 (2019–21)*		*NFHS-4 (2015–16)*	
	Men	*Women*	*Men*	*Women*
CED <18.5	16.2	18.7	20.2	22.9
Normal 18.5–24.9	60.9	57.3	61.2	56.4
Obese >25	22.9	24.0	18.6	20.7

* All values in percentages

MICRONUTRIENT DEFICIENCY DISORDERS

Micronutrient deficiency, such as iron, folic acid, and B_{12} vitamin A, iodine and zink are found across all age groups.

Nutritional Anaemia

Iron deficiency anaemia is a problem of serious public health significance. Nutritional anaemia (iron deficiency) is the most common micronutrient deficiency in the world affecting more than 700 million persons. Nutritional anaemias are most common in pregnant and lactating mothers, infants, preschool children and adolescent girls.

Causes

Predominant cause is inadequate food intake. Dietary iron intake may be inadequate or insufficient iron is absorbed to meet body requirements or reduced bioavailability of dietary iron or needs for iron get increased or due to chronic blood loss. Iron deficiency is by far the commonest cause of nutritional anaemia. Malaria, hookworm disease (ankylostomiasis or necatoriasis), schistosomiasis and other infections play an important role in tropical climates. Conditions which initiate and perpetuate anaemia will be discussed subsequently.

At Risk Groups

Infants, preschool children, adolescents, women in child-bearing age, particularly pregnant women and lactating mothers are at greatest risk of developing iron deficiency anaemia. Adult males may also be at risk where there is chronic energy malnutrition due to inadequate food intake or frequent parasitic infection.

Definition of Anaemia

Anaemia is defined as reduction of haemoglobin level in circulation. WHO in 2001 has suggested cut-off values for different groups of population as mentioned in Table 5.12.

Table 5.12: Haemoglobin (Hb) levels below which anaemia is present in population

Age or gender group	*Haemoglobin g/dL*
Children 1–4 years	<11
Children 5–11 years	<11.5
Children 12–14 years	<12
Non-pregnant women (above 15 years of age)	<12
Pregnant women	<11
Men above 15 years of age	<13

Severity of anaemia: Depending upon the level of haemoglobin, the degree of anaemia can be classified as mild, moderate and severe as mentioned in Table 5.13. The classification helps to determine priorities and launching of intervention and allocation of scarce resource. Health workers track severely anaemics. The level of Hb was estimated by using cyanmethaemoglobin method.

Table 5.13: Classification of anaemia in pre-school children 1–4 years age and pregnant women

Degree of anaemia	*Level of Hb (g%)*
Mild	10–10.9
Moderate	7–9.9
Severe	<7

Requirements of Iron

The types of diet consumed normally in India should contain 11–15 mg iron to meet the iron requirement of adult. The iron requirements are substantially increased during the special physiological conditions like pregnancy and rapid growth during early childhood period (infancy and preschool period). Similarly, in adolescent girls and boys, the iron requirements are more. The RDA for special age and gender group are as mentioned in Table 5.1.

Magnitude of Problem of Anaemia

Nutritional anaemia during pregnancy is widespread in India. As many as 52.2% of pregnant women have haemoglobin level below 11 g% which is unacceptably high prevalence. Of these, 13% are severely anaemic (haemoglobin levels below 7 g%).Thus anaemia is severe public health problem in pregnant women and pre-school children (67% children age 6–59 months are anaemic).

- One in five of all maternal deaths is attributable to anaemia during pregnancy.
- Overall 67% of pre-school children, 24% of school children and 28% of adolescents had some degree of anaemia.
- About 40% of adolescent girls are anaemic.
- Overall 14% of pre-school children, 17% of school children and 31% of adolescents had vitamin B_{12} deficiency. 23% of pre-school, 28% of school children and 37% of adolescents suffer folate deficiency.

Public Health Consequences of Anaemia in Pregnant Women

In Pregnant Women: Anaemia is Killer

Anaemia in pregnant women is reflection of insufficient food intake. This leads to serious consequences. Anaemia during pregnancy is responsible for 19% of all maternal deaths. Anaemia is also a contributory factor of maternal deaths due to haemorrhages, septicaemia and eclampsia. While a healthy woman may tolerate a blood loss up to 500 ml or more during childbirth, for anaemic women even a normal blood loss of 250 ml can be fatal.

Infection

Since anaemic women have lower resistance to infection and their general health condition is low, they are at higher risk of complications, such as sepsis after delivery (post-puerperal sepsis) which is responsible for 11% of maternal mortality.

Anaemic mothers are more prone to haemorrhages after delivery and are at risk of maternal mortality. Haemorrhages account for 27 to 37% of maternal mortality.

Low Birth Weight Babies

Anaemic mothers give birth to low birth weight babies (less than 2.5 kg) and around 22 to 28% of births are low birth weight babies in India. Anaemia in pregnancy is one of the significant cause of low birth weight. Anaemic mothers have three times greater risk of premature delivery and low birth weight babies, nine times higher risk of perinatal mortality and higher risk of irreversible brain damage in infants born to severely anaemic mothers. Work capacity of women is reduced, they become lethargic, breathless and get tired easily even after normal work. Anaemia incapacitates women and reduces their physical work capacity and productivity.

In Young Children

Anaemia retards physical growth and mental development of child, reduces scholastic performance, decreases attention span, memory and concentration.

In Adolescents

Anaemia may lead to delayed menstrual cycle, poor growth, reduced work capacity and poor reproductive outcome. It reduces their concentration and school performance.

Factors and Conditions Responsible for Anaemia

- In India, prime factor being lack of sufficient intake of food and particularly lack of intake of iron rich foods and poor absorption of iron from food into the body. On the whole bioavailability of vegetarian sources of iron is low. In vegetarian diets based on staple cereals (millets, wheat, rice and vegetables), the iron absorption ranges from 2 to 5%. The iron absorption on an average for mixed cereal diets is 3%. Phytates of cereals, tannins and polyphenol of vegetables inhibit iron absorption. Haem iron is better absorbed. Bioavailability of haem iron is high and absorption ranges from 10 to 20%. It is available from animal sources (meat, fish, poultry and blood products).
- Presence of persistent diarrhoea and worm infestations prevents absorption of iron.
- Once absorbed chronic diseases like malaria, which causes damage to the red blood cells produces anaemia in endemic areas of malaria.
- Increased demand of iron during pregnancy also causes anaemia, repeated pregnancies and short birth interval cause anaemia among women.
- Hookworm disease is another important factor in causation of anaemia due to chronic blood loss.
- Non-haem iron is mainly found in cereals, vegetables and pulses, its bioavailability is poor.
- ***Contamination of iron:*** From soil dust, water, iron pots, bioavailability is low.
- ***Fortification of iron:*** Varied bioavailability depends on composition of food.

Social Factors, Wrong Beliefs and Practices

Heavy workload and long hours of work combined with inadequate food intake leads to chronic malnutrition including anaemia. Traditional social values requiring women to eat last in the family and observing rituals like fasts during pregnancy and avoidance of certain foods thought to be hot or abortifacient (sugar, jaggeries and even iron and folic acid tablets), seem to be important social factors contributing to anaemia.

Poverty and reproduction behaviour of having too many children and repeated pregnancies deplete iron stores of women. Low status of women and illiteracy are other important social factors.

Poor acceptance: Only 26% of mothers consumed 100 or more IFA tablets as per NFHS-5.

Factors and Causes in Children

In children, iron deficiency in first 6 months is dependent upon the iron reserves acquired from the mother during

fetal life. If women are anaemic children born to them will have less iron reserve.

The major factor is delayed weaning and insufficient semisolid and solid food intake by young children. Cereals, pulses and green leafy vegetables are deliberately withheld from the diets of young children because of many wrong beliefs.

Apart from inadequate dietary iron intake, impaired absorption due to persistent diarrhoea and other chronic infections are other factors. Iron supplements are seldom accepted by families.

Adolescent

Adolescent girls are more vulnerable due to poor eating, insufficient foods, onset of menstruation and consequent blood loss and avoidance of IFA tablets.

STRATEGIES FOR PREVENTION OF NUTRITIONAL ANAEMIA

Adequate Food and Iron Rich Foods

Ensuring adequate indigenous food consumption and iron rich food consumption during pregnancy, lactation, early childhood period, adolescent girls, and boys. 150 g of green leafy vegetables consumption per day can provide adequate quantity of iron in diet, besides providing calcium, beta-carotene and vitamin 'C' however, green leafy vegetable consumption per consumption unit is quite low in India (15 g per day). Along with green leafy vegetables, adequate consumption of cereals, rice, wheat, ragi, jowar and bajra, sprouted pulses and jaggery can provide enough of iron in usual diets.

Bajra is good source of iron. Milk is poor source of iron. Bajra has 8.0 mg of iron per 100 g. Wheat contains 5.3 mg, Bengal gram 4.5 mg per 100 g. Amaranth and Bengal gram leaves has 23 mg of iron per 100 g.

Feeding Young Children

Exclusive breastfeeding for 6 months and including green leafy vegetables in the weaning foods of infants after 6 months by mothers and families. Timely weaning and enough food for young child is essential to prevent anaemia.

Promoters

Vitamin C promotes absorption of iron. Vitamin C rich foods are lemon, orange, guava, amla and tomatoes.

Deworming

Deworming pregnant women and children periodically to get rid of worms and promote iron absorption.

Malaria Prophylaxis

Personal protection and prophylaxis by use of insecticide treated bednets should be promoted.

Environmental Sanitation

Promotion of sanitary latrines to avoid contamination of soil with faecal matter and thereby prevention of worm infestation (hookworms). Promoting personal hygiene (handwashing) and wearing of shoes will prevent infection.

Contraception

Contraception and limiting family size to one or two children can prevent anaemia in women.

Supplementary Food and Iron and Folic Acid

Supplementary feeding through ICDS programme for pregnant women, lactating mothers and young children as also distribution of IFA supplements to women, adolescent girls and children have not met with much success.

Food Fortification (Double Fortified Salt)

Technology of salt fortification exists in the country. Salt iodation (iodized salt) is already being done in the country. Technology of double fortification of salt (adding iodate and iron) was developed in India at NIN, Hyderabad. Since iodine was found to be highly unstable in the iron fortified salt developed earlier; an alternative technology was developed by use of sodium hexametaphosphate as the stabilizer along with ferrous sulphate to enhance iron stability and bioavailability. Sodium hexametaphosphate helps to chelate iron, keep it in a soluble form and prevents its interaction with iodine. This has been pilot tested in limited area. However, iron fortified or double fortified salt has not as yet become part of public health programmes to combat anaemia, though feasible and effective. Currently attempts are being made to manufacture and distribute iron fortified salt in Tamil Nadu. Hopefully this will be extended to other parts of the country.

Consumption of locally grown leafy vegetables in home kitchen garden and in farms along with adequate staple foods (cereals and pulses) remain the sheet anchor to prevent malnutrition and anaemia.

Competency addressed: The student should be able to:
CM 5.6: Enumerate and discuss important national nutritional programmes.

POLICY ON CONTROL OF NUTRITIONAL ANAEMIA

Nutritional anaemia is a serious public health problem. In India more than 50% of children under two, pregnant and lactating mothers are anaemic. To respond to this problem, the Government of India launched National Nutritional Anaemia Prophylaxis Programme (NNAPP) way back in 1970 as part of National Family Planning Programme, revised it in 1991 as NACP, and in 2015 National Iron Plus Initiative (NIPI) was started.

NATIONAL NUTRITIONAL ANAEMIA CONTROL PROGRAMME (NNACP)

Objective

The NNACP aims at significantly decreasing the prevalence and incidence of anaemia in women in reproductive age group, especially pregnant and lactating women and preschool children. Adolescent girls were also included in the programme under RCH programme. The programme focuses on the following strategies.

Strategies

1. Promotion of regular consumption of foods rich in iron.
2. Provision of iron and folate supplements in the form of tablets (folifer tablets) to the high-risk groups.
3. Identification and treatment of severely anaemic cases.
4. Deworming programme.

Implementation: The NIPI programme is being implemented through primary healthcare set-up (PHC and SC). The multipurpose health worker female and male are responsible for distribution of iron tablets (adult and paediatric doses) to pregnant, lactating women, IUD users and children aged 6 months to 5 years, 6–10 years and also to adolescents (10–19 years) and women in reproductive age group.

PREVENTION OF NUTRITIONAL ANAEMIA

Promoting Consumption of Iron Rich Foods

- Adequate diet and regular consumption of iron rich foods, such as green leafy, vegetables, mustard leaves, spinach (palak), amaranth (*Cholai sag*), *Colocasia* leaves, knol and knol leaves *(ganth gobi ka sag)*, Bengal gram leaves, turnip green leaves and cereals, such as wheat, ragi, jowar and bajra, pulses (especially sprouted pulses and *gur* (jaggery) must be promoted widely. In addition, whatever culturally and economically feasible, such as consumption of animal flesh foods—meat, liver, etc. must be encouraged.
- Ensure incorporation of iron rich foods as green leafy vegetables in the weaning foods of infants.
- Vitamin C (ascorbic acid) promotes absorption of iron. Regular consumption of vitamin C rich foods, such as lemon, orange, guava, amla, green mango along with iron rich food must be encouraged.
- For increasing availability of iron rich foods, growing of iron rich foods in home gardens, kitchen garden, farms and fields and consumption of these must be promoted (applied nutrition programme).
- Tea inhibits absorption of iron in the body. Advise reduced consumption of tea, specially during pregnancy for improving absorption of iron and prevention of anaemia.

To manage the widespread prevalence of anaemia in the country the policy has been revised and **National Iron Plus Initiative** launched.[10]

National Iron Plus Initiative (NIPI), New Strategies Under Reproductive Maternal, Newborn, Child and Adolescent Health (RMNCH + A)

This initiative brings together existing programmes for IFA supplementation among pregnant and lactating women, adolescents and children. The initiative aims to ensure provision of IFA supplements and therapeutic management of mild, moderate and severe anaemia in the most vulnerable groups, viz. children (6 months to 10 years), adolescents (10–19 years) both in and out of school, pregnant and lactating women and women in reproductive age group (15–45 years). This initiative includes:

- Screening and tracking undernutrition and anaemia in homes, schools and *Anganwadis*;
- **Preschool children (6–59 months):** Bi-weekly iron supplementation in home setting under direct observation of ASHA, one tablet of 20 mg elemental iron + 100 µg folic acid or in syrup 1 ml.
- **School children (5–9 years):** 45 mg elemental iron + 400 mcg folic acid weekly (WIFS Junior) pink tablet throughout the entire period of 5–9 years in government and government aided, municipal and private schools plus deworming under supervision of teachers.
- **Out of school children (5–9 years):** At *Anganwadi* centre weekly IFA supplementation.
- **Adolescents (10–19 years):** Weekly IFA supplementation (WIFS) programme covers adolescents enrolled in class VI–XII (10–19 years) in schools and out of school. IFA tablet of 60 mg elemental iron + 500 µg folic acid for adolescents is coloured blue (*iron ki nili goli*). The programme covers adolescents of government, government aided and municipal schools as well as out of school girls.

Programme Envisages

- Supervised administration of weekly IFA supplement.
- Screening of target groups for moderate and severe anaemia and referral to appropriate health facility.
- Bi-annual deworming (albendazole 400 mg). National deworming days are observed in February and August of every year since 2015 to cover 1–19-year age group.
- Information and counselling to improve dietary intake and preventive actions for intestinal worm infestation.
- **Pregnant women:** One red tablet containing 100 mg elemental iron + 500 µg folic acid prophylactically daily, starting after first trimester of gestation for 180 days. If clinically anaemic two such tablets to be given daily for 180 days.
- Nursing mothers and acceptors of family planning: One red tablet containing 100 mg elemental iron + 500 µg folic acid daily for 180 days.
- **Women in reproductive age group:** One tablet containing 100 mg elemental iron + 500 µg folic acid weekly to women of age 20–24 years.

- Use of folic acid is promoted in planned pregnancies during the periconception stage (3 months before and 3 months after conception) for prevention of neural tube defects and other congenital anomalies.

Treatment of Severe Anaemia

If Hb is less than 11 g% in pregnant women she is enemic and women with Hb level below 7 g% are considered to be severely anaemic.

Recommended therapeutic dose for anaemic women in reproductive age group is one tablet (large) of folifer twice daily for a minimum of 180 days. This will provide equivalent to 200 mg elemental iron and 1000 µg of folic acid per day. Further cases of severe anaemia should be referred to PHC medical officers for diagnosis of causative factor and treatment. Tracking system of severely anaemic pregnant women has been introduced now. Parenteral iron is recommended to treat severe anaemia.

Distribution

These tablets can be distributed during outreach immunization sessions or on the day of antenatal clinic along with Td immunization or at *Anganwadi* to children 1–5 years of age. It is important to understand that intake of folifer tablets may cause change in the consistency of stool, i.e. stool may either become loose or hard. The colour of stool may also turn black. There is no cause to get worried with such mild symptoms and one must continue taking folifer tablets. IFA (large) and IFA (small) are distributed free of cost at government health centres. To prevent deterioration of quality of the tablets, it is now supplied in strip of 10 tablets in bubble packs. It is important that drinking tea should be avoided within an hour of taking iron tablets.

Since these tablets are sugar coated, young children may consume excess of iron and toxic effects may occur, at times fatal outcome/accidents have been reported hence the safety should be ensured by family and parents and health workers must educate parents. These tablets should not be accessible to young children in homes.

POSHAN ABHIYAN—ANAEMIA MUKT BHARAT

Government of India MOH and FW Intensified National Iron Plus Initiative (1-NIPI) Poshan-Abhiyan-PM's overarching scheme for Holistic Nourishment.[10]

Target: To reduce the prevalence of anaemia by 3% point per annum (from 50% in 2016 to 32% by 2022).

Why? Anaemia is silent epidemic impacting physical growth, mental and work capacity and lives of future generation.

6 Categories of Beneficiaries in India

Problem—Extent or Prevalence of Anaemia in 2019–21

1. 67% of children 6–59 months,
2. 59% of adolescent girls (15–19 years),
3. 31% of adolescent boys (15–19 years),
4. 57% of women in 15–49 age group,
5. 52% of pregnant women and
6. 50% of lactating mothers were anaemic in 2018.

Anaemia prevalence of >40% is considered as serious Public Health Problem

These figures/prevalence translate into 450 million beneficiaries—nearly one-third population of India.

6 Interventions

1. Prophylactic IFA supplementation
2. Periodic deworming
3. Behaviour change communication—education on-adequate diet at home rich in iron
4. Testing anaemia using digital method
5. Provision of fortified foods
6. Addressing non-nutritional causes like malaria, kala-azar, diarrhoeal diseases.

6 Institutional Mechanisms

1. Inter-ministerial coordination—health, women and child development, food and agriculture, environment water and sanitation, etc. (convergence action).
2. Intra-ministerial coordination—within the same ministry/department with different programmes (MCH, malaria, IDSP, immunization).
3. National Anaemia Mukt Bharat Unit
4. National centre of excellence and research
5. Strengthening supply chain management
6. Anaemia Mukt Bharat Dashboard and digital portal. One stop shop for anaemia.

IFA supplementation as magic tablet is partial answer, IFA tablets are viewed as allopathic medicines by most people and compliance/use rate are as low as 26% of pregnant women consumed for 180 days or more and much lower in children. Anaemia problem should be viewed as macro + micro nutritional deficiency or inadequate diet. Emphasis should remain on enough eating, clean eating, clean water, clean hands and clean utensils. Only 11.3% of children between 6–23 months received adequate diet (NFHS-5).

National Deworming Day (NDD)

Recognising worm infestation as an important cause of anaemia, NDD is being observed in February and August, targeting all children in the age group of 1–19 years. Single dose of albendazole 400 mg under supervision is given.

Expected outcome: Reduction in anaemia and worm load, improved work capacity, immunity and alertness.

VITAMIN A DEFICIENCY (VAD)

Vitamin A is essential for normal vision. It also maintains integrity of epithelial cells and is essential for many

metabolic functions and it supports immune functions. It is a fat soluble vitamin and can be stored in liver for a longer time. Vitamin A deficiency (VAD) is common in underprivileged population. Severe forms of VAD (like keratomalacia) has declined considerably, however, it remains a public health problem in many parts of the world including India. The risk of deficiency is greater in preschool children as also in pregnant and lactating women; as their requirements are higher owing to physiological reasons, i.e. rapid growth in children, growing foetus draws its nutrients from its mother and lactating mothers have to produce milk around 700 ml per day.

Requirement of Vitamin A (Retinol)

Groups	*Retinol mcg/day*	*β-carotene**
Infants		
• 0–6 months	350	2100
• 6–12 months	350	2100
Children		
• 1–3 years	390	2340
• 4–6 years	510	3060
• 7–9 years	630	3780
Adolescents 10–18 years	770–1000	4620–6000
Pregnant woman	900	5400
Lactating mother	950	5700

*A conversion ratio of 1:6 is used.

For non-pregnant and non-lactating women (NPNL), the recommended dietary allowance (RDA) is 840 µg/day.

Pregnant and Lactating Mothers

For pregnant women 900 µg per day of retinol is considered to be adequate. For lactating mothers who secrete 700 ml of breast milk per day require 950 µg of retinol per day.

Dietary Intakes

It has been observed that over the years the dietary intake of vitamin A has not improved in India, intake of vitamin A remains much below the RDA for young children as also for pregnant and lactating mothers.

Dietary Sources of Vitamin A

Rich sources of vitamin A of animal origin are milk, liver and egg where it is available as preformed vitamin A (retinol).

The vegetable rich sources are green leafy vegetables, carrots and yellow fruits (mango, papaya and pumpkins) where it is available in the form of β-carotene which can be converted in the body into vitamin A (retinol). Conversion ratio for β-carotene to vitamin A is 6:1. In India, major dietary sources of vitamin A are green leafy vegetables and milk.

VAD as Public Health Problem

VAD is considered to be public health problem in many countries including India. According to WHO guidelines prevalence of ≥20% vitamin a deficiency was identified as a severe public health problem in 12 states among pre-school children and 4 states among adolescent (Jharkhand, MP, Bihar, Chhattisgarh, Telengana, Odisha, AP, Mizoram, Nagaland, Assam, Tripure and Haryana). According to WHO, if prevalence of any one indicator, such as Bitot's spot more than 0.5% and corneal xerosis in excess of 0.05% and **keratomalacia** more than 0.0% and corneal opacity more than 1.0% in young children, then it is considered as significant public health problem necessitating urgent response and action.

PROBLEM OF VAD IN INDIA

In India, the level of Bitot's spots which was 2% in 1979 has declined to 0.7% in 2001, indicates that it is still a public health problem. There are considerable interstate variation of prevalence (Table 5.14).[11]

Table 5.14: Problem has been sized-up by various surveys[1]

Surveys	*Bitot's spots%*
NIN-1997	0.70
India nutrition profile 1998	0.21
District survey-2001 (ICMR)	0.70
NNMB survey 2011–12	0.2*
Target	<0.5

* Pooled data of seven states (Kerala, Tamil Nadu, Karnataka, AP, Maharashtra, Gujarat and Odisha)

Vulnerability

Young children below the age of 3 years, pregnant and lactating women are most vulnerable to vitamin A deficiency. Young children in age group 9 months to 3 years are most susceptible. Protein energy malnutrition is also common in this age bracket.

Sex: Prevalence is more in male children as compared to female children but it may vary.

Geographical distribution in India: The prevalence of VAD is more pronounced in Rajasthan, Bihar, Madhya Pradesh, Odisha, UP, Tamil Nadu, Karnataka and Andhra Pradesh. There may be pockets with high prevalence of VAD within the state or the district.

Social Significance

VAD may produce blindness; a permanent disability. Around 40,000 children used to become blind due to VAD way back in 1970s per year.

Famines and Droughts (Monsoon Failure)

Droughts lead to failure of crops and vegetables as also poor yield of milk by animals because of lack of fodder. Children are most vulnerable to droughts and famines and suffer from the effect of malnutrition including vitamin A. Special attention has to be focused on young children

during droughts and famines. Vitamin A is more stable than carotene. Light, particularly ultraviolet rays and air have destructive influence on vitamin A. However, ordinary cooking of vegetables causes negligible losses in the carotene content. Fresh green leafy vegetables contain more carotene than do stale ones.

Serum Plasma Level

Serum/plasma vitamin A/retinol concentration of 20 µg/dl or above is considered to be normal in children. If it is less than that it indicates subclinical deficiency. Among pre-school children aged 1–4 years, 18% were vitamin A deficient, 22% of school children of 5–9 years and 16% adolescents were vitamin A deficient.

Deficiency

Vitamin A deficiency does not occur in isolation. It is a reflection of undernutrition or PEM. Vitamin A deficiency produces night blindness, delayed dark adaptation, and lowers the resistance to infections. Common infections (measles, acute respiratory infections, diarrhoea and worm infestation) increase the demand of vitamin A and produce vitamin A deficiency in young children or precipitate subclinical vitamin A deficiency to clinical deficiency.

Food Intake

Pregnant women in India are malnourished and during pregnancy food intake including vitamin A are much lower than RDA. This leads to poor vitamin A reserves of liver of neonates, who are born as low birth weight babies. Consequently after delivery these babies get less vitamin A through breast milk as breast milk of poorly nourished women is low in vitamin A content. Further the young children who are often given inadequate quantities of supplementary food (less of milk and less of green vegetables) are susceptible to the effect of VAD. Therefore, VAD is a nutritional deficiency in its origin. Logically, the adequate diets during pregnancy and lactation period with food rich in vitamin A should be encouraged to mitigate VAD.

PREVENTION STRATEGIES

Food-based Approach

Apart from adequate diet, regular consumption of dark green leafy vegetables or yellow fruits and other diets rich in vitamin A during pregnancy, lactation and childhood period prevents vitamin A deficiency.

Infants

Immediately after birth 'colostrum feeding' to young babies provides best of vitamin A as colostrum is rich in vitamin A.

Encourage: Exclusive breastfeeding till 6 months of age.

- Adequate quantity of supplementary feeding beyond 6 months of age; add vitamin A rich foods like egg yolk, green leafy vegetables and milk besides staples.
- ***Control infection:*** Early recognition and prompt treatment of diarrhoea, acute respiratory infections and deworming for parasite infection will improve the status of vitamin A.
- Immunization against measles and giving vitamin A 1,00,000 units at 9 months of age.
- ***1–5 years children:*** Adequate diet and vitamin A rich foods and prompt treatment of infection. Vitamin A megadose 2,00,000 IU at 16, 24, 30, 36, 42, 48, 54 and 60 months of age.

Measles, Severe Malnutrition and Vitamin A

- All children suffering from measles or suspects should be given one dose of vitamin A, even if the child has received it within the previous one month. Vitamin A reduces measles mortality and associated complications of the respiratory and gastrointestinal tract and hence beneficial (*see* Chapter 8: Measles).
- All cases of severe protein energy malnutrition should be given one additional dose of vitamin A.
- All children with xerophthalmia should be given 2 doses of synthetic vitamin A as per present schedule of Government of India under RCH programme.
- No additional dose of vitamin A is required for children suffering from diarrhoea and respiratory infection.
- No vitamin A mega dose for pregnant or lactating mother recommended under the programme.

Improving diets and dietary intakes of vitamin A holds key in the long run. Growing vitamin A rich foods in the kitchen garden or in farms and fields and consumption of these foods by children, pregnant and lactating women can go a long way. Administration of synthetic vitamin A is a short-term measure and it cannot substitute the adequate intake of vitamin A through food rich in vitamin A and culturally acceptable foods.

Bad Practices and Beliefs

Bad practices and beliefs are discarding of colostrum, delaying supplementation of food, feeding less quantities of food to young children, belief that green leafy vegetables cannot be digested by young children. Many families consider that mango and papaya are 'hot' foods and are harmful for children and pregnant women; hence discouraged. Lack of information to families and community has been a stumbling block.

NATIONAL PROGRAMME FOR VAD (CONTROL OF BLINDNESS)

VAD was recognized as a major public health problem in India in 1970 and in late 1970s it was estimated that 30,000–40,000 children could lose their eyesight due to

VAD in India. The prevalence of eye signs of VAD was as high as 30–50% in some states in 1960. The National Prophylaxis Programme against blindness due to VAD was launched in 1970 and by 1975 the whole country was covered.

Objective

To prevent nutritional blindness due to VAD, leading to keratomalacia in children under 5 years of age. There were two strategies—short-term and long-term.

- **Short-term strategy:** To administer synthetic vitamin A to young children of 9 months to 5 years of age with the objective of decreasing the prevalence of VAD to below 0.5%.
- **Long-term strategy:** Ultimate solution for prevention of vitamin A deficiency is regular consumption of vitamin A rich foods which are cheap and locally available (food based approach).

Target—short-term strategy: Preschool children in age group 9 months to 5 years were targeted for the programme.[12–14]

Vitamin A Prophylaxis: Current Strategy

Prevalence of vitamin A deficiency is maximum in age group 6 months to 3 years. In addition to the risk of blindness, the children with vitamin A deficiency are at a risk of dying due to infections. It is, therefore, imperative that all children in this age group be given vitamin A prophylaxis.

- Every child in age group 9 months to 5 years be given 9 doses of vitamin A.
- The first dose of 100,000 IU or 1 ml solution of vitamin A will be given at 9 months preferably along with measles immunization.
- The second dose of 200,000 IU will be given at 16 months with booster dose of DPT/OPV.
- Seven more doses of 200,000 IU will be given at 6 months interval thereafter.

Vitamin A Deficiency

In children who have vitamin A deficiency, the surface of cornea becomes dry and rough and may ultimately breakdown partially or completely. This may lead to ulceration and permanent scarring or irreversible damage and permanent loss of eyesight. Ocular signs which are associated with vitamin A deficiency are night blindness, xerophthalmia, Bitot's spots, corneal xerosis/ulceration, keratomalacia, corneal scars and fundal xerophthalmia. In a child with symptoms of night blindness, therapeutic doses of vitamin A should be given.

- Give 200,000 IU of vitamin A immediately after diagnosis.
- Give one more dose of 200,000 IU 4 weeks after (dose in infant is 100,000 IU). Children who have an eye lesion must be given the first therapeutic dose of vitamin A and referred urgently for specialist care.

Delivery System

Vitamin A solution is provided to sub-centres as part of drug kit A. 12 bottles (1200 ml) per annum are provided in the kit at sub-centre.

Multipurpose health worker female (MPHWF) provides vitamin A prophylaxis to children and maintains records and submits reports to primary health centre. She assesses the needs of vitamin A prophylaxis as part of community need assessment under RCH programme.

Similarly, under integrated child development services (ICDS), the *Anganwadi* workers also help administer vitamin A solution to children in age group 9 months to 5 years. This helps to increase the coverage of vitamin A prophylaxis. Vitamin A bottle once opened should be used within 8 weeks.

Integration: Administration of vitamin A has been integrated with universal immunization programme to reduce the number of visits of mothers to sub-centre or *Anganwadi*. At least two doses will be ensured—one with measles immunization and one with booster DPT/OPV.

Coverage

Vitamin A prophylaxis coverage level has been low. Overall coverage for first dose as revealed through coverage evaluation survey (2009) in India was around 64%. NFHS-5 indicated that 71.2% of children in age group 9 to 35 months received a vitamin A dose in the last 6 months. It is linked with coverage of measles immunization which is around 81%.

Logistic Problems

Problem of shortages of supplies and frequent stock-outs and delay in supply are the major bottlenecks which interrupt the programme, available infrastructure on the ground needs to ensure adequate coverage.

Vitamin A with national immunization days (NIDs) along with pulse polio immunization (PPI): This strategy was promoted by WHO and UNICEF in UP and Odisha state in October 1999 and March 2000. High level of coverage was ensured in Odisha state but in UP variable coverage was reported. This massive drive ensured the increase in coverage but it was not favoured as a regular strategy in the country.

Pregnant and Lactating Mothers

It is neither possible nor necessary to give vitamin A supplements to all pregnant and lactating mothers in the country. As part of comprehensive antenatal and postnatal care, women should be screened for night blindness. If pregnant/lactating women have night blindness, they should be referred to physician in the nearby primary health centre or any other health facility for appropriate management. In view of the potential toxic and *teratogenic* effects of high doses of vitamin A, pregnant and lactating women with symptoms of night blindness should be treated

with vitamin A in dosage not exceeding 10,000 IU per day. They can be given vitamin A till symptoms of night blindness disappear.

Fortified Foods

In several countries including India under the micronutrient initiative programme, attempt has been made to fortify common food items (sugar, wheat flour, candy, etc.) with vitamin A concentrate, however, this has not been favoured as a strategy. Food-based approach holds the key to improve the dietary intake of vitamin A.

Ultimate Solution (Food-based Solution)

The ultimate sustainable solution for the prevention of vitamin A deficiency is regular consumption of vitamin A rich foods which are cheap and locally available. Vitamin A consumption must be ensured from birth itself. Breast-feeding, including feeding of colostrum, will protect children from vitamin A deficiency during the first 6 months. From the age of 6 months, it is crucial to introduce complementary (semisolids) food containing rich sources of vitamin A, such as dark green leafy vegetables, yellow vegetables and fruits (carrots, capsicum, yam, pumpkin, papaya, mango). Most leafy vegetables contain more than the recommended dietary allowance (RDA) of vitamin A, for Indian children is about 50 g of edible portion. This quantity on cooking, is reduced to two tablespoons. A child can easily consume this amount with other food items, thereby meeting its total daily requirement.

In addition to green leafy vegetables as far as possible, incorporation of other vitamin A rich foods, such as dairy products (milk, cheese, curd, butter) liver, eggs, oil and fat should be encouraged in the daily diet of preschool children who are prone to develop vitamin A deficiency. Such food practices will prevent vitamin A deficiency. Daily consumption of dark green leafy vegetables and other vitamin A rich foods are also recommended during pregnancy and lactation. Mother's vitamin A status influences the vitamin A content of mother's milk and the health status of her children. Adequate intake of vitamin A rich food during pregnancy and lactation will prevent vitamin A deficiency both in mother and child.

Future strategies: Targeted intervention in areas showing vitamin A deficiency, such as Odisha, MP, Rajasthan, UP and other pockets may be over-riding priority.

IODINE DEFICIENCY DISORDERS (IDDs)

LEADING CAUSE OF PREVENTABLE MENTAL RETARDATION

Iodine deficiency disorders are prevalent worldwide. Iodine is an essential micronutrient and element and it is necessary for synthesis of the thyroid hormone, i.e. thyroxin (T_4) and tri-iodothyronine (T_3). Thyroid hormone regulates wide variety of vital physiological processes, such as early growth and development of the brain and body in man. Scientific studies in India and abroad have evidence that nutritional iodine deficiency causes deficiency of thyroid hormone during fetal life and childhood.

Why Iodine Deficiency?

Iodine is only present in soil, hence IDDs are environmental problem. Iodine deficiency results from geological rather than socioeconomic conditions. The problem is aggravated by environmental factors, such as accelerated deforestation and soil erosion. Iodine is present in the top crust of soil, frequent floods cause washing of iodine from soil crust and same happens when glaciers slide down mountains. Unlike nutrient, such as iron, calcium or the vitamins, iodine does not occur naturally in specific foods, rather it is present in the soil and is imbibed through food grown on that soil. The ideal situation is where the daily needs of iodine are met from natural foods grown in iodine rich soils.

Foods grown in iodine deficient region can never provide enough iodine to the population and livestock living in such areas. IDD cannot be eliminated by changing dietary habits or eating certain kinds of foods grown in that area. The correction has to be achieved by supplying iodine through the external source. This can be done by *fortifying* a commonly consumed food with iodine.

Solution

Iodation of salt is a long-term and sustainable low-cost solution, which will ensure that iodine reaches the entire population and is ingested on regular basis. *Fortification* of salt with iodine has been extremely successful in eliminating iodine deficiency all the world over.

Requirement of Iodine

Iodine is an essential micronutrient. Normal daily requirement of iodine for an adult is 150 µg which is absolutely safe for normal body functions (Table 5.15). Iodine deficiency produces wide-spectrum of disorders and these disorders caused due to deficiency of iodine are called iodine deficiency disorders (IDDs).

Table 5.15: Revised recommended daily iodine intake (ICMR–NIN 2020)

Age groups	*Requirement (µg)*
• Infant (6–12 months)	130 (AI)
• Children (12–59 months)	90
• Children (7–9 years)	90
• Adolescents	100–140
• Pregnant and lactating women	220–280
• Adults	140

Upper Limit of Iodine Intake

Excess of iodine ingestion can be harmful, which may inhibit the synthesis of thyroid hormones. The iodine induced hypothyroidism is known as 'Wolff Chaikoff' effect.

Spectrum of IDDs

Lack of iodine in the environment has serious consequences for both human beings and animals. Goitre is only the tip of the iceberg or just one manifestation of spectrum of IDD.

A less obvious but more serious condition affecting million of iodine deficient children include impaired mental functions, poor intellectual performance, lowered IQ, muscular disorders and impaired coordination and sluggishness. In pregnancy, iodine deficiency causes spontaneous abortions, stillbirth, and infant deaths.

Deficiency of iodine in pregnant women interferes with the brain development of foetus and results in birth of iodine deficient babies who may be cretins characterized by mental deficiency, hearing defects, squint and stunted growth. Children born to iodine deficient women can develop, neonatal chemical hypothyroidism (NCH) and develop total brain damage which is permanent and irreversible and limits intellectual growth in later years.

The world's single most significant cause of preventable brain damage and mental retardation is deficiency of iodine. Iodine deficiency is the leading cause of preventable mental retardation in the world. Current research indicates that iodine deficiency results in lowering the average intelligence of the entire school age population by as much as 10–15 IQ points. 40 million school children in endemic areas may lose 400 million IQ points.

Effect of Iodine Deficiency in Humans and Animals: Spectrum of IDD in Human Beings

Foetus: Abortions, stillbirth, congenital abnormalities, increased perinatal mortality, increased infant mortality. Neurological cretinism: Mental deficiency and deaf-mutism, spastic diplegia, squint. Myxomatous cretinism: dwarfism, mental deficiency and psychomotor defects.

Neonate: Neonatal goitre, neonatal hypothyroidism.

Child and adolescent: Goitre, juvenile hypothyroidism, impaired mental function, retarded physical development.

Adult: Goitre with its complications, hypothyroidism, impaired mental function.

In animals: IDD leads to reduced yield of milk, eggs, meat and wool and reproductive failure.

Epidemiological Criteria for Assessing Severity of IDD and Elimination of IDD

WHO has fixed criteria for classifying IDDs as significant public health problem by following indicators (Table 5.16):

- TGR—total goitre rate (grade I plus garde II goitre)
- Median urinary iodine concentration
- Thyroid volume by ultrasound
- Salt iodine content.

For sustainable **elimination** of IDDs, the following three criteria should be met.

1. Ensure 15–30 ppm of iodine in salt at consumer level.
2. Median urinary iodine exertion between 100–200 µg/L.
3. TGR (percentage of children aged 6–12 with palpable and visible goitre) should be less than 5% (WHO).

Magnitude of Problem

IDDs is a global problem. In 1994, it was estimated that around 1500 million people were at risk of IDD and 225 million had goitre, 0.6 million were cretins and 20 million had mild neurological disorders. Many babies are born as cretins who are mentally retarded, physically stunted, deaf, mute or paralysed. Many more have IQ at least 13.5 point below their potential[15] with poor **scholastic performance**.

Magnitude of IDD in India

IDDs have been recognized as a public health problem in India since 1920. Unlike other micronutrient deficiencies, iodine deficiency disorders are due to deficiency of iodine in water, soil and foodstuffs and affect all socio-economic groups living in a defined geographical area. Initially IDD was thought to be problem in sub-Himalayan region, however, surveys carried out subsequently showed that no state in the country is completely free from IDD.

Table 5.16: Epidemiological criteria for assessing the severity of IDD

Indicator	*Target population*	*Severity of public health problem (prevalence)*		
		Mild	Moderate	Severe
Goiter grade >0	School aged children (6–12)	5–19.9%	20–29.9%	≥30%
Median UIE (µg/L)	SAC	50–99	20–49	<20
Thyroid volume >97th centile by ultrasound	SAC	5–19.9%	20–29.9%	≥30%
TSH >5 mU/l	Neonates	10–19.9%	20–39.9%	≥40%
Median Tg ng/ml serum	C/A	10–19.9%	20–39.9%	≥40%

Target population is school aged children (SAC); C/A: Children and adults UIE: Urinary iodine excretion

At risk population: The general notion that goitre is confined to endemic area/belt is wrong, it has widespread prevalence. In our country, whole of population is at risk but 200 million people are at serious risk of IDD while the number of persons suffering from goitre and other IDDs is above 71 million (Fig. 5.7). Surveys conducted in the country indicate that no state/union territory is free from problem of IDDs. Out of 427 districts surveyed up to 2018 there are 348 endemic districts, where prevalence of TGR (palpable and visible goitre) is above 5%. There is significant reduction in visible goitre in the country.

Endemic district: The district is declared as endemic district if the prevalence of total goitre rate (TGR) is above 5% in the children of age group 6–12 years surveyed.

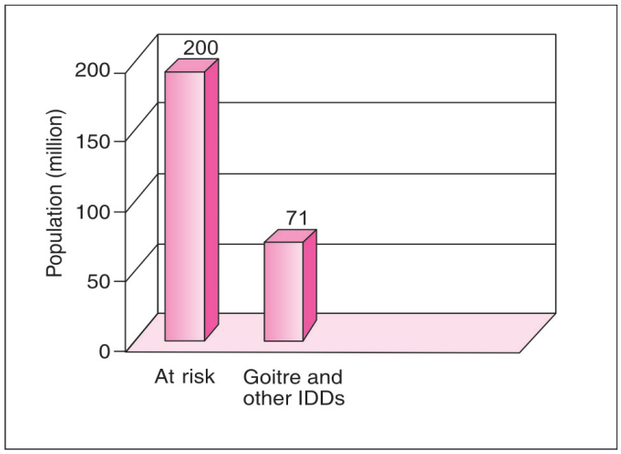


Fig. 5.7: Problem of IDDs in India

Prevention

IDDs are preventable. Daily consumption of iodized salt prevents the spectrum of disorders caused due to iodine deficiency. Consumption of iodized salt is safe. Iodation of salt is a low-cost highly effective means of prevention. The cost of iodation is ₹ 2–3 per person per month. The average consumption of iodated salt per person per day is 10 g. The supply of iodated salt must ensure that availability is between 150–300 mcg of iodine per day at consumer level.

NATIONAL IDD CONTROL PROGRAMME (NIDDCP)

Following the successful trial of iodized salt in Kangra valley, Himachal Pradesh, a National Goitre Control Programme (NGCP) was launched in 1962. Initially, the programme aimed at providing iodized salt to well recognized sub-Himalayan 'goitre' belt. However, there was no substantial reduction of iodine deficiency disorders due to erratic availability of salt, use of cheaper non-iodized salt and lack of awareness of use of iodized salt. In view of the fact that no state was free from IDD, a decision was taken for universal iodation of salt for human consumption, which was implemented in phased manner from 1986. The progress of implementation of this programme was tardy as the production and availability of iodised salt was a fraction of what was required.

Realizing magnitude of the problem, the Government of India launched a 100% centrally assisted National Goitre Control Programme (NGCP) in 1962. In August 1992, the NGCP was renamed as National Iodine Deficiency Disorders Control Programme (NIDDCP) taking into its ambit the control of wide-spectrum of IDDs like mental and physical retardation, deaf mutism, cretinism, stillbirth, abortion, etc. In 1984, policy decision to universal iodization of edible salt was taken by the Government.[16]

Objectives of NIDDCP

The goal of NIDDCP is to reduce the prevalence of IDDs (iodine deficiency disorders) below 5%.

The important objectives and components of NIDDCP are as follows:

- Universal iodization of salt and supply of iodated salt all over country in place of common salt and to ensure 100% consumption of adequately iodized salt (15–30 PPM) at the household level.
- Surveys to assess the magnitude of the IDDs.
- Resurvey after every 5 years to assess the extent of IDDs and impact of iodated salt.
- Laboratory monitoring of iodated salt and urinary iodine excretion (UIE).
- Health education and publicity.

Goal of NIDDCP

The goal of NIDDCP is to reduce the prevalence of IDDs below 10% in entire country by 2015 and below 5% by 2025.

- Achieve universal access to iodized salt by iodization of 50 lakh MT of edible salt.
- Generate district-wise data on iodized salt consumption.

Strategies[17-20]

1 *Universal salt iodization* (USI) to eliminate IDDs. It is essential to ensure that only iodized salt is made available for human consumption in order to enable children of 21st century to attain their full intellectual potential and take their rightful place in a knowledge-based society. The Government of India took a policy decision to iodate the entire edible salt in the country by 1992. The programme of iodation commenced in 1986, in phased manner. Since then the approach has been to enhance the production, demand and supply of iodated salt. All states and cities have been advised to ban sale of non-iodized salt under prevention of Food Adulteration Act (Now Food Safety and Standards Act, 2006). Ban was imposed by most states. Most states banned non-iodized salt. The ban, however, was lifted in the year 2000 by central government, which was a

set back indeed. The central government again issued the notification banning the sale of non-iodated salt for direct human consumption in the entire country with effect from 17th May, 2006 under the Prevention of Food Adulteration Act, 1954.

2 *Improve the quality of iodized salt by:*
- Mandatory certification of adequacy of iodization as a prerequisite for getting priority for the transportation of salt.
- Ensuring that salt is packed in half or one kg consumer poly-packs at production site itself to prevent deterioration in quality during transportation and storage.
- Periodic checking of iodine content of salts available at wholesale/retail outlets.
- Quality check at the household level through health workers, ASHA, *Anganwadi*/school-based testing—using spot testing kits (STK).

3 *Information education and communication (IEC):* To increase the demand for good quality iodized salt providing ready access to iodized salt through targeted public distribution system.

4 *Monitoring:* Monitoring of production and distribution of quality of salt at various levels:
- Monitoring of prevalence of goitre in 6–12 years age group in schools, urinary excretion of iodine, neonatal thyroid status by appropriate screening techniques may be used to assess the impact on reduction of IDDs.
- Monitoring of iodine content of salt at production, distribution and consumer level. The goal of USI is >90% households should be consuming iodized salt.

Iodization of Salt

Salt is universally consumed by all households. Hence, this has been used as carrier of iodine to mitigate the problem of IDD.

On an average, 10 g of salt is consumed per day per person. To meet daily requirement of 150 µg of iodine we need to ensure 15–30 parts per million (ppm) or 15–30 mg of iodine per kg of salt, at consumer level. It is a common knowledge that salt from production centre to consumer takes a long journey and time and is exposed to heat, sunlight, moisture and cooking. Therefore, to ensure iodine content of 15–30 ppm at consumer level, it is necessary to ensure 30 ppm of iodine at production level so that when salt reaches at household level it retains at least 15–30 ppm of iodine to meet FSSAI standards.

Policy and Revised Standards by FSSAI

As per the revised standards recommended by FSSAI, all forms of edible salt should have 15–30 ppm of iodine. The desired **mUIC** should be between 100–200 µg/L as per **WHO**. Salt comes under the purview of food adulteration Act. It is mandatory for manufacturers to adhere to these standards.

Chemicals for Iodization

Salt can be iodized with potassium iodide (KI) or potassium iodate (KIO_3). In India, potassium iodate, which is more stable in Indian weather conditions, has been chosen for iodation of salt. Potassium iodate of 50 ppm (equivalent to 30 ppm of iodine) is added at production level. Since losses are imminent because of transportation, storage and weather conditions (moisture and heat) and cooking it is expected that 50 ppm of iodate at production level will ensure at least 25 ppm of iodate (equivalent to 15 ppm of iodine) at consumer level.

Testing of Iodine Contents of Salt

Spot testing kit (STK): Iodine content of the salt can be tested at consumer level by spot testing kit (STK). This is a qualitative and rapid test but does not indicate absolute value. When kit reagent indicator solution is dripped on salt sample spread in a plate or any container a blue colour develops if the salt contains iodine. The intensity of colour can be matched with the colour codes depicted over the kit to judge qualitatively iodine content of sample as: 30 ppm (deep blue), 15 ppm (light blue) 7 ppm (lightest blue), 0 (no colour). Do not jump to conclusion if there is no colour change of salt. This may be due to high alkalinity. Take another sample and spread it on a surface and add sulfuric acid and then add indicator solution on the same spot where sulfuric acid was added and observe the colour change and match it with the colour coded scale. STKs have been supplied to ASHA and health workers.

Iodometric Titration

Analysis of iodine content of iodated salt on quantitative basis can be done by iodometric titration, at the district level or state level laboratory. Sample of salt is treated with concentrated sulfuric acid which liberates iodine. The free iodine is titrated with sodium thiosulphate; using starch as an indicator.

Urinary Iodine (mUIC)

Adequate median urinary iodine concentration (mUIC) in 1–19 years age group is 100–200 µg/L and for pregnant women 150–250 µg/L. If the intake of iodine is optimal, the mUIC less than 50 µg per litre in children and adolescents is classified as suboptimal iodine intake at population level. This is the most important indicator for assessment of impact in salt iodization programme and assessment of intake of iodized salt.

Present Status of Programme

Accessibility of iodized salt: During the year 2017 nearly 93% of the population was consuming iodated salt. The goal of USI is 100% of households to consume iodized salt. As per NFHS-5 data 94.3% of households used iodated salt in 2021.

Guidelines for District IDD Goitre Survey

Purpose is to study the prevalence of IDD with a view to know the magnitude of problem and to assess the impact of interventions.

Focus: School-aged children (SAC) 6–12 years, and general population.

Guidelines for District IDD Survey[18]

Survey Method

The IDD survey at the district may be conducted by using the method of population proportionate to size (PPS) sampling in the age group of 6–12 years children. A sample of 30 villages/wards or schools is selected from the district by cluster sampling technique.

Sample

- A sample of 90 children (45 boys and 45 girls) of age group of 6–12 years from the school and out of school/households of selected village/ward has to be selected as explained below.

Suppose in the selected village the enrolment rates are:

Boys = 40% and Girls = 30%.

Then, the allocation of samples of 45 boys and 45 girls to be selected from school and out of school would be as under.

	Boys	*Girls*
School	18 (40%)	13 (30%)
Out of school	27 (60%)	32 (70%)
Total	45 (100%)	45 (100%)

For selection of 18 boys from primary school classes, if the number of classes are 5, then the sample would comprise selecting 3 children each from class 1st and 2nd, 4 children each from classes 3, 4 and 5 by random method from attendance register. Similarly, sample of 27 out of school children from the village/ward has to be selected. This has to be allocated into various age groups approximately equal. In the present case, it would be 5 children in each age groups 6, 7, 8 and 12 children from the remaining age groups by random selection. Register of *Anganwadi* workers can be used for the purpose to locate households/families.

Salt Samples

Every 5th child selected in the earlier steps for goitre survey be covered for collection of salt samples by visiting the corresponding houses.

Sample for Urinary Iodine Excretion

For UIE, every alternate child out of those selected earlier step for salt samples has to be taken for collection of urine sample.

If the school enrolment rate in the village is 90%, then the sample may be restricted to school mainly. Alternative if the enrolment rate is as low as 10% then the household approach may only be used.

Monitoring

Fifty samples of salt per month per district, 25 from rural households, 15 from urban households, 7 from rural retailers and 3 from urban retailers are to be collected. 25 samples per district per month for urinary iodine excretion (UIE) should be collected.

Techniques of Examination

From the clinical point of view, the diagnosis of goitre is based entirely on inspection and palpation of the neck. The position taken by the examiner in relation to the person being examined is a matter of personal choice. Some workers face the subject and usually palpate the isthmus and lobes with two thumbs, the fingers of both hands being spread around the lateral side of the neck. Other workers stand at one side of the subject, the side depending on whether they are right-handed or left handed. The palpation is done with the first or the first and second fingers. The examiner should be so positioned that his eyes are approximately at the level of the subject's neck. This means that in case of young children, the examiner must be seated. When assessing the visibility of an enlarged gland, it is important that the subject keeps the head steady so that the eyes and the external aural meatus are on a plane.

To assist in palpation, it is frequently desirable to depress the subject's chin to relax the neck muscles. At the commencement of palpation, the isthmus should first be located and then the thumbs and fingers should move laterally to identify the lobes and assess their size.

In people with a short neck, the sternum may hide a part or the whole thyroid gland; this occasionally makes diagnosis difficult.

Nodules should be noted and recorded separately.

Classification of Goitre

Most classifications distinguish between different grades of goitre and broadly between visible and palpable goitres and record the presence or absence of nodules. Visible goitres, as a general rule, indicate a moderate-to-severe deficiency of iodine of a relatively long duration and thus tends to be more common among older people. Their presence in children suggests a severe deficiency of iodine. Similarly, nodules are likely to be present to a significant degree only in areas of marked deficiency of iodine for a very long period. Palpable goitres have a special significance in the assessment of the control programme, e.g. salt iodization programme.

As per a recent WHO publication (1994), the previous five grades of goitre namely grade 0, IA, IB, grade II and grade III have been classified into three grades as grade 0,

grade I, and grade II. The detailed description of each grade is given below.

Grade Description

- *Grade 0:* No palpable or visible goitre/**no goitre.**
- *Grade I:* A mass in the neck that is consistent with an enlarged thyroid, that is palpable but not visible, when the neck is in normal position. It moves upward in the neck as the subject swallows. Nodular alteration(s) can occur even when the thyroid is not enlarged/**goitre palpable but not visible**.
- *Grade II:* A swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated/**goitre visible and palpable**.

Salt Consumption Pattern and Practices

Salt consumption pattern and practices were studied by ICMR in year 1987. It was observed that in rural areas crystal salt was preferred and purchased in bulk by 20% of the households for 3–6 months for human and animal consumption. Most households procure loose salt and store it in earthen pots. Storage practices were bad and most salts were exposed to light and moisture. Over 80% of households preferred loose crystal salt because of being cheaper. Washing of crystal salt was observed in 20% of families.

Cooking in open pan/utensil was common. Pressure-cooker was used by a few households. Iodine losses due to cooking practices could be as high as 40%. Most of the families added salt before cooking. Average consumption of salt per person per day was around 10 g.

Sustainable elimination of IDDs is possible by daily consumption of iodated salt by all.

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ZINC NUTRITION

Zinc is a trace element or micronutrient. Deficiency of micronutrients like iron and iodine is widespread but zinc deficiency is not that common.

Functions

Zinc is a cofactor for over 200 metal enzymes regulating various cellular functions of the body.

Zinc is associated with wide range of body functions like cell division and growth, membrane function, provides protection against free radical damage, helps in gonadal

functions, helps in immune functions, foetal development, brain development and influences metabolism of vitamin A.

Requirements

The daily requirement is 2 mg for infants, children up to 10 years 5–7 mg, and for adults 13–17 mg per day (Table 5.17).

Table 5.17: RDA of zinc (mg per day)

Men	*Women*	*1–3 yrs*	*4–6*	*7–9*	*10–12*	*13–15*
17	13.2	3	4.5	5.9	8.5	12.8 to 14.3

Severe Zinc Deficiency

Severe zinc deficiency leads to neuropsychiatric changes, dermal lesions, diarrhoea and loss of hair, impotence and hypogonadism.

Acrodermatitis enteropathica: It is an autosomal recessive genetic disorder which leads to intestinal zinc malabsorption. This condition interferes with zinc uptake by the intestinal epithelium. The manifestation of deficiency appears around 6 months of age in the form of severe skin lesions, alopecia, failure to thrive and diarrhoea. Plasma zinc levels are very low in these cases.

Acquired zinc deficiency syndrome: This was described from Egypt in 1960. The syndrome produced dwarfism, hypogonadism, geophagia, anaemia and hepatomegaly. Response to zinc therapy was quite dramatic in these children. Zinc deficiency occurs due to wide ranging pathological disorders, such as chronic alcoholic liver disease, sickle cell anaemia, in severe protein energy malnutrition, chronic malabsorption syndrome.

Zinc deficiency does not occur in isolation. Sometimes, back, zinc as nutrient was widely recommended to pregnant women, to low birth weight babies and in acute diarrhoeal diseases to promote growth of babies and early recovery from disease process.[1,2] The widespread use as therapeutic agent or for prevention is hardly justified. Nearly one fifth (19%) of pre-school children aged 1–4 years, 17% of school age children 5–9 years and 32% of adolescents 10–19 years were zinc deficient in 2018.

Zinc as an adjunct to ORS: Government Policy (*see* under Diarrhoea Control and ICDS Programme).

Other nutritional deficiency diseases: Vitamin B complex deficiency particularly riboflavin deficiency leading to angular stomatitis, glossitis and cheilosis. Pellagra, which is primarily due to nicotinic acid deficiency, is reported to be caused by excess leucine in the staple jowar leading to amino acid imbalance and decreasing conversion of tryptophan to niacin. Vitamin D deficiency is also prevalent in some areas. Serum 25(OH) D concentration <12 ng/ml (30 nmol/L) was used as cut-off level to define vit. D deficiency. Accordingly 14% of preschool children aged 1–4 years, 18% of school children, 5–9 years and 24% of adolescents aged 10–19 years had vit. D deficiency in 2018.

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Competency addressed: The student should be able to:
CM 5.2: Describe and demonstrate correct methods of performing a nutritional assessment of individuals, families and **community** by using the appropriate method.

DIETARY (FOOD CONSUMPTION) SURVEYS

The dietary surveys mean what people eat and how much they eat, what are their likes and dislikes and dietary beliefs as also dietary practices.

Purpose and Uses

The primary purpose of dietary survey is:

1 To ascertain dietary intake of most vulnerables.
2 To improve the diets of people at household level particularly to improve the diets or feeding of young children, pregnant and lactating women.
3 For planning of national food strategies, data on dietary consumption is essential.
4 Dietary surveys are also done to assess the effect of nutrition education programme.
5 Periodic dietary surveys done at time intervals provide information on trends of consumption.
6 These surveys also help to know the special preference for a food and foods avoided or disliked and alternate foods consumed during the special conditions like droughts and in tribal areas.
7 When designing specific programme on nutrition, dietary surveys are needed to have evidence-based data.

Dietary surveys in medical profession are not new, however, the only part of 'dietary survey' most often known to a medical student/doctor is dietary history, vegetarian or non-vegetarian and it begins and ends there only. No details or dietary intake/assessment are made.

Limitation of Dietary Surveys

These are time consuming and expensive and requires training of workers. The data collected may have limitation and may not be representative of total population.

Types of Dietary Surveys

There are two types of dietary surveys:

1 Qualitative food intake
2 Quantitative intake of food.

Qualitative Survey

How? The qualitative intake of food means food items consumed, their frequency of consumption, daily, weekly or once a while/occasionally, food preferred and food avoided. We can also assess the dietary beliefs and practices of interest. This is a rapid method of assessment. Qualitative methods can have focussed attention on dietary practices during infancy, young children, pregnancy and lactational period.[1]

Food consumption of young children between 6–23 months of age can be assessed by three indicators: Minimum dietary diversity, meal frequency and acceptable diet (proportion of children consuming 4 or more food groups, proportion of children consuming solid and semisold foods for minimum number of times and minimum acceptable diet).

Quantitative Survey

The quantitative dietary survey makes assessment of amount or quantities of food items consumed, are recorded and nutrient composition are determined from tables of food consumption.

Methods of Dietary Surveys[2]

Several methods for dietary surveys have been used at national and international level. These are:

1 Food balance sheet (FBS)
2 24 hours recall method
3 Weighment method
4 Inventory method list
5 Expenditure pattern method
6 Diet history
7 Duplicate samples
8 Recording methods.

Before the surveys are conducted, we should list all the family members who partook the meals yesterday, their ages in completed years for adults and completed months for infants and young children, their physiological status (pregnancy and lactation) and occupation (sedentary, moderate, heavy and very heavy worker) as also socio-economic status. This step helps to arrive at adult consumption units.

1. Food Balance Sheet (FBS)—at National Level

Each country maintains food balance sheet, which indicates total food available or produced in the country as also the available buffer stocks. At the international level, Food and Agricultural Organization (FAO) monitors the food available in each country. India produces 316 million tonnes of food grains every year and there are buffer stocks of 60 million tonnes. It gives an estimate of food available in the country per person per year or per day.[3] It is no guarantee that this much is consumed by each person. This information helps national planners for adequacy or inadequacy of available food. Per person availability of food is determined by:

$$\text{Per person per day of food availability} = \frac{\text{Beginning of the year stock (BOYS) + total food produced + imports} - \text{Stocks at the end of the year + exports + seeds + cattle/poultry feeds + wastages}}{\text{Total mid-year population} \times 365 \text{ days}}$$

During the year 2021–22 record food grain production of 316 million metric tonnes was achieved in India.

Per capita availability of cereals in India in 2019 per person per day was 444 G besides 48 G pulses.[3]

2. 24 Hours Recall Method

This is the most popular method, most practical and easy low-cost method to make assessment of quantitative dietary intake. The housewife or individual is asked, which food and what amounts were consumed on previous day or yesterday. Avoid festival, fast and feast days.

Information on type of food preparation, ingredients used, raw amount of ingredients used for each preparation and total cooked amount (g/ml) from morning to night are collected on the proforma (Table 5.18). Cooked amount in g/ml consumed by individual is obtained/calculated. Equivalent raw amount is arrived at in g/ml. In addition data on cooking practices and iodine content of salt is also tested.

Gathering this information takes not much time but the conversion of household measures to g/ml can be laborious process. Common household measures are standardized and shown to individual or housewife to get approximate consumption of cooked food and thereafter the equivalent raw amount intake by individual is arrived at. Much depends upon the cooperation of family and response of individual and the type of investigator. Since practice of cooking of rice is universal; the cooked rice is filled in standardized cups, which are serially numbered and conversion factor is applied to get amount of raw rice consumed (Table 5.19).

To assess the total cooked amount, for the preparation like tea/coffee/milk or any other beverage or soft drink or dal/sambar/curries use the volume of standardized cups and measures. Under field conditions, volumes and weights have to be considered as one and the same. Total cooked amount of rice in the family need not to be assessed since each cup is standardized for its raw amount equivalent. Preparations like chapatis may be assessed in numbers. Assess the individual intake in terms of cooked amount with the help of standardized cups both for rice and for

other preparations. Calculate the individual intake in terms of raw amounts in the following way.

$$\text{Individual intake in terms of raw amount (g/ml)} = \frac{\text{Total raw amount of each ingredient used in preparation by the family (g/ml)}}{\text{Total cooked amount of each preparation}} \times \text{Subject intake of cooked amount (ml)}$$

3. Weighment Method

Weighing of raw food and cooked food offers advantage over questionnaire method or 24 hours recall method of dietary survey, as it is more accurate. The family may not allow to weigh the foods. Weighing of cooked food in institutions or hostels is favoured. Usually in field and community survey, raw foods are weighed for consecutive one week. This necessitates presence of investigator each time a preparation is made, hence it is quite difficult and least practical method. Weighing for one day could be considered sufficient in view of practical difficulties involved.

Only edible portions of raw food are weighed before cooking. The results of raw food consumption are expressed as intake of foods in g per consumption unit (CU) or per person as follows:

$$\text{Intake per CU per day (g/ml)} = \frac{\text{Raw amount of each food (g/ml)}}{\text{Total CU} \times \text{No. of days of survey}}$$

$$\text{Intake per person per day (g/ml)} = \frac{\text{Raw amounts of each food (g)}}{\text{No. of persons} \times \text{No. of days of survey}}$$

4. Inventory Method List (Logbook Method)

This method is applicable in hostels, orphanage, hospital and other institutions.

In this method, actual amount of foodstuffs issued by the incharge of the institute are taken into account for consumption. If the housewife is able to maintain a log-book of amounts of foodstuff purchased and consumed in a week time then this method can be used for food-consumption at household levels. The average intake of food per person per day is calculated as follows:

$$\frac{\text{Stock at the beginning of week} - \text{Stocks of the end of the week}}{\text{Total number of inmates partakingg the meal} \times \text{No. of days of survey}}$$

5. Expenditure Pattern Method

We determine the money spent on food and non-food items by questionnaire. The reference period is fixed and indirectly the amount of food items consumed during a period is arrived at and amount of food items consumed per consumption unit or per person is derived at. If the instructions are correct and family is cooperative, this method is good proxy method for weighment method.

6. Diet History

This method assesses the qualitative intake of food items and their frequency of intake as discussed in the beginning.

7. Duplicate Samples

What is consumed in the family, the same amount of each food item is kept separately per day as duplicate sample.

Table 5.18: Dietary information by 24 hours recall method

Meal pattern	*Previous day's intake of family*				*Individual Intake*	
(a)	*Type of preparation (b)*	*Ingredients used (c)*	*Raw amount used (g/ml) (d)*	*Total cooked amount (g/ml) (e)*	*Cooked amount (g/ml) (f)*	*Equivalent raw amount (g/ml) (g)*
• Morning tea and snacks						
• Breakfast						
• Lunch						
• Evening tea and snacks						
• Dinner						

Table 5.19: Standardization of cups for raw rice equivalents

Take 200 g of raw rice and cook with known amount of water subtract the weight of vessel and calculate the conversion factor

Raw rice (g)	Water used (ml)	Total cooked amount with vessel (g)	Weight of empty vessel (g)	Net weight of cooked amount (g)	Conversion factor (CF) Raw/cooked
200	400	800	200	600	200/600 = 0.33

Note: If individual has eaten 50 g of cooked rice, raw amount is 50 g × 0.33 = 17 g

These samples can be weighed or samples can be sent to laboratory for analysis. Laboratory analysis of nutrients is most accurate method.

8. Recording Methods

A record of all items of food eaten is maintained by family or individual for a specified period of time, by actual weighing of the quantities eaten. The cooperative and literate families can provide this information, however it needs validation.

Evaluation of Adequacy of Diet

The adequacy of diet is measured by comparing the actual intake of nutrients to the recommended dietary allowances (RDA) for each nutrients.

$$\text{\% adequacy of intake} = \frac{\text{Nutrient consumed per day}}{\text{Recommended dietary intake}} \times 100$$

Dietary survey data has to be combined with nutritional assessment survey. Further, we are particularly interested in dietary consumption of preschool, adolescents, pregnant and lactating mothers, as also their nutritional assessment to corroborate the association between intake and nutritional status. Dietary surveys in India are undertaken on sample basis periodically by NNMB, Hyderabad.

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Competency addressed: The student should be able to:
CM 5.6: Enumerate and discuss important national nutritional programmes.

NATIONAL NUTRITIONAL PROGRAMMES (NUTRITION INTERVENTION PROGRAMMES)

Some of the direct nutrition intervention programmes which are operative in the country to improve the nutritional status of vulnerables were as under. These broadly fall into two categories.[1,2]

1 Food supply and supplementary nutrition programmes:
   a Supplementary nutrition programmes for preschool children.
   b Mid-day meal programme—for school children.
   c Food for work programme—for below poverty line and economically weaker section adults.
   d Subsidized food grains through targeted public distribution system (TPDS), to below poverty line families.
2 Specific nutrient supplementation:
   a Vitamin A prophylaxis for prevention of nutritional blindness.
   b Iron and folic acid for National Nutritional Anaemia Control Programme.
   c Iodized salt for National Iodine Deficiency Disorders Control Programme.
   d Food fortification programme.

SUPPLEMENTARY NUTRITION PROGRAMMES FOR PRESCHOOL CHILDREN (0–6 YEARS)

Logic: Dietary surveys indicated that preschool children diet in the country was inadequate and there was 'food gap' of 300–400 calories and consequently there was widespread protein energy malnutrition (undernutrition and severe undernutrition) among preschool children in the country.

To bridge this food gap, supplementary nutrition programmes were started in the country.

Since pregnant women and lactating mothers were also vulnerable groups, they were included in the programme subsequently.

NATIONAL MID-DAY MEAL PROGRAMME

Mid-day meal in Tamil Nadu started way back in 1925–26 by the corporation of Chennai. In July 1956, the school lunch programme was launched as people's movement for organized charity as part of the school improvement efforts. The state achieved another milestone in 1982 with the launch of nutritious meal programme for school children in classes Ist to Xth. During 2001–02 around 5.80 million children were enrolled for the mid-day meal scheme.

The Government of India initiated mid-day meals for primary school children in 1962–63 as a follow-up measure of school health committee report in 1961–62. The supplies for mid-day meals were donated by the cooperative American relief everywhere (CARE) which were valued as ₹ 40/– per child per year. During the period of droughts in 1966–67, the mid-day meal programme was extended in many areas to cover preschool children, pregnant and lactating mothers, mostly through the CARE programme. Under the scheme, food supplements were to be provided to children of age 6–11 years to meet at least one-third of calories and half of protein requirements for the day. The implementation of programme rests with the education department. The programme coverage was limited and variable.

The national programme of nutritional support to primary education known as National Mid-day Meal Programme (NMMP) was launched in 1995. The honour of starting NMMP goes to Tamil Nadu. The programme took a national shape in 2002. The central government now provides 100 g of grains per child per day as hot cooked meal which provides 300 calories and 10–12 g protein per day for 200 days in a year. Two rupees per child per day are allocated for cooking cost of which one rupee should come from the state government, food grains are provided by the central government free of cost.[3]

Objectives

The objectives of this programme were:

1 To promote universal elementary education by increasing enrolment, retention, attendance and continuation rate in primary classes.

2 To improve the nutritional status of students in primary classes as also their learning or scholastic achievements.

Under the scheme, 100 g of wheat or rice per student per school day is provided for 10 academic months. The mandate is to provide cooked food but in practice 3 kg of cereals (wheat or rice) was given as take home grains at the end of each month to each child. Beneficiary has to attend school for 20 days in a month. In Delhi, ready to eat foods are being provided. Lifting of food grains is an important operational problem. Cooked meal is not provided. Take home ration is no surety that it will be consumed by the child. Subsequent to the directive of Supreme Court cooked meal is being provided now.

This programme has enhanced the school enrolment and attendance, particularly in weaker sections of community. It is one of the largest programme for feeding. Improvement of nutritional status by this much ration appears to be doubtful.[3] School health programmes must be revived and converged with NMMP and NMMP itself merged with SSA *(Sarva Shiksha Abhiyan)*.

SUPPLEMENTARY NUTRITION PROGRAMME (SNP) THROUGH ICDS

ICDS is the world's largest outreach programme. It is now universal programme in India.

Focus

For supplementary nutrition, the focus is on young children from 0 to 6 years of age, pregnant and lactating mothers as also adolescent girls. ICDS programme started in 1975. ICDS is now universal in India and 7067 projects were operational in the country against 7075 sanctioned.

It is an integrated programme of nutrition, health and education with the objective of overall development of young children by good nutrition, reduced morbidity and mortality and empowerment of mothers and women. It is also a programme of enhancing school enrolment. Adolescent girls are also the beneficiaries of supplementary feeding.

Indira Gandhi Matritva Sahyog Yojana (IGMSY)—A Conditional Maternity Benefit Scheme: The Ministry of Women and Child Development provides cash incentive of ₹ 4000 to pregnant and lactating women of 19 years of age and above, for the first two live births. Cash incentive is provided in three installments. If the conditions are fulfilled, *Anganwadi* worker and helper receives an incentive of ₹ 200 and ₹ 100, respectively per pregnant and lactating woman.

APPLIED NUTRITION PROGRAMME

Objective

The objective of this programme was to raise the level of nutrition and standard of living of the vulnerable population; preschool children, pregnant and lactating mothers through education in nutrition and to increase production and consumption of protective foods by the above mentioned vulnerable groups.

- The applied nutrition programme (ANP) was one of the nutrition intervention programme extended to entire country in 1963 with the help of UNICEF, FAO and WHO.
- ***Areas:*** It was meant for rural areas. The Ministry of Rural Development exercised administrative control over the programme. Block development officer (BDO) was incharge of the programme at the block level.
- ***Food production:*** Emphasis was local production of protective foods (through poultries, fisheries, community and school kitchen gardens and community dairies, etc.).

Trained officials and non-officials at block and village level were to organize local committees for supervision and implementation of the programme which was undertaken by village *Panchayats*, schools and *Mahila Mandals* who organized cooking demonstration and feeding programmes for vulnerables. An amount of ₹ 30,000/- per block per annum was provided from central and state funds. During fourth plan, central assistance was raised to 100%. This amount was utilized for digging tube wells, fencing school gardens, establishing community and school gardens and poultry. UNICEF provided vehicles, equipment, supplies and technical experts. The programme failed to generate desired awareness for improved diets and failed to make an impact on production and consumption. The radiating effect of the programme through demonstration was not achieved.

However, the concept of ANP is valid even today, ultimate solution of undernutrition lies in self-reliance and adequate food at home level and that much food for young child is always there. Best of food and nutrition is available in the farm and the home.

TARGETED PUBLIC DISTRIBUTION SYSTEM (TPDS)

While at present, India has in reserve 65 million tonnes of food grains, with heavy post-harvest losses. It is now well recognized that the availability of food grains is not a sufficient condition to ensure food security to the poor. It is also necessary that poor have sufficient means to purchase food. The capacity of the poor to purchase food can be ensured in two ways—by raising the incomes or supplying food grains at subsidized prices. While employment generation programmes attempt the first solution, the targeted PDS is a mechanism for the second option.

With a network of 4.62 lakh fair price shops (FPS) for distributing food at subsidized rates, the PDS in India is perhaps the largest distribution network of its kind in the world. It ensures availability of food to the poor.

TPDS now provides 20 kg of grains per month at 50% of economic cost from 1st April 2000 to below poverty line families. In addition, 35 kg of food grains was to be provided to the poorest of the poor families under the *Antyodya Anna Yojana* at a highly subsidized rate of ₹ 2/- per kg for wheat and ₹ 3/- per kg for rice. TPDS ensures household food and nutrition security to the poor.

National Food security Act (NFSA): From Jan 2023 until December 2023 the beneficiaries would get free food grains, will not have to pay a single penny.

POVERTY ALLEVIATION IN RURAL INDIA

At the beginning of new millennium, 260 million (27%) people in India did not have incomes to access a consumption basket which defines the poverty line, the estimates for which have been revised to the level of 21.9% (2010–11).

Mahatma Gandhi National Rural Employment Guarantee Act and Scheme (MGNREGA): It is successor to many employment guarantee schemes of the past. As per the Act any adult who applies for work is entitled to being employed on public works within 15 days. The work guarantee is limited to 100 days per household per year in rural areas. The Act contains 30% reservations for women. Rate of payment—₹331 per day.

FOOD FOR WORK PROGRAMME

The food for work programme has been in existence since long. Food grains are given as part of wages to the poor. Food for work (FFW) is now component of employment assurance scheme and is operative in eight drought affected states of Odisha, Bihar, Madhya Pradesh, Chhattisgarh, Gujarat, Rajasthan, Maharashtra and Uttarakhand. The programme aims at augmenting food security through wage employment. Food grains are supplied to states free of cost. However, lifting of food grains from Food Corporation of India (FCI) godowns has been slow. All the employment generation schemes now operate under the banner of *Sampoorna Grameen Rozgar Yojana* with the basic aim of provision of food and nutrition security to the poor. Payment of wages is done partly in cash and partly in kind (5 kg of food grains and the balance in cash). The centre and state share the cost of cash component of the scheme in the ratio of 75:25. Renewed thrust has been given to food for work programme in 150 backward districts; the programme will provide 100 days employment to all able bodied rural persons. This will be a step towards national employment guarantee scheme.

The Pradhan Mantri Garib Kalyan Anna Yojana: This scheme provides free ration—5 kg of wheat/rice per person per month and 1 kg of pulses per family to poor and marginalized who lost income due to Covid-19. The scheme extends till December 2022 and benefits 800 million poor.

The micronutrient supplementary programmes (Anaemia, VAD and NIDD) have been discussed earlier in this chapter.

Conclusion

Targeted supplementary nutrition programmes to poorest have beneficial effect to improve the severe malnutrition (PEM) while National Mid-day Meal Programme has a role to improve the universal elementary education but not the nutritional status. On the whole, the supplementary nutrition programmes as a strategy to improve child nutrition have not met much success, it acts as a spring board to develop other activities, such as washing hands, eating clean food, brushing of teeth, etc.

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Competency addressed: The student should be able to:
CM 5.6: Enumerate and discuss the National Nutrition Policy/ policies.

NATIONAL NUTRITION POLICY

The National Nutrition Policy adopted in 1993 advocates a comprehensive intersectoral strategy for alleviating the multifaceted problem of malnutrition and achieving an optimal state of nutrition for all sections of the society. The policy seeks to strike a balance between the short-term measures like direct nutrition intervention and the long-term measures like institutional/structural changes and thus creates an enabling environment and necessary conditions for improving nutritional and health status.

The national nutrition goals which were to be reached by 2000 AD were as under.

- Reduction in moderate and severe malnutrition among preschool children by half.
- Reduction in chronic undernutrition and stunted growth in children.
- Reduction in incidence of low birth weight to less than 10%.
- Eliminate blindness due to vitamin 'A' deficiency.
- Reduction in iron deficiency anaemia among pregnant women by 25%.
- Universal iodization of salt for reduction of iodine deficiency disorders to 10%.
- Giving due emphasis to geriatric nutrition.
- Production of 250 million tonnes of food grains per year.
- Improving household food security through poverty alleviation programmes.
- Promoting appropriate diets and healthy lifestyles.

The overall strategy comprises increased awareness of energy and micronutrient deficiencies and empowering household and communities to tackle these through existing resources. Emphasis is laid on providing sustained support and guidance for better utilization of services and appropriate behavioural actions at community level for improving diets and promoting healthy lifestyle. Advocacy, communication, training and social mobilization play a crucial role in operationalising this plan of action on nutrition.

The policy has identified key areas for action in various spheres like food production, food supply, education, information, healthcare, rural development, women and child development, people with special needs, and monitoring and surveillance. The policy requires a series of actions to be undertaken by various concerned departments/ministries of the government. Some of the direct interventions enshrined in the policy are explained in forthcoming text.

SECTORAL PLANS OF ACTION

National development policies and strategies can have an important bearing on the nutritional status of the population. Since many of the basic causes of malnutrition lie outside the immediate field of nutrition, the most effective governmental strategies to reduce malnutrition on a national scale can be those that focus on incorporating nutritional considerations in all development policies and programmes including even the non-nutrition interventions. Maximizing the positive nutritional impacts of development policies both at the national level and in different sectors can significantly contribute to improving nutritional status. At the same time, to ensure an adequate impact from specific nutritional interventions, a favourable environment in terms of both overall development policies and sectoral policies is required.

The sectoral plans, thus, represent a starting point in their process of analysis, articulation, planning, reinforcing and monitoring each sector's contributions for reducing malnutrition in the country. The clear statement of nutritional objectives, review and analysis of existing policies and programme, development of strategies and action plans will help integrate and institutionalize these processes into sectoral planning as well as contribute to strengthening national development planning (Table 5.20).

Table 5.20: Sectoral plans of action

Direct short-term interventions	*Indirect long-term interventions by various sectors*
• Expanding the nutrition intervention net (ICDS, UIP, ORT)	• Food security
• Empowering mothers with nutrition and health education	• Improving dietary pattern
• Reaching the adolescent girls	• Purchasing power/employment
• Ensuring better coverage of expectant women	• Public distribution system
• Controlling micronutrient deficiencies	• Land reforms
• Fortifying essential foods with nutrients	• Health and family welfare
	• Nutrition and health education
	• Education and literacy
	• Nutrition surveillance
	• Information and communication
	• Community participation

NATIONAL ACTION PLAN ON NUTRITION (NAPN)

The sectoral plans define the general objectives, specific objectives and activities for the sector which can contribute to nutrition improvement through their respective programmes. These sectors are agriculture, civil supplies, education, food, mother and child health, women and child development, health, environment and forest, rural development and information and broadcasting.

There are certain other sectors like welfare, labour, food processing, industrial, etc. which can make significant contributions to nutrition promotion. These sectors have also been co-opted for integrating nutritional objectives in their sectoral strategies and plans for contributing towards nutritional improvement.

IMPLEMENTATION OF NUTRITION POLICY

The nodal department is department of women and child development which manages ICDS programme, is responsible for monitoring of achieving the set goals. The implementation is weak; because of lack of coordination.

- We have achieved self-sufficiency in food grains production (over 316 million tonnes per annum) and targeted public distribution system (TPDS) which ensures food security at household level.
- Purchasing capacity is being increased through employment generation programmes to reduce the level of poverty in India. The current level of poverty (2018) in India is 27.9%. Poverty and unemployment is widespread in India and it indicates need of focussed attention and targeting poor persons for health–nutrition and food for work and employment.

- Dietary intakes of young children and pregnant women are much lower than recommended dietary allowance (RDA), hence there is widespread malnutrition.
- Low intakes of food in young children, women and adolescent girls are due to wrong beliefs and practices and differential care of girls and boys in terms of feeding.
- Widespread infections like diarrhoeal diseases, worm infestations, acute respiratory infections and measles lower the nutritional status of young children.
- High fertility in some states (repeated pregnancies and short birth interval) and 23% of girls getting married below 18 years of age, half of them are anaemic.
- National Nutrition Policy has addressed these problems in the policy. Direct nutrition intervention may yield limited results. More emphasis needs to be laid on adequate eating at home and control of infection, fertility, providing safe water supplies, safe-excreta disposal, besides deworming operations and contraception. In view of emerging epidemic of obesity, diabetes and cardiovascular diseases there is imperative need to revise National Nutrition Policy.

National Nutrition Mission (NNM) (Poshan Abhiyan) Launched in 2018 and Mission Poshan 2.0 in 2021

NNM is PM's overarching programme.

Goals/Targets

i To reduce stunting, undernutrition, wasting and low birth weight by 2% per annum and anaemia among children, women and adolescent girls by 3% per annum. Current level of anaemia in young children of 6–59 months is 58.4%, over 50% of pregnant and non-pregnant women are anaemic in India.

ii Reduce stunting from 38.4% in 2016 to 25% by 2022 (Mission 25 by 2022).

The Mission will supervise, monitor and fix targets for the existing anti-malnutrition plans to steer them in right direction. These schemes include—ICDS, JSY, Mid-day-Meal and National Food Security Mission. The NNM will bring in convergence of different ministries apart from technology-based real time monitoring growth of children as well as check the pilferage of food/ration provided at *Anganwadis*. Services delivered by ANMs, AWWs, ASHAs will be monitored and SMS alert sent to parents on progress of child health and nutrition for early actions.

Coverage

All the states and districts will be covered in **phased manner,** i.e. 315 districts in 2017–18, 235 in 2018–19 and remaining districts in 2019–20 with focus on high burden districts and on the first 1000 days in the development of child (pregnancy period to first 2 years of child life).

Key Nutrition Strategies and Interventions

Convergence of key determinants of nutrition: The key nutrition strategies and interventions: IYCF (infant and young child feeding), food and nutrition, immunization, institutional delivery, WASH (water, sanitation and hygiene), de-worming, ORS-zinc, food fortification, dietary diversification, adolescent nutrition, maternal health and nutrition, ECD (early childhood development)/ ECCE (early childhood care and education). Convergence action plan from top to village level has been drawn-up for sustained monitoring.

Pillars of the Mission/Components

- ICT-based real time monitoring system, smart phone to AWW for monitoring and elimination of registers used by AWW and measurement of weight and height of children at AWCs.
- Convergence of nutrition determinants
- Behavioural change, IEC advocacy
- Training and capacity building
- Innovations
- Incentives
- Community participation—*Jan Andolan* (peoples movement).

Additional staff—manpower

Block level and district level coordinators and assistants have been provided for monitoring and reporting, apart from 'SAKSHAM' (educated youths) for 100 hours a month, with honorarum of ₹7500 to ₹9000 per month.

Visible activities/actions

India has introduced millets in Poshan Abhiyan as also in food security. Intensive nutrition education activities by *Anganwadi* workers by home visits, organized group meetings of pregnant and lactating mothers, and women with children below 5 years on 8th and 22nd of every month and village/urban Nutrition and Sanitation Day on 15th of every month, nutrition demonstration, popularization of indigenous foods/recipes and respecting/observing cultural/ religious ceremonies such as '*Annaprashan*', i.e. introduction of cereal in the diet of young children at 6 months of age and '*Godbharai*' for pregnant women in second trimester of pregnancy, encouraging enough eating (extra eating) and eating protective foods, etc. Health and nutrition messages are integrated with growth monitoring sessions (4 days a month) and on immunization day. Weight and height measurement of 0–6 years children twice a year by dedicated team of RBSK is being done to measure the indicator of stunting, severe acute malnutrition (AM) and Moderate acute malnutrition (MAM). The supplementary nutrition programme of ICDS and Poshan Abhiyain has been merged to Launch Mission Poshan 2.0. Further these programmes need to be integrated with health sector for better outcome

PREVENTION OF FOOD ADULTERATION (PFA) ACT

Ministry of Health and Family Welfare is responsible for ensuring availability of safe wholesome and healthy food to the consumers. This is done through 'Prevention of Food Adulteration (PFA) Act, 1954'. The subject of PFA is in the concurrent list of the constitution. The enforcement of the Act is done by the states.[1]

World Health Day 2015

'From farm to plate make food safe'

New threats to food safety are emerging—changes in food production, distribution and consumption, changes in the environments, new and emerging pathogens, antimicrobial resistance—all these pose challenges to National Food Safety System.

Competency addressed: The student should be able to:
CM 5.8: Describe and discuss the effects of additives and adulteration.

THE FOOD SAFETY AND STANDARDS ACT (FSSA)-2006

This Act has been enacted by parliament. The responsibility to implement this Act has been entrusted to Ministry of Health and Family Welfare. FSSA-2006 has come into force with effect from 5th August 2011. PFA 1955, fruit product order 1955, solvent extracted oil order 1967, and other food orders stand repealed.

This Act was enacted to consolidate the laws relating to food being administered by different Ministries/departments and to establish the Food Safety and Standards Authority of India (FSSAI) for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption.

Pure food is essential for maintenance of health. The food available to consumer should be nutritious, wholesome and pure. It is observed that the evil of food adulteration prevails in the country on large scale.

For the first time a limit of 1 ppb (part per billion) for each pesticide has been fixed in carbonated water (like cola drinks) by notification in June 2009. The government has reduced the maximum limit of caffeine from 200 ppm to 140 ppm in june 2009.

REASONS FOR ADULTERATION

Reasons are mostly socioeconomic and to get rich quickly by adopting unscrupulous practices. It is also because of processing or preservation of food items to increase the acceptability, appearance and shelf life of food. The manufacturers or food processors use food additives which may be harmful to the health.

Objectives of PFA

i The PFA has been enacted to ensure protection of health of the consumers.
ii To prevent gross food adulteration, to control over contaminants and additives and to control over dumping of substandard foods.
iii To improve the nutritional status of population by ensuring wholesome food.
iv To earn foreign exchange by supply and sale of quality food items (exporting of food).
v Banning the entry and sale of non-iodated salt.

Implementation

The food samples are collected from the grocer's shops, fair price shops, milk sellers, dairy development and cooperative and from traders by the designated food inspectors or even consumer can collect the sample by observing proper instructions. The food samples are sent to designated laboratory. There are 137 food laboratories under the administrative control of various states/union territory Governments and local bodies. In addition, there are four central food laboratories at Mysore, Kolkata, Ghaziabad and Pune. Three food samples are collected, one is sent to the designated laboratory, the second one is left with the retailer and the third is kept with the food authority at district level. 45 state public labs are being strengthened. National reference Laboratories—13 have been approved.

Common Adulterants in Food

1 Colouring agents—non-permitted coal tar dyes and colours, excessive lead and lead chromate. Most pulses are coloured with coal tar dyes.
2 Artificial sweeteners like dulcin, saccharin.
3 Starches.
4 Citric acid, saw dust.
5 Non-permitted flavours and preservatives, non-permitted acids like boric acid.
6 Mixing of cheaper edible oils in pure ghee, animal fat, rancid stuff, mineral oils, argemone oil, argemone seeds, excess sand dirt and grit.
7 Fats abstraction and addition of water and starches in milk besides urea mixing in milk to prevent curdling. Synthetic milk is deadly mixture of caustic soda, detergent, urea, vegetable oil white paint and paper pulp.
8 Ripening agents like calcium carbide for ripening of bananas and mangoes.
9 Formalin—a toxic and carcinogen chemical is used to make fish look fresh.

In addition, the food may be sold as misbranded and wrong label or without label or with excessive moisture. Varieties of foreign seeds/matters may be added.

The prevalence of food adulteration remains a big problem.

During 2012–13 out of 72200 food samples 13571 cleared the laboratory test, this means 81.3% of the samples failed the test for food safety. This amounts to adulteration evidence in 81.3% of samples. Similarly in 2016–17 and 2018–19 nearly 23 to 28% of food samples were found non-confirming (unsafe, sub-standard and misleading/labelling) against the WHO norms of 5% (Table 5.21).[2]

National Milk Safety and Quality Survey

Milk and milk products are the most commonly adulterated items, followed by beverages and edible oils, fats and vanaspati ghee (Table 5.22). National Survey on Milk Adulteration (2011) found that 68.4% of milk samples were found adulterated in India (FSSAI-2011). Adulteration in urban areas was higher than rural areas and more so in loose milk samples.[3–4] National Survey of 2018 by FSSAI shows that 93% of milk samples were found to be absolutely safe. Nearly 10% of samples had contaminants rendering the milk unsafe. Nearly 39% of samples did not meet quality parameters. However, contamination due to aflatoxin MI and antibiotic residues is more serious than adulteration. Blending of mustard oil has been prohibited w.e.f 8.6.21 so that pure oil is available to consumers.

Table 5.21: Trends of food adulteration in India

Year	*No. of samples examined*	*No. of samples found adulterated*	*% of adulteration*
1981	133242	19050	14.2
1982	129595	16765	12.9
1983	129062	17965	13.9
1984	122296	14990	12.2
1985	128511	14677	11.4
1986	121969	13730	11.2
1987	131391	14091	10.7
1988	130390	15365	11.8
1989	122599	11549	9.4
1990	118580	11124	9.3
1991	115554	12841	11.1
1992	111591	11853	10.6
1993	99278	8562	8.6
1994	107360	10370	9.7
1995	103638	9424	9.1
1996	106229	11221	10.5
1997	95110	9315	9.8
1998	96479	7834	8.1
1999	88929	8197	9.2
2000	82701	8877	10.7
2008	63035	4096	7.0
2012–13	72200	58429	81.3
2016–17	60671	14130	23
2018–19	106459	30415	28.5

Table 5.22: Percentage of food articles found adulterated in India (1998–2008)

Name of food	*Percentage adulterated*		
	1998	*2000*	*2006–08*
1 Milk	26.33	19.36	7.43
2 Non-alcoholic and alcoholic beverages	11.86	12.6	
3 Milk products, butter, ghee, ice cream	14.92	30.4	
4 Spices and condiments	5.59	7.84	
5 Cereals and pulses	6.18	7.47	
6 Tea, coffee, cocoa and chikory	1.4	2.56	
7 Fruit products	7.93	2.91	
8 Edible oil, fats and vanaspati	8.41	10.39	7.43
9 Sweetening agents	6.56	11.70	
10 All foods	8.1	10.7	7.0

Food Additives

Food additives are substances which are added to food in controlled amount to process the food, preserve or improve its outlook and acceptability or to improve keeping qualities of food items or to enhance palatability. Monosodium Glutamate (MSG) is a common food additive as flavour enhancer.

The type and amount of most additives are controlled by law in most countries and only those substances, "generally recognized as safe" are allowed in the minimum amounts (permissible limits). Food additives are non-nutritious substances.

A harmful chemical potassium bromate has been banned in breads by Health Ministry of India. This chemical was being used to enhance the texture of bread.

Commonly used additives include nitrates used to preserve flavour and texture of meat products, to enhance the colour and to protect from *Clostridium botulinum* (which forms the fatal toxins). Nitrates can be converted to nitrites which in turn can interact with amines and amides in the meat or body to form nitrosomines which are carcinogenic. It is, therefore, important that the amount of nitrate and nitrite, is carefully controlled and the risks of cancer be weighed against the risk of botulinum poisoning.

Unpermitted artificial sweeteners, i.e. dulcin in soft-drinks and confectionary and other foods, excessive amounts of preservatives, antioxidants and other additives or unpermitted colours or excess amount of coal tar colours can be carcinogenic. Similarly, use of *pesticides* and *insecticides* in foodgrains and vegetables, fruits can be injurious to health.

The FSSI has approved 12000 standards for additives and ingredients.

Punishment under PFA

When the adulterated food is likely to cause death or injury to the body or amounts to grievous hurt it can be punished according to Section 320 of Indian Penal Code. There is an imprisonment of not less than 7 years extendable up to life term and with a fine not less than ₹ 10 lakh.[1]

Six years jail and 5 lakh for grievous harm caused by unsafe food intake and one year jail and 3 lakh fine for non-grievous harm. Even for misbranding a seller could face 6 months jail and ₹ 1 lakh fine.

The Food Adulteration Act is a partial solution. The problem of adulteration needs to be mitigated by strong component of education of people, voluntary organizations, manufacturers and retailers.

Codex

The issue of international trade in food has become very important. Food standards at the international level are set by Codex Alimentarius Commission established by UN and WHO. India has participated in the meeting of the commission and has effectively advocated the stand of developing countries regarding the process of standard settings so that their interests are kept in view. An attempt is being made to harmonize to the extent possible the standards under the PFA rules with Codex.

Agmark and ISI

These are two other agencies which set standards for food. The work on standardization being highly specialized activity, these two organizations have developed the elaborate capacity and these agencies extend their laboratory services for testing of foods to the private industry, trade and consumers at nominal cost. Many food items bear ISI or Agmark as a mark of standard.[3]

Competency addressed: The student should be able to:
CM 5.8: Describe and discuss the importance and methods of food fortification.

FOOD FORTIFICATION

Food fortification means the addition of nutrients to a food so that the quality is maintained or improved without the quantity being significantly increased.

Food fortification can be important part of nutrition intervention strategy as a means of delivering nutrient to population. Micronutrient deficiency, such as iodine, vitamin A and iron is widespread in India. To deliver these nutrients to the community, the programme of fortification has been launched. The best example of fortification is iodation of common salt with potassium iodate to deliver nutrient-iodine, 15 PPM in salt at the consumer level, to eliminate Iodine Deficiency Disorders (IDDs). Similarly, delivery of iron through common salt was launched by National Institute of Nutrition (NIN) on experimental basis to mitigate the problem of anaemia. Double fortified salt with iron and iodide has been introduced in mid day meal (MDM) and ICDS supplementary nutrition programme.

Definition

Nutrient added to a food or an article of diet to improve the quality of diet of a group, community or population (WHO).

Improving Quality of Food

***Examples*:** Wheat proteins are deficient in lysine and it can be improved by addition of lysine in wheat flour. Maize protein is deficient in lysine as well as tryptophan and we can add these amino acids to improve the quality of maize proteins.

Similarly, highly milled and polished rice are deficient in B-group of vitamins (thiamine) we can add vitamin B to enrich the polished rice.

To improve the quality of vanaspati ghee (hydrogenated oils), we used to fortify all hydrogenated oils with vitamin A—700 IU and vitamin D—50 IU per ounce as per regulations but now it is optional.

Enrichment of Food

Enrichment is another term for fortification. It is a process to add back a nutrient to food lost due to processing of that food. It is also called restoration of food quality. During the process of milling and polishing of rice, vitamins of B group are lost as also threonine (protein). Similarly, preparing of fruit juices causes loss of vitamin C. Hydrogenation of vegetable oils causes loss of essential fatty acids (EFA). During the process of baking of bread lysine is lost. Adding lost nutrients like vitamin C, EFA and vitamin B to above-mentioned foods is known as enrichment or restoration process.

Fortification as Tool to Deliver a Nutrient

The examples have been already given. To deliver iodine to population by universal salt iodation and to deliver iron by fortification of salt (double fortification with iron and iodate). Similarly, delivering vitamin A through the vehicle of monosodium glutamate (MSG) to mitigate the problem of vitamin A deficiency.

Fortification of common salt has been a successful intervention to reduce the prevalence of iodine deficiency disorders in India. However, fortification rarely solves all the nutritional problems of a country.

Justification and Criteria for Fortification

1. The deficiency of nutrient should be widespread.
2. The vehicle food must be consumed by the target group, e.g. salt consumption is universal in India on an average 10 g of salt is consumed per day per person. This is an ideal food for iodate fortification. Similarly, sugar is also consumed in every household.

3 The high consumption of fortified food will not lead to toxicity.
4 The addition of micronutrient should not change the taste, colour, flavour, texture and shelf-life of the food item.
5 The item of food should be centrally controlled and monitored.
6 The cost of fortification should be affordable.

Mid-day meal programme (MDM) and ICDS have mandated the use of fortified wheat flour, edible oil and double fortified salt nationally. This way it covers 250 million beneficiaries. Public distribution system covers 65% of population and hence an important channel for implementing both wheat flour and rice fortification. The food authority of India has also launched + F logo to be put on all fortified packaged foods.

Many state governments—Madhya Pradesh, Gujarat. Maharasthra and Haryana have launched fortification of wheat flour with iron, folic acid, and vitamin B_{12} to mitigate the problem of anaemia and neural tube defects. People will get fortified flour instead of wheat grains from PDS. Rice is being fortified with IFA, vitamins A, B in Odisha and Karnataka.

NEUROLATHYRISM

In India, neurolathyrism has almost disappeared and now sporadic cases may be there. Diets which were predominately based on the pulse *Lathyrus sativus* (Khesari dal) led to spastic paraplegia. The toxic factor in the pulse which led to spastic paralysis was identified as BOAA (β-oxalyl aminoalanine). The disease used to occur in epidemic proportion in central India and epidemics continued from 1844 to 1974. Since 1974, the epidemics have stopped; however, sporadic cases do occur from time to time but the disease has virtually disappeared by late 1980. Cultivation of Khesari dal was banned. Now the government is considering to allow cultivation of three new varieties (Ratan, Parteek and Mahateara) which are safe for human consumption.

Measures which Succeeded

- Labourers avoided using *Lathyrus sativus* as the sole staple diet and instead used small quantities.
- Soaking of *Lathyrus sativus* for 15 minutes in water before cooking or parboiling of pulse could remove the toxin.
- Banning payment of wages in the shape of *Lathyrus sativus* to farm labourers with effect from 1983.
- This pulse became costlier item and landlords could not afford to distribute this item to poor labourers from 1980 onwards.

EPIDEMIC DROPSY

Argemone mexicana (Prickly Poppy) seeds grow as wild weeds in the field. The seeds of this plant resemble mustard seeds. The argemone seeds contain two toxic alkaloids: Sanguinarine and dihydrosanguinarine. The other minor alkaloids present are berberine propionate, cheletrythrine and coptisine which are less toxic.

The consumption of adulterated mustard oil with *Argemone mexicana* seeds leads to epidemic dropsy. In the recent past, Delhi and neighbouring states experienced outbreak of epidemic dropsy which affected 2000 people and caused 50 deaths.

The symptoms of poisoning appear within 5–20 days of consumption of adulterated oil containing 2–10% argemone oil.

Effects

The symptoms include vomiting, diarrhoea, abdominal pain, oedema of feet and legs. The patients may complain of lethargy, low grade fever and dyspnoea. Liver enlargement may occur without jaundice.

The cardiovascular manifestations include tachycardia and precardial pain. The ocular manifestations include itching and burning of eyes with superficial retinal haemorrhages, disc oedema and glaucoma in some cases. Death occurs due to cardiac arrest.

Tests for detection of argemone oil: The permissible level of argemone oil in edible oil is 0.01%.

Concentrated nitric acid test is nonspecific test. Ferric chloride test can detect 0.25% of argemone oil.

Cupric acetate test can detect 0.5% of argemone oil.

Hydrochloric acid test is most sensitive and specific test and can detect argemone oil up to 0.001% in edible oil.

Thin layer chromatography (TLC) is done for biological samples.

Prevention

- Use of unsealed oil is not advisable.
- Enforcement of Food Adulteration Act.
- Education of people about early signs.

Competency addressed: The student should be able to:
CM 5.7: Describe food hygiene.

FOOD HYGIENE AND FOOD POISONING

GLOBAL PROBLEM

Unsafe food causes staggering range of diseases from diarrhoea to cancer and hepatitis. Worldwide unsafe food is linked to the deaths of estimated 2 million people mostly

children. Food contamination with bacteria or their toxins is a common feature in India because of poor hygienic conditions. Contamination is more common during mass cooking, feasts and festivals. Food contamination can occur during preparation, processing, cooking, storage or serving of foods. More than 200 diseases spread through contaminated food (WHO).

Foodborne Infection

These infections are caused by consuming foods or liquids contaminated with bacteria, viruses and parasites. These pathogens cause infection by:

- Invading and multiplication in the lining of intestine and/or other tissues.
- Invading and multiplication in the intestinal tract and releasing toxin (bacteria only).

Foodborne intoxication—caused by consuming foods or beverages already contaminated with a toxin. Sources of toxins are as follows:

- Certain bacteria (preformed toxins)
- Poisonous chemicals—malathion, parathion and toxic metals
- Natural toxins found in animals, plants and fungi.

Occurrence—Indian Scenario

This may be sporadic and effect is limited to number of persons in household. Many a times outbreaks and particularly explosive outbreaks occur due to *Staphylococcus enterotoxin*.

Foodborne disease outbreaks are defined as the "Occurrence of two or more cases of a similar illness resulting from ingestion of a common food or when observed number of cases exceeds the expected number. These can be confirmed (when at least 1 causal agent is identified) or suspected (based on clinical and epidemiological information)".

- Ministry of Health recognises foodborne illness as greater health burden in India than malaria, HIV/AIDS and TB.
- Integrated disease surveillance programme (IDSP) found food poisoning one of the commonest outbreaks reported in 2017 apart from acute diarrhoeal diseases. During 2018 many people died after consuming contaminated "Prasad" in Karnataka temple.

Common Features of Food Poisoning

Staphylococcal and Bacillus cereus

Enterotoxins A, B, C, D and E of *Staphylococcus aureus* from food handlers, skin lesions, and nose. The symptoms appear within 1–6 hours. Common symptoms include nausea, vomiting, abdominal cramps and diarrhoea but no fever.

Salmonella sp., *Campylobacter jejuni*

These organisms from faeces of infected humans and animals can contaminate food items and produce inflammatory diarrhoea. Signs and symptoms appear in 18–36 hours. Manifestations are abdominal pain, fever and chills, nausea and vomiting.

Vibrio Cholerae, Enterotoxigenic E. coli

Incubation period varies from 6 hours to 5 days. These organisms produce watery diarrhoea. Enterohaemorrhagic *E. coli* produce bloody diarrhoea.

Botulism

Enteroneurotoxins A, B, E, and F of *Clostridium botulinum*. Spores are found in soil and animal intestine. The signs and symptoms of poisoning appear within 18–36 hours which include gastrointestinal symptoms and neurological symptoms.

Clostridium perfringens and B. cereus Gastroenteritis

Enterotoxin of *C. perfringens* and *B. cereus* produce abdominal cramps and diarrhoea within 8–16 hours.

Epidemiological Investigations

Epidemiological investigations of food poisoning outbreak is an important exercise.

Food items can be pinpointed by thorough investigations. Attack rate can be determined in persons who consumed that food, and similarly attack rate can be determined in those who did not consume that food item and finally odds ratio can be worked out to arrive at incidence in exposed and non-exposed persons.

Stool samples, vomitus, gastric aspirate and food items for isolation of organisms and toxins can be collected as soon as possible after onset of illness. Government has approved for the first time for carrying out standard bacteriological tests for items like milk and milk products like cheese, curd, ice cream, etc.

Treatment: Correct dehydration by oral rehydration therapy or by IV fluids. Specific treatment in case of pesticide poisoning with chelating agents may be done under medical supervision.

Prevention: Hazard Analysis and Critical Control Point (HACCP) is a systematic preventive approach to food safety that addresses physical, chemical and biological hazard as a means of prevention rather than finished product inspection.

Food Safety and Standard Act (FSSA) in India regulates food safety but implementation is a big challenge.

Five keys for safer food ***(food hygiene)***

1. Wash your hands before handling food and food preparation.
2. Separate raw and cooked food.
3. Cook thoroughly.
4. Keep food at safe temperature.
5. Use safe water and raw material.

World Health Day 2015 was an opportunity to alert people working in different government sectors, farmers, manufacturers, retailers, health practitioners as well as consumers about the importance of food safety and hygiene. However in India basic hygiene facilities are available to 68% of people (82% urban and 60% rural)

Safe and healthy food should be accessible to all by:

- Strengthening food safety management and regulations.
- Risk-based approach to monitor food safety.
- Surveillance of foodborne diseases be strengthened under IDSP to know when, why, how foodborne hazards and resulting illness occur.
- It also includes integrated surveillance of anti-microbial resistance to foodborne bacteria.

GENETICALLY MODIFIED (GM) CROPS

GM crops being promoted by foreign multinational biotech. Companies are proving to be serious hazards for both environments and human and livestock health. GM will not solve the world food problem. GM crops lead to reduction of soil fertility. Increased use of toxic, carcinogenic and mutagenic agriculture chemicals lead to water, air and soil pollution and increased incidence of cancer, birth defects and other diseases.

Bio-fortification is a process of breeding staple food crops with higher micronutrient contents.

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1 Chadha DS. National Programme on Prevention of Food Adulteration, New Delhi: NIHFW; 1988.

2 The Sunday Tribune, Haryana Edition–Adulteration: Northern region takes the cake – Vol 130, No 71 March 14, 2010 by Aditi Tandon.

3 FSSAI-National Survey on Milk Adulteration, 2011.

4 FSSAI-Annual Report 2016–17 and 2018–19 MOHFW Government of India, 2016–17 and 2018–19.

Competency addressed: The student should be able to:
CM 5.6: Enumerate and discuss Integrated Child Development Services (ICDS) scheme.

INTEGRATED CHILD DEVELOPMENT SERVICES (ICDS) MISSION

CHILD IS THE FATHER OF MAN

Integrated child development services (ICDS) scheme was launched on 2nd October, 1975 as a follow-up measure of National Policy for Children, formulated in 1974.[1]

Development of children is the first priority on country's development agenda, not because they are most vulnerable, but because they are our supreme assets and also the future human resources of the country. Therefore, the foundations of lifelong learning and human development are necessarily to be laid down in the very critical years of the childhood. ICDS programme is essentially *human resource development programme* and it adopts life cycle approach. Prime focus in on **mothers**.

The ICDS has covered many milestones since its inception in 1975, today ICDS is globally recognized as one of the world's largest and most unique community based outreach systems of promoting early childhood care for survival, growth and development. The Nodal Ministry of ICDS is Human Resource Development or Social Welfare Department/Women and Child Development. ICDS has been universalized in India.

MAJOR OBJECTIVES OF ICDS MISSION

1 To lay the foundation for overall development of child (physical, social and psychological development).

2 To improve the nutritional and health status of children below the age of six, pregnant and lactating mother and adolescent girls.

3 Reduce the incidence of mortality, morbidity, malnutrition and school dropouts.

4 Achieve effective coordination of policy and implementation among various departments to promote child development.

5 Enhance the capability of mother to look after the normal health, nutritional and development needs of the child, through proper community education.

These objectives are being achieved through package of following services. The services relate to *health*; *education* and *nutritional* (HEN) *components*.

Package of Services under ICDS Mission/Umbrella

- *Health services—these include*: Immunization, health check-ups, treatment of ailments and referral services, besides health and nutrition education.
- *Nutritional services*: Supplementary nutrition/feeding, growth monitoring and promotion, nutrition and health education.
- *Education services*
  - a Early childhood care and stimulation for younger children under 3 years.
  - b Early joyful learning opportunities to children in the 3–6 age group (Preschool Non-Formal Education).

Supportive Services and Convergence of other supportive services, such as safe drinking water, environmental sanitation, women's empowerment programmes, non-formal education and adult literacy.

Package of core services has been redesigned and following new components have been added in 12th plan (Table 5.23).

Table 5.23: Core package of services under ICDS mission

Services	*Service standards*
1. Early childhood care education and development (ECCED)—the foundation of learning	4 hours session per day Monthly fixed ECCE day
2. Supplementary nutrition	300 days in a year
3. Care and nutrition counselling	
(a) Growth monitoring and promotion including development (milestones)	0–3 years once a month 3–5 years every 3 months
(b) Infant and young child feeding and counselling	Home visits at critical contact points
(c) Lactation support	Regular quarterly parents meet
(d) Maternal care counselling	
(e) Nutrition and health and hygiene education	One session per month
(f) Community-based management of severely and moderately underweight children	Improvement in nutritional status
4. Health services	Monthly fixed VHNDs • Full immunization and micronutrient supplement and referral services • Regular health check-ups
5. Community participation and mobilization	Quarterly AWC management committee meeting Quarterly meeting VHSNCs

- Child care and nutrition counselling service for pregnant and breastfeeding mothers of 0–3 years children has been introduced as one of the **core services**.
- Early stimulation and detection of developmental delays.
- Community based care for under-nourished children.
- Tracking of pregnant women and children on mother and child protection card.
- Redefining—preschool education, as Early Childhood Care and Education (ECCE).

Target Groups/Beneficiaries

The following are targeted for package of services:

- Children under 6 years of age. *Priority is for children under 3 years of age*. Second priority is for children between 3 and 6 years age group.
- Pregnant and lactating mothers.
- Women in reproductive age group (15–49 years).
- Adolescent girls (10–19 years).

Heart of ICDS System—*Anganwadi*

The *Anganwadi* (AW), literally means courtyard play centre, is a child care centre, located within the village or urban slum area. It is the focal point for delivery of services at the community level to children below 6 years of age, pregnant women, nursing mothers and adolescent girls. *Anganwadi* centre functions for 6 hours (including 4 hours of ECCED and SNP, 2 hours for home visits) per day.

Besides this, the *Anganwadi* centre is a meeting ground where women and mother groups can come together with other community-based workers to promote awareness and joint action for child development and women's empowerment; hence AW is the heart of ICDS. Over 1342126 *Anganwadi* centres were operational as on 22nd September 2022.

Anganwadi Worker (AWW)

AWW is the key functionary or key volunteer at *Anganwadi* centre to provide the package of services. The *Anganwadi* worker is middle or matriculate married women, resident of the same village or community—chosen by the community and has received three months training for child and mother development. Duration of basic training of AWW has been reduced from 3 months to 52 days (45 working days and further reduced to 30 days).

Population Assigned and Job Functions of AWW

Each *Anganwadi* worker has been assigned a geographical area of about 400–800 (80–160 houses) population in rural/urban slum and in tribal area the population is 300–800. Even small hamlets of 150–400 population have mini *Anganwadi* center. Her job functions are:

A. Planning and Implementation of ICDS

1. Village or urban slum mapping—to know her area.
2. Rapport building with community, right from the beginning.
3. Conducting community survey and enlisting beneficiaries keeping household records of each family, children 0–6 years, children at risk, below poverty line households expectant and nursing mothers and adolescent girls.
4. Registration of marriages, pregnant women, births and deaths.

B. Service Delivery

1 Preparation and distribution of supplementary nutrition for children 6 months to 6 years, nursing mothers pregnant women, and adolescent girls.
2 Early childhood care and education and non-formal pre-school education.
3 Growth monitoring.
4 Assisting health staff in immunization and health check-ups. She motivates mothers for immunization.
5 Referral services.
6 Detection of disability among children.
7 Providing treatment for common ailments.
8 Integrated management of neonatal and childhood illnesses.
9 Health and nutrition education of adolescent girls, women and community.
10 *Anganwadi* worker as facilitator of ASHA: Depot holder of medicine kit and contraceptives for ASHA and will guide ASHA in organizing health day.
11 Assists CDPO and supervisors in implementation of KSY and national programme for adolescent girls.
12 *Beti Bachao Beti Padao*—attain better sex ratio.

C. Information Education and Communication

Communicate with and counsel parents, families and communities besides organizing awareness campaigns.

D. Community Contacts

1 Mobilize community and elicit community participation.
2 Maintain liaison with Panchayat, primary schools, Mahila Mandals and health functionaries.

E. Management and Administration

Management of *Anganwadi* centre, maintenance of records and registers and preparation of reports.

THE ICDS TEAM AND ORGANIZATION

- The ICDS team consists of *Anganwadi* worker, ASHA, helper at village level, supervisors (Mukhya Sevikas) one for 25 AWWs at circle level and women child development project officers (WCDPO) one for one lakh population at block level. In large sized rural and urban projects, additional (WCDPO) are also part of the team. **District programme offices** (DPO) is at district level.
- The female health workers, male health workers at subcentres, health supervisors and medical officers of PHCs form a team with social welfare/women and child development functionaries to implement ICDS programme and provide integrated services. Of necessity, the ICDS functions have to be integrated with health services.[2]

ICDS is unique because all basic sectoral services related to early childhood care, preschool *education*, *nutrition* and *health* converge and are delivered under one roof at *Anganwadi* centre.

The convergence of services by ANM, AWW and ASHA are essential to address the interrelated needs of children and women in a comprehensive and cost-effective manner. The spectrum of services has been expanded during 12th plan period. *Anganwadi* centres have been transformed as early childhood care and development centres. Package of services have been reframed.

PACKAGE OF SERVICES AND PARTICIPANTS (TABLE 5.23)

1. EARLY CHILDHOOD CARE AND EDUCATION (ECCE): THE FOUNDATION OF LEARNING

Over 85% of child's cumulative brain development occurs prior to age of 6–7 years. It is one of the core service in ICDS.

ECCE: This component of ICDS includes two types of services of 4 hours session:

i Early psychosocial stimulation (EPSS) for children below 3 years (free play and lot of adult child interaction), a home-based programme.
ii Non-formal preschool education (NFPSE) for children 3–6 years, redefining NFPSE to ECCE.

EPSS: It aims to provide learning opportunities and know his/her environments for holistic development. It is meant for under three children. It is a programme of close interaction between the child and the mother or caregivers with the help of AWWs. It is mainly home based and mother centred activity.

NFPSE/ECCE: It is a programme for 3–6 years children at *Anganwadi*. It is child centred programme which follows play way activity approach. It is mainly *Anganwadi*-based and reinforced at home by home visits.

The early childhood care and education (ECCE) is an activity to promote cognitive physical, social, emotional and psychological development of young children. It lays foundations for all-round development. This is the first step in the ladder of education. ECCE is considered as most important and pivotal activity. In ICDS, ECCE is done through play-way daily activities visibly sustained for 4 hours a day **preceded** by **snacks** and **followed** by **supplementary nutrition**, growth monitoring and other related interventions. Children learn by playing and undertaking creative activities with the help of *Anganwadi* worker who provides learning stimuli and arranges material for play-way and creative activities. Children have lot of curiosity and they eagerly explore or discover and satisfy their curiosity. Varieties of games and ECCE activities are organized at the *Anganwadi* and a special kit material has been provided to all *Anganwadis*. It attracts and keeps young children at the *Anganwadi* centre—an activity that motivates parents and communities.

Focus of ECCE is total development of child, in the age range up to 6 years from the under privileged groups. It combines physical, mental and social development by organized age appropriate activities for ECCE as per, norms and quality standards guided by book: Ankur now replaced by "ANGANWADI annual Guide book" in 2021. 'Preparation for school in 100 days' Khazane Ka Pitara 2021–22. The early learning component of the ICDS is a significant input for providing a sound foundation for cumulative lifelong learning and development. It also contributes to universalization of primary education by providing to the child the necessary preparation for primary schooling and offering substitute care to younger siblings thus freeing the older ones especially girls to attend school. **Currently**, preschool component of ICDS is very weak.

Some of the positive **outcomes** of ECCE have been learning of language, recognition of common objects, colour, size and shape discrimination, concept of heavy and light, waiting for their turn, sitting in rows and circle, mixing with each other, competition and cooperation, sharing and healthy lifestyles, such as washing hands, brushing teeth, and eating clean food, etc.

Regular monthly fixed ECCE day should be observed at *Anganwadi* as '*Balbodh Divas*'.

Elementary education for all, i.e. *Sarva Shiksha Abhiyan* (SSA) aims at universalization of elementary education up to 8 years of schooling. Under SSA, importance has been given to preschool learning and early childhood care and its role in improving participation of children in schools. Also there is an emphasis on convergence between SSA and ICDS with an effort to strengthen the preschool education component of ICDS.

Under the National Education Policy, the District primary education programme (DPEP) has established pre-primary education wing covering children 4–6 years of age and providing mid-day meal.[3] This step reduces the workload of *Anganwadi* workers as shifting preschool education programme to teachers provides more time to AWW to *focus attention* to mothers and young *children below the age of three*. Under the New Education Policy 2020 ECCE of 3–6 years children has been made part of foundational learning of 6 years. Accordingly the Anganwadi centres are being upgraded to "playschools" in the rooms of primary school building or in buildings of Anganwadis. National curriculum framework (NCF) for foundational stage has been launched in Oct 2022. Anganwadis workers have been given intensive pre-school education training for 7 days and refresher training for one day. Nearly 13.6% of children age 5 years attended pre-primary school in year 2019–20 (NHFS-5).

2. SUPPLEMENTARY NUTRITION MISSION POSHAN 2.0

Supplementary feeding is given to pregnant women, nursing mothers and children between 6 months and 6 years of age and selected adolescent girls (Table 5.24). Priority is given to low income families and moderately underweight children and all children who attend *Anganwadi* for non-formal preschool education. These beneficiaries avail supplementary feeding support for 300 days in a year. By providing supplementary feeding, the *Anganwadi* worker attempts to bridge the caloric gap between the recommended daily allowance (RDA) and average daily intake (ADI) of children and women, in low income and disadvantaged communities. The objective is only supplementing and not substituting for family food. It also provides an important contact opportunity with pregnant women and mothers of infants and young children, to promote improved behavioural actions for care of pregnant women and young children. This provides a crucial opportunity to counsel pregnant women, enabling utilization of key services, i.e. antenatal care, immunization, iron and folic acid supplementation and improved care, adequate extra food and rest during pregnancy; exclusive breastfeeding and introduction of complementary food at right age. Special care is taken to reach children below the age of 3 years. The type of food varies from state to state, but usually consists of a hot meal cooked at the *Anganwadi*, containing a varied combination of pulses, cereals, oil, vegetables and sugar/iodized salt. Some states provide ready to eat meal; containing the same ingredients. There is flexibility in the selection of food items; to respond to local needs. The expenditure towards supplementary feeding is met by the state under the plan budget. The nursing mothers are provided food up to 6 months after delivery to help meet increased requirement during this period.

Table 5.24: Norms for supplementary nutrition in ICDS

Recipients	*Calories*	*Grams of protein*
• Children (6–72 months)	500	12–15
• Severely underweight children	800	20–25
• Adolescent girls	600	18–20
• Pregnant and nursing mothers	600	18–20

The supplementary nutrition acts as a spring board to develop other activities, such as improving attendance at *Anganwadi*, eating clean, washing hands, development of non-formal education besides developing healthy lifestyles. It should not be perceived as "feeding Programme". It seldom improves malnutrition because of many problems, such as sharing and not eating enough food at home or missing a meal at home as also problem of acceptance of food. Supplementary feed is no guarantee to improve nutritional status. More than half of ICDS budget is spent on SNP. The supplementary nutrition programme has been merged to launch Mission Poshan 2.0, from 2021 onwards. Intensive nutrition education activities are being organized for mothers, two days in a month on 8th and 22nd of every month.

Decentralization of supplementary feeding: The supplementary feeding activity has been decentralized now.

The money of supplementary feeding has been given to village level coordination committee, chaired by Mahila Panch. Now local recipes are prepared at the village. Village people (self-help groups) have greater say now and they themselves decide local recipes. Usually a hot meal is cooked at *Anganwadi* based on a mix of pulses, cereals, oil, vegetable, sugar and iodised salt. ₹ 6, 9 and 7 per day is spent on supplementary feeding for child, severely underweight child and pregnant women, respectively.

Incorporation of green leafy vegetables, seasonal fruits, milk, egg in the supplementary feeding under ICDS, needs to be promoted and community educated on the importance of these foods.

Micronutrient Supplementation

National prophylaxis programme for prevention of blindness caused by vitamin. A deficiency and control of nutritional anaemia among mothers and children, are two direct interventions integrated in ICDS. Dietary promotion of foods rich in vitamin A, iron, and folic acid and vitamin C is an important part of nutrition and health education and targeted supplementation is also provided. At 9 months of age 1,00,000 IU of vitamin A solution is administered along with measles immunization. Children in the age group of 1–5 are provided 2,00,000 IU of vitamin A solution every 6 months with priority given to children under 3 years of age. Similarly, iron and folic acid tablets supplements are given to pregnant women and children for prophylaxis and treatment of anaemia as per National iron plus initiative. Double fortified salt is mandated in ICDS in addition to fortified wheat flour and rice.

Therapeutic Nutrition

It is given to treat severe malnutrition, i.e. severely underweight children (weight-for-age below –3SD of median). Therapeutic food is given as per revised scale or adequate eating/feeding at home is to be encouraged or special supplementary feeding is advised. Domiciliary management helps and these children are also referred to Nutrition Rehabilitation Centre (NRC) at district level.

3. CARE AND NUTRITION COUNSELLING SERVICES

A new initiative under ICDS as one of the **core services**, targeting mothers of children under 3 years, pregnant and Lactating mothers. Objective of this activity is to enhance the child care abilities/capacities of mother and or care givers to look after the health and nutritional needs of children within the family environments. Following interventions are in place to achieve this:

a. **Infant and young child feeding (IYCF):** Promotion and counselling—One to one counselling for optimal breastfeeding practices linked to growth monitoring. One to one counselling on complementary feeding to ensure adequate food intake by home visits and follow-up.

b. **Monitoring and promotion of child growth and development:** Growth and development monitoring and nutrition surveillance is one of the vital services under ICDS. Family retained Mother and Child Protection Cards (MCPC) are being used by AWW and ANMs to monitor growth and early detection of delayed developmental milestones.

c. **Lactation support:** Support for early initiation and exclusive breastfeeding.

d. **Maternal care and counselling:** Early registration of pregnancy, 4 or more ANCs, institutional delivery and postnatal care, counselling on diet, rest, IFA compliance during home visit, monitoring weight gain, examination of pallor and oedema and any other danger signs, home based counselling for essential newborn care and counselling on spacing.

e. **Nutrition, health and hygiene education (NHHE):** Targeting pregnant and lactating and other caregivers, community and family by organizing monthly health and nutrition education sessions, education on improved caring practices—feeding, health and hygiene and behaviour change communication to promote healthy eating during pregnancy, lactation and adolescence and early childhood period, promoting local foods by food demonstration, celebration of nutrition week or month and breastfeeding week and ICDS day.

f. **Community-based care and management of under-weight children:** This activity targets moderately and severely underweight children and their mothers/ caregivers for:

- 100% weighing of all eligible children and identification of underweight children and referral to Nutrition Rehabilitation Centre (NRC).
- Community based management of severely and moderately under-weight children: **Sneha Shivirs** for mothers for 12 days at AWCs, followed by 18 days of home practice and monitoring weight gain after 12 days and 18 days. Those severely underweight children with medical complications are referred to nutrition rehabilitation centre (NRC).

4. HEALTH SERVICES

Health centre and subcentre staff have their obligatory responsibility to provide maternal and child health services in geographical area of PHC covering 30,000 population. Providing maternal and child services in an area with the help of ICDS infrastructure becomes much more easier as system of *Anganwadi* workers prepare mothers and children, motivate them to utilize services. Since mothers and children come to *Anganwadi* that becomes the focal point for delivery of services. The health component of ICDS comprises health check-ups, immunization, referral services, and nutrition and health education.

i. Health Check-ups

This includes health check-up and growth monitoring of children under 6 years of age, pregnant and lactating, mothers as per norms laid down. At the *Anganwadi*, children, adolescent girls, pregnant women and nursing mothers are examined at regular intervals by health worker (female), and health supervisors with the supportive supervision of medical officers. Infants and young children below 3 years of age is a priority group for weighing, health check-ups and management of sicknesses like diarrhoea, fevers and respiratory infections and worm infestation, etc. *Anganwadi* centre based screening of 0–6 years children for 4Ds and early intervention services under *Rashtriya Bal Swasthya Karyakram* has been initiated in Feb 2013. Mobile team screens children at anganwadi twice a year.

ii. Referral Services

During the health check-ups and growth monitoring, sick and malnourished children, in need of prompt medical attention, are provided referral services through subcentre, female health workers or through nearby PHCs by medical officers. The *Anganwadi* worker has also been trained to detect disabilities in young children. She enlists all such cases in a special register and refers them to medical officer. The effectiveness of this service depends upon timely action. The referral support services are weakest or just minimal that is why people turn to private sector for treatment of illnesses in mother and children and for other disease as well. Early response at home, at *Anganwadi* and at health subcentre and health facility is most critical and it saves many deaths due to diarrhoea, respiratory infections and fevers.

iii. Immunizations

AWW mobilizes mothers and children and identifies all pregnant women at the earliest and registers all the births occurring in her area, motivates them and informs them the place and date of immunization. It is better to plan immunization activities with ICDS system and AWWs. Immunizations are done by health workers and their supervisors as AWWs have not been trained for the task of injection and immunization procedures. Coverage of immunization for pregnant women and infants can be increased with the help of *Anganwadi* workers. *Anganwadi* workers help in organization of outreach session and she maintains perfect records of immunizations and she knows the left over children and pregnant women in her area.

iv. Management of Childhood Illnesses

Anganwadi workers have been provided with drug kit for managing diarrhoea, anaemia, fever, worm infestation, minor cuts and injuries. She also holds contraceptives, vitamin A solution, iron and folic acid tablets besides other drugs. She is depot holder of medicine kit of ASHA. She has been trained in IMNCI strategy.

Growth and Development Monitoring and Promotion

New WHO growth standards for girls and boys have been introduced in ICDS. Growth monitoring and nutrition surveillance are two important activities that are in operation in ICDS. Children below the age of three year are weighed once a month and children between 3 and 6 years are weighed once in three months. Mother and child protection session or immunization session held on fixed days, when mothers and children come to avail services, is the best opportunity for growth monitoring and promotion of growth. Result of growth and development monitoring must be shared and communicated to mother, best is let mothers themselves weigh their children and know the status of nutrition of their child for appropriate actions. Weight-for-age growth charts are maintained for all children below 6 years of age. This helps to detect growth faltering and also would help identify children in various categories like normal, moderately underweight and severely underweight children.

Community-based monitoring has been further strengthened by use of ICDS NRHM Mother and Child Protection Card (MCPC) which is retained by the family which incorporates new WHO child growth and development standards. In new revised MCPC age appropriate 'Redflag Signs' of Developmental issues are being used for early guidance and referrals.

Monitoring of developmental delays and milestones is being undertaken from now onward, integrated with growth monitoring. Weight for height measurement has been included now to measure wasted and severely wasted children.

5. COMMUNITY MOBILIZATION/PARTICIPATION

This component aims at enhancing community participation and ownership in ICDS programme. Powers have been given to *Panchayati Raj* Institutions (PRIs) and Local Bodies in the implementation of the ICDS. These institutions have been involved in selection of *Anganwadi* workers, supervision and monitoring, location, construction and maintenance of the ICDS centres. Village health, sanitation and nutrition committee has been involved in management and supervision of ICDS programme at the village level. Prime position have been given for involvement and participation of PRIs and urban local bodies at village, block, district, state and national levels. Similarly, NGOs and voluntary associations have been involved in ICDS programme. However, this component is weak and needs further strengthening.

Village Health Nutrition and Sanitation Day

ASHA along with *Anganwadi* workers and auxiliary nurse midwife (ANM), self-help group and community-based organizations, PRIs, and preraks of continuing education

centres organizes village health, nutrition and sanitation day (VHSND) once a month on fixed date at the *Anganwadi* centres. This day is used for provision of immunization, ante/postnatal check-ups and services related to mother, child, and adolescents healthcare, including nutrition. This generates awareness and leads to increased utilization of services besides promoting convergence. Preparation and implementation of local village plan and meeting of village health committee also happens on that day. Fixed monthly early childhood care and education (ECCE) day *Balbodh Divas* can be combined with (VHSND).

6. ADOLESCENT GIRL'S SCHEME IN ICDS

Adolescent girl's scheme has been redesigned as *Kishori Shakti Yojna* (KSY). The KSY aims at improving the nutrition and health status of adolescent girls and promoting self-development, awareness of health, hygiene, nutrition, and family life and child care.

Initially the KSY covered 2000 ICDS projects and it has been expanded further to cover all ICDS projects. A new comprehensive scheme for adolescent girls called SABLA has been implemented in 200 districts replacing KSY.

New initiatives: In view of NFHS-5 findings 2 Lakh anganwadis are being upgraded to Saksham anganwadis, which is an integrated architecture to improve women and child health and nutrition indicators. This architecture includes Mission shakti for women's health, Mission vatsalya for care of pregnant women and empowering anganwadis to improve child health and poshan 2.0 to improve dismal child nutrition indicators.

Conclusion

ICDS is the finest example of intersectoral coordination in operation and achieving results.

In the light of experience gained over the last 48 years the task of ICDS will not only be confined to feeding programme but transformed into early childhood development programme.

Salient Features of Reformed ICDS

i Continued implementation of ICDS in 12th Five-year plan in Mission mode along the lines of NRHM and SSA (*Sarva Shiksha Abhiyan*).

ii **Universalization of ICDS:** Redesigning and reinforcing of revised package of ICDS services to focus on under 3 children; maternal care, early childhood care and education (ECCE).

iii Rolling out strengthened and restructured ICDS in three years beginning with 200 high burden districts in 2012–13, additional 200 districts in second year and remaining 243 districts in third year of plan period.[4]

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CHAPTER

6

Basic Statistics and its Applications Including Research Methodology

"Transforming raw data to information by analysis helps in decision-making"

BIOSTATISTICS

Meaning of Statistics

Statistics means data or numerical observations.

What are data? Data mean set of related numbers or raw material for statistics. Data are the starting point in Epidemiology/Biostatistic studies/investigation. We collect data, compile and analyze data and convert raw data into information and interpret the information for **decision-making**.

Biostatistics: The statistics related to living or human beings.

Vital statistics: Means data on vital events like births, deaths and marriages, and migration, etc.

Health statistics: Data related to health service system/ organizations and institutions. It includes all the data required for planning, implementation and evaluation of health services or health systems.

Variables

Any characteristic that can be measured or categorized is called variable.

A variable means a characteristic of interest in a study. Variables differ from one person to another, such as age, sex, weight, height, literacy, economic status, vaccination and nutritional status, physical activity, pulse rate, haemoglobin levels, cholesterol levels, etc.

For certain variables, the values are numeric, for others, the values are descriptive. The type of values influences the way in which the variables can be summarized. Variables can be classified into one of four types, depending upon the type of scale used to characterise their values.

Dependable variables are—weight, haemoglobin level, blood pressure and disease.

Independent variables are—interventions like immunization, supplementary feeding/nutrients, and treatment.

SCALES OF MEASUREMENT

The four principal scales used to measure data are: The nominal, ordinal, interval and ratio scale.

1 ***Nominal scale variable:*** It is the scale in which names, labels or tags are given to distinguish one measurement from another on the basis of certain qualities or attributes.
Examples: Nationality, language spoken and outcomes of a disease can be measured as survived or died, and outcome of treatment can be measured as cured, not cured. Psychiatric patient may be classified as psychotic, neurotics, manic, depressive or schizophrenics.

2 ***Ordinal scale variable:*** It is also called ranking scale. It has the characteristics of the nominal scale with implicit order/relationship among measurements.
Examples: Social status of patients may be measured as upper, middle or lower class. Goitre may be measured as no goitre, grade I and grade II. Nutritional status can be measured as normal, moderately underweight and severely underweight. The qualitative and attributive data are usually measured on nominal or an ordinal scale.

3 ***An interval scale variable:*** It is characterized by a numerical unit of measurement, such that the difference between any two measurements is explicitly known in terms of intervals between the two points but without a zero point.
Example: Body temperature is usually measured on an interval scale and unit of measurement is degree Celsius (°C). Body weight and height are measured on interval scale.

4 ***Ratio scale variable:*** In which both the distance and ratio between two measurements are defined (e.g. length, incidence of disease and number of children). In both ratio and interval scales, it is possible to specify the extent to which one measurement is larger than another (e.g. 80°C is 40° warmer than 40°, one meter is 60 cm longer than 40 cm. However, a ratio scale has additional possibility of specifying the ratio between two measurements (e.g. one meter is twice as long as 50 cm). Further, it has true zero point.

Competency addressed: The student should be able to:
CM 6.2: Describe, discuss and demonstrate classification of statistical data.

Objective: The student collects peers data and classifies their variables (characteristics) on scales of measurement.

Classification or Types of Statistical Data

There are two types of data according to the strength of the scale of measurement:

1 Qualitative
2 Quantitative

1. Qualitative Data

a These data have no magnitude or size.
b These are not measurable on scale.
c These are classified only by counting the units that have same attribute.

Example: Sex, colour, race, and nationality.

Qualitative data/variables are measured either on nominal or an ordinal scale. Types of qualitative data are:

a. *Qualitative Binary Data or Dichotomous Variable*

The variable can only take two values, such as male or female, yes or no, cured or died, vaccinated or not vaccinated, exposed or not exposed, healthy or sick. These data can be presented by pie diagram or by simple table by frequency distributions.

Categorical/qualitative binary data can be summarised by ratios, proportions, incidence and prevalence and mortality rates.

b. *Qualitative Nominal Data*

- The variable can take more than two values or any value.
- The information fits into one of the categories.
- The categories cannot be ranked.

Example: Nationality or state to which one belongs to, spoken language, blood groups.

Disease classification: Psychosis, neurosis, manic, and depressives, etc.

These data can be presented by frequency distribution in tabular form or by using a **horizontal** bar **chart**.

c. *Qualitative Ordinal Data*

The variable can take a number of values that can be ranked through some gradient.

Example:

Birth order: First, second, third …

Severity of illness: Mild, moderate, severe …

Goitre grades: No goiter, grade I and grade II.

Nutritional status can be graded as normal, moderately underweight or severely underweight. Social status of a person/patient can be graded as upper, middle and lower class.

These data can be presented by frequency distribution table or by vertical bar diagrams.

2. Quantitative Data

These data have size or magnitudes. We can measure these data either on an interval or on a ratio scale.

Types of Quantitative Data

- Discrete
- Continuous

Quantitative Discrete Data

- Values are distinct and separated
- Normally, values have no decimal and are in whole numbers.

Examples: Number of sexual partners, parity, number of persons died of measles, number of households in community, number of beds in hospital

These data can be presented by frequency distribution table or by histogram. Date of onset of disease in epidemic can be displayed by histogram or epidemic curve and long-term trend by line diagram.

Quantitative Continuous Data

- These data can assume continuous, uninterrupted infinite number of possible values in any interval.
- Values may have decimals.

Examples: Weight, height, Hb level, temperature.

Quantitative continuous data can be measured by an interval scale, which is characterized by numerical unit of measurement, such that the difference between any two measurements is explicitly known in terms of an interval between the two measured points.

Examples: Body temperature is measured on an interval scale and unit of measurement is degrees Celsius (°C). Interval scale can have negative values as temperature can be –20°C.

The *ratio scale* has all the characteristics of the interval scale as well as true or absolute zero so that ratio between two values on the scale are meaningful or relative magnitude of the two measurements.

Examples: Height in meters and weight in kg.

No values exist below zero in this scale. The continuous quantitative variable/data can be presented by frequency distribution table or by diagram, such as histogram.

Data measuring procedure consists of instruments like weighting scales, thermometers, BP apparatus or clinical examination or combination of human and instruments.

Uses

The science of statistics along with epidemiology are used in health services system to assess the health needs of community, to plan services and to evaluate results of interventions or services and conduct research studies in the field of health as also for making decisions in healthcare delivery.

The hallmark of biostatistics is "variations" or uncertainties. Variation in characteristic occurs when its value changes from subject to subject, from time to time, or instrument to instrument, within same subject or from observer to observer. For example, no two individuals are similar. The blood pressure, weight, height, pulse rate, respiratory rate, biochemical levels like haemoglobin, blood sugar, blood counts and other values vary from one person to other. Blood pressure varies from person to person from morning to evening, before and during excitement or exercise, sitting and supine position, recording by different people and in measurement instrument. These variations are hallmarks in population. To fix a range of normal value for a community or individual, we take the help of science of statistics to compare two groups and populations.

SOURCES OF UNCERTAINTY OR VARIATIONS IN HEALTH

Uncertainty is caused by variations in:

- ***Biological factors,*** e.g. age, sex, birth order, and heredity determine the health and disease status in community.
- ***Environmental factors:*** Water supply, sanitation, socioeconomic status, stress, nutrition, addiction, smoking, availability, accessibility and use of services. The environments are major determinant of health and disease variations.
- ***Methodological factors:*** Observer variations, instruments, laboratory techniques, diagnostic tool, and questionnaires used.
- Chance or unknown factors.
- Incomplete information, imperfect tool, poor compliance of drug regimen and inadequate medical knowledge can lead to variations.

Expected outcome: The students collects different variables from peers such as urban, rural, sex, health status, social status, age, weight, haemoglobin level and classifies variables on scale of measurements and displays data by table and graph.

Competency addressed: The student should be able to:
CM 6.2: Describe and discuss principles and demonstrate the methods of collection of data.

Objective: The student practices various methods of data collection on peers, in family, Indoor patients or in community by using standard format.

SOURCES OF HEALTH DATA AND METHODS OF DATA COLLECTION

From where to get data facts and figures? In statistics or biostatistics we must have data for analysis to generate information. From where to get data which is the basic requirement of statistics or biostatistics.

Data collection is the starting point for all kinds of statistics. It is not an easy task. Many sources of data are available and each source has its merits and demerits. Depending upon the need of data for health system, various sources are used. The health data can come from following two sources:

(A): Regular or routine systems and

(B): Adhoc systems such as surveys/studies.

i. People themselves—report outbreaks, diseases, births and deaths and unusual events.
ii. Civil registration system—births and deaths registration under 1969 Act.
iii. Sample Registration System (SRS) of Registrar General of India—once a year provides information on fertility, i.e. birth rates, death rates at state and national level.
iv. Routine records and reports of a health facility—Subcentre, PHC, CHC and Hospitals (OPD and Indoor).
v. A disease notification system at National and International levels.
vi. Disease specific registries (cancer, etc.)
vii. Data of specific National Health Programme. Published in Annual reports by DGHS.
viii. Census data (population count) after every 10 years.
ix. Survey data, of National Sample Survey Organization (NSSO).
x. Integrated National Family Health Survey data (NFHS).
xi. General and special health surveys (Singur, Calcutta), Tuberculosis 1952–1958 and national survey on annual risk of tuberculous infection 2002 and National TB Survey 2019–21.
xii. District level household surveys data under reproductive and child health—every alternate year—as also facility survey data besides annual district health survey data.
xiii. Surveillance data, e.g.
    - HIV annual sentinel surveillance data.
    - National polio surveillance project reports.
    - Malaria surveillance and IDSP.

xiv Media reports and outbreaks investigation.
xv World Health Reports: Weekly epidemiological reports, annual statistical reports, etc.
xvi Health information of India—Published by CBHI

Routine reports/sources generate regular data on health at low cost but these data are incomplete and inaccurate and may not be reliable. Adhoc data is collected by national health and demographic surveys at regular interval which in more reliable.

- **Methods of data collection:** Most common methods are—**Interviews, questionnaires, direct observations, review of health records and reports, health examination, laboratory investigations,** and group **discussions,** by **surveys,** case studies and special studies (*see* pages 237, 238) besides participatory rural appraisal, transact walk, and social mapping.

People First

People themselves are great source of information and most of the time people report the unusual events first, the official machinery comes to the scene much late. People's resources must be used. Rumour register kept at PHC level records rumours of disease/outbreaks which can be subsequently verified by health workers. This system was used in smallpox and guinea worm eradication programme.

Data Quality

High quality data mean that the data are accurate, reliable, complete, sufficiently precise, timely reported with integrity.

Accuracy: Valid data are data that have been accurately captured, that is, the data measures what they are intended to measure. Fever may not be valid measure for malaria.

Reliable: It means data are consistent. If the process of data collection is repeated the data do not change.

Completeness: It means all indicators of all reporting units are being collected and reported.

Precision: This means the data have sufficient details (e.g. age group, sex and geographic area and exact unit of measurement).

Timeliness: Data are timely when the information is available on time (within prescribed timeline).

Integrity: It means no manipulation of data and ensuring confidentiality. Data error can happen while collecting data, during entry, during cleaning and validation of data.

Expected outcome: Student uses community based assessment checklist (CBAC) for risk assessment of common NCDs in allotted family/community or else uses flow charts of IMNCI, he asks, looks, listens, feels to assess, classify and identify treatment of a sickness/ syndrome.

Competency addressed: The student should be able to:
CM 6.2: Describe, discuss and demonstrate methods of analysis, interpretation, and presentation of statistical data.

Objective: To develop data analysis and interpretation skill.

Data Analysis and Interpretation

The term data and information are often used synonymously. A distinction must be made between them. Data mean collection of facts. Information is the outcome of data analysis. Information is used in programme management for **decision-making process**. Thus, data are abstract which when processed, (compiled and analysed) provides information that is meaningful to the person receiving it. All reports which come with loaded data must be analyzed and processed to generate information for action. Data on diseases collected by health system at various levels must be analysed locally first of all by count, divide by population denominator to calculate rates. Rates are useful for comparing disease frequency at different **times, places** and **persons** for **action.** Raw data collected by workers is transformed to information by data analysis.

The primary healthcare facilities in rural and urban areas collect voluminous data which lies dormant and invisible and seldom used at local level for microplanning. There is built-in system of data collection at all the levels—community, households outreach and health facility. Household survey and village survey data is gathered by ASHAs, AWWs and ANMs. They have with them the information of each and every household. Broadly it enumerates, total population, households/families, their socio-economic, and demographic status, drinking water and sanitation, eligible couples, pregnant and lactating mothers, births and deaths, immunization records and under six children. There is built-in tracking system and service delivery—at home, through outreach sessions, and at facility level (sub-centre and PHC). Lot of service statistics data is generated and reported in regular routine reports. Work reporting appears to be the only use of voluminous data in compliance to the requirement of the health system. The data on morbidity, mortality, injury and disability is seldom compiled and analysed at local level for microplanning.

How? Data analysis means data reduction or summarization, i.e. reduce the voluminous quantity of numbers to summary because human mind cannot handle too many bits of information at the same time. In **tables** and **diagrams,** the quantum of data is reduced for easy understanding and interpretation. Data can be summarized by: **Tabulation, graphing** or by **summary measures:** Such as ratio, proportion, rates, and measures of central tendency (mean, median, mode) or by dispersion. The final step in analysis is interpretation of information generated by data analysis as shown in flow diagram on next page.

The simplest and feasible analysis at local level include:

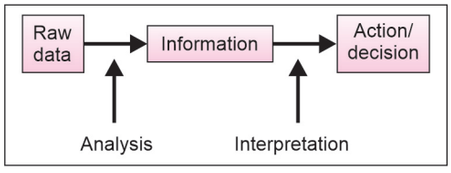
- Line listing of births, deaths and causes of deaths in chronological order of occurrence.

- Line listing means compiling data in rows and columns. Each row represents one person's record/observation. Each column is called variable containing one characteristic of an individual/person.
- At the end of the year, one can calculate birth rate and death rate of subcentre area and then by aggregating data of all subcentres to arrive at birth rate, death rate, infant mortality and under five mortality rate of larger geographical area, we can compare these rates in urban and rural and different CHCs (geographical areas).
- Causes of death statistics can be compiled in tabular form or in graph to know the major killers in the area.
- Time trends of birth rates, death rates and causes of deaths can be analysed to know the impact of various national health programmes/interventions. System of death review is built in the healthcare delivery system.

Descriptive analysis of data by person, time and place generates evidence/information for further analytical studies to determine cause to effect relationship of disease or event. Direct comparison of absolute number of cases is not possible in the absence of rates.

Morbidity Data and Surveillance data Analysis and Interpretation (Table 6.2)

- Simple frequency table depicting number of persons or diseases treated/attended at facility level can be prepared to measure disease burden and trends over time and their geographical distribution depicted by maps.
- Ratio of male and female sick persons and proportions of various sicknesses in the frequency table can be displayed.
- Proportion of sick infants, pre-school children, school-age children, reproductive age group and old age persons can be compiled, tabulated and graphed to identify high risk persons/age groups.
- Data on point of care tests at PHC and subcentre can be compiled and tabulated to classify any anaemia, moderate and severe anaemia in pregnant women and school children at different points in time to capture trends. In brief, the raw data available with health teams at primary healthcare facility can be compiled, analysed and interpreted by simple frequency tables, graphs, and frequency can be measured by ratios, proportions, and rates to transform raw data into information. The information can be interpreted for decision making and action at local level as depicted below:



- Data can be shared with community. Raw data when complied, analysed, and displayed by tables and graphs/big pictures, becomes easier to communicate with people and stakeholders. Remembering the adage that a picture is worth a thousand words. Thus, tables and graphs are critical tools for descriptive and analytic epidemiology. Students can learn the skill of data analysis on live data as described above. Teachers can facilitate the access of such data to students for developing analytical skills.

PRESENTATION OF STATISTICAL DATA—VISIBILITY OF DATA

Most data collected lie dormant and lie as unprocessed and uncompiled. The data become visible if compiled and presented. The data collected can be made visible by tables and by simple diagrams (graphs, charts and maps). A diagram is worth thousands words.

HOW? TABULATION OF DATA—DATA REDUCTION

Data are transferred from observations to simple matrix. Table means arranging data in rows and columns. If you measure the birth weight of 2700 newborns in a rural block it is raw data. These raw data must be compiled and summary data should be presented so that it can become visible summary (data reduction). Data in table is more precise.

Table 6.1 (Frequency table) gives summary value of large number of observations. In table, the data becomes visible in summary form. One can draw inferences quickly.

Table 6.1 is a **frequency table** with one variable providing summary of birth weights of 2700 newborn babies. We can quickly draw inferences that one-third of the babies had low birth weight in rural area and two-thirds of babies were born with adequate birth weight. This also provides a lead point for action as how to reduce the proportion of low birth weights in the community and with what interventions? Similarly, the data also may raise a question as to what factors or conditions are responsible for low birth weight babies in the community? If the health workers are able to interpret the data they are collecting, they will have a better understanding of the needs of their community, e.g. the health workers summarized the list of eligible couples in their area in tabular form for Community Needs Assessment Approach (CNAA) under reproductive and child health to determine contraceptive needs and priority eligible couples.

The data on outdoor attendance of a primary health centre for the year 2004 was compiled and presented as **simple counts** in tabular form (Table 6.2). This summary table presents the data on annual morbidity in OPD and one can interpret that the leading morbidity in this rural area was respiratory infections, followed by diseases of bone and Joints, myalgia, fevers, accidents and injuries.

Table 6.1: Birth weights of newborns in a rural block 1997

Weight in kg	*No. of newborns*	*% age*
<2.5 kg	900	33
>2.5 kg	1800	67
Total	**2700**	**100**

Table 6.2: OPD morbidity at PHC—Chiri 2004

Disease	*Number*
Fevers	2495
Respiratory infections	4921
Diseases of bones and joints, osteoarthritis, myalgia	3550
Accidents and injuries	1987
Conjunctivitis	857
Diseases of skin	239
Worm infestation	272
Diarrhoea	143
Cervical discharge and vaginal discharge	182
Tuberculosis	51
Others	2890
Total	**17587**

According to morbidity load one has to arrange or plan for indent of medicines. One can also draw inference that acute communicable diseases were the major cause of morbidity in the area. One can draw year wise comparison to know the trends of morbidity in the area.

Contingency Table can be 1, 2 or 3 Way Tables

Tables 6.1 and 6.2 are simple tables. Table 6.3 is contingency table. It is 2 × 2 table and it follows two-way classification. Each cell has two attributes. This table shows distribution of one variable in rows and another in column, used to study the correlation between the two.

Table 6.3: Occurrence of measles in vaccinated and non-vaccinated children in a primary health centre area

	Measles disease		
Vaccinated	Yes	No	Total
Yes	40	320	360
No	486	54	540
Total	**526**	**374**	**900**

Example: Vaccinated and unvaccinated children against measles and attack rate of measles disease in these two groups.

Each cell has two attributes—disease occurrence and vaccination status. This is also called cross-tabulation. For chi-square test of significance, we usually prepare 2 × 2 contingency table for qualitative characters; which is first step in χ^2 test.

Frequency Distribution for a Continuous Quantitative Variable

Frequency table is used to present quantitative data: Class intervals are presented in the first column and against that class interval, the mid-point of class interval in second column and frequency is depicted in third column (*see* Table 6.4 at page 209).

Life Table

This is a special kind of table to calculate life expectancy at birth and subsequent ages (Table 6.11), respectively.

Diagrams/Graphs: Displays Numeric Data in Visual Form

The frequency table or other tables can be presented by means of suitable diagrams such as histogram, bar charts, pie charts and line diagrams and scatter diagram.

Age and sex composition of an area can be presented by **population pyramid** (*see* under demography and population problem).

Histogram is diagrammatic presentation of the frequency distribution of quantitative variable with areas of rectangles proportionate to the class frequency. In histogram size of interval chosen can vary. Histogram is an area diagram (Fig. 6.1).

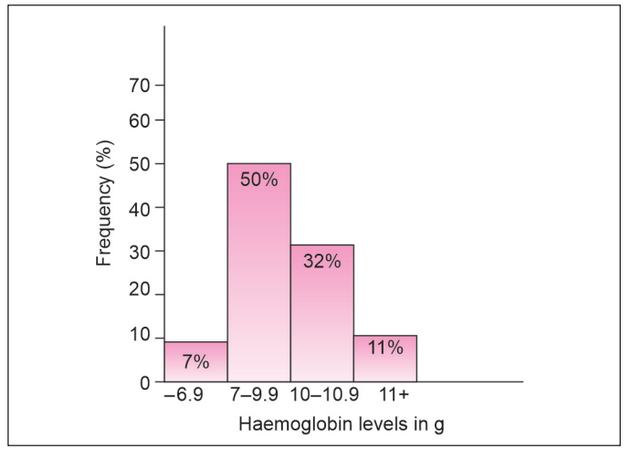


Fig. 6.1: Histogram showing levels of haemoglobin in adolescents in India 2001

Interpretation of Bar Charts

The prevalence of malnutrition in India during 2019–21 was quite high as 32.1% of children below 5 years were underweight, 35.4% were stunted and 19.3% had wasting and 7.7% had severe wasting (Fig. 6.2). The malnutrition starts at 6 months of age and tends to increase as the child grows to age one and prevalence is maximum between 12 and 23 months of age. Qualitative ordinal data can be depicted by horizontal bar diagram.

Pie diagram provides visual impression of an event and is quite eye catching. Observer can immediately grasp the event or use of service by such diagrammatic presentation (Fig. 6.3). Qualitative binary data can be presented by pie diagram.

Inference: 56.5% of eligible couples were using modern contraceptives. Female sterilization (38%) was the most popular and acceptable method. Men participation

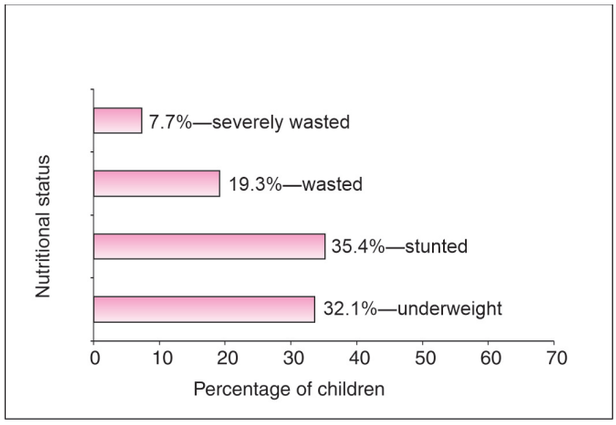


Fig. 6.2: Nutritional status of under 5 children (NFHS-5) 2019–21

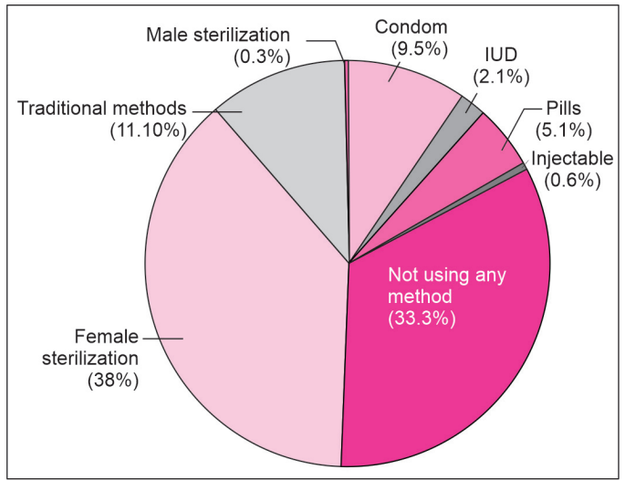


Fig. 6.3: Current use of contraceptives in India (NFHS-5)

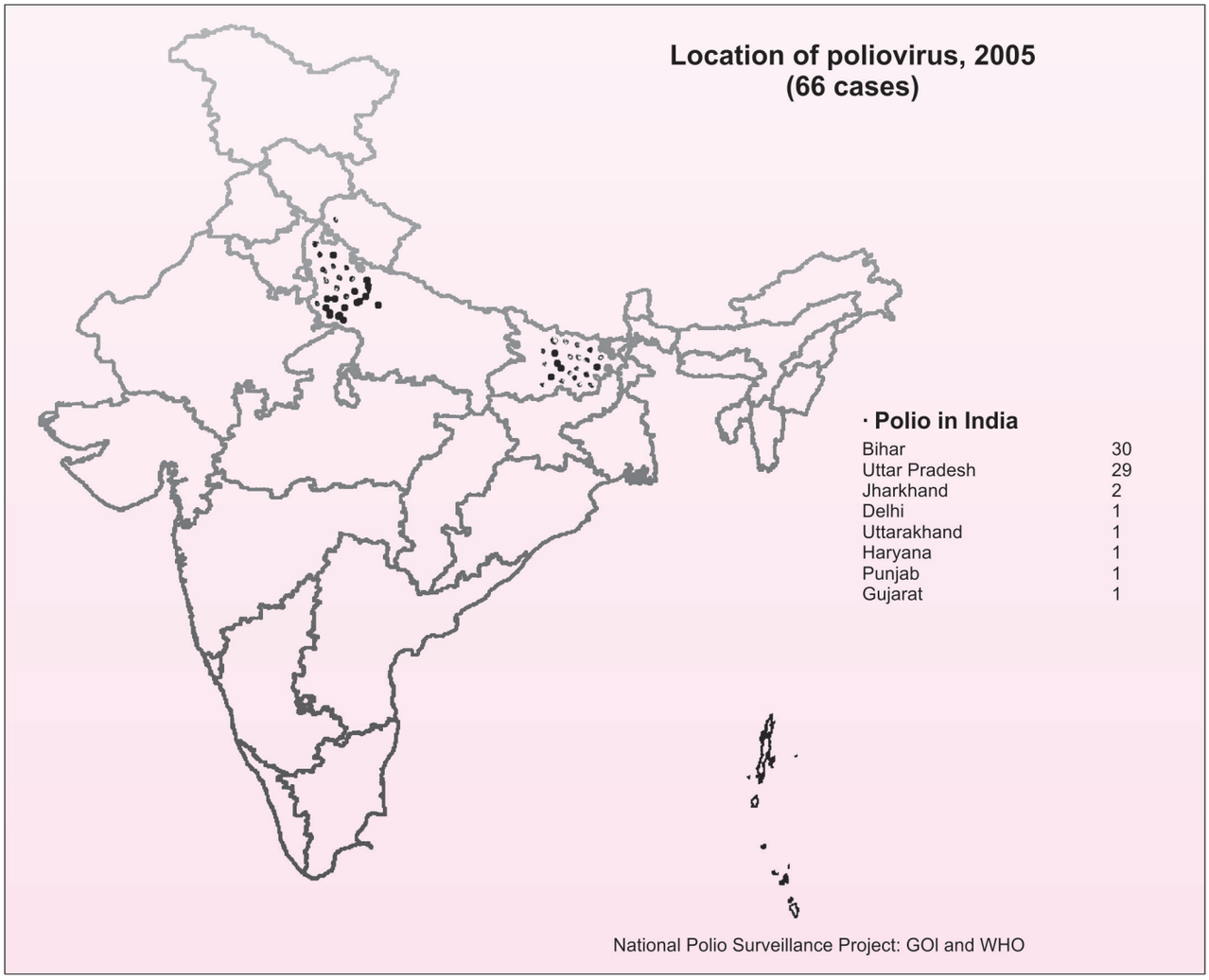


Fig. 6.4: Map of India showing distribution of confirmed cases of polio during the year 2005

in contraceptive use tend to be low at 0.3% for sterilization and 9.5% for condom use. Overall the spacing methods are used by less number of women, only 2.1% used IUD and other 5.1% used pills and 0.6% used injectable contraceptives. Spacing methods and men participation needs to be scaled up by IEC activities and increasing access to contraception (Fig. 6.3).

Line diagrams are drawn to depict trends of an event over long time period. In the present line diagram (Fig. 9.5), it is evident that population growth rate in different decades in India witnessed marked increase from 1941–51 to 1971–81 and thereafter there was some respite, as for the first time in demography history the country observed decline in population growth in decade 1981–91 and the decline continued in next two decades as well (1991–2011). It means India's family welfare programme is making a slow but sure impact on population growth. Lowest ever decadal growth rate of 17.64% was observed in 2001–11, which further declined to lowest level at 15.1% in 2011–21.

Spot Maps and Incidence Maps (Fig. 6.4)

Maps are used to depict the geographical distribution of disease or prevalence of disease in different geographical areas. Incidence maps help to compare events in population.

If there is clustering of cases of a disease it provides a useful clue for epidemiological investigation of an outbreak. Spread of outbreak can be shown on spot map of locality by marking dots for an event or disease.

Concentration or clustering of cases in an area draws an attention of affected locality and the epidemiological factors and conditions responsible for such a behaviour. Spot maps of an outbreak of hepatitis E is shown elsewhere (investigation of an outbreak of jaundice, *see* Fig. 7.10). Incidence maps make use of population as denominator.

Other Charts

Growth chart is a visual impression of growth of a young child. Direction of growth can be monitored and intervention can be undertaken at appropriate time. Growth charts are being used in ICDS to monitor the growth and prevent the occurrence of malnutrition in young children. Thus, growth charts are valuable tools to prevent malnutrition (*see* Figs 5.2 and 5.3).

Expected outcome: Student collects raw data, prepares simple frequency tables and graphs showing distribution by time, place and persons for interpretation.

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APPLICATION OF SIMPLE ELEMENTARY STATISTICAL METHODS

The most important information of the data collected, is to obtain one single value that describes the characteristic of the entire data. Such value is called '*central value*' or '*average*'.

Definition

"Average is an attempt to find out one single figure to describe whole of figures"

—Clark

"The average is sometimes described as a number which is typical of whole group"

—Leabo

Objectives of Averaging

1 To get single value representing entire data.
2 To facilitate comparison between different data.

Qualities of Average

1 Easy to understand.
2 Should be simple to compute so that it can be used widely.
3 Representativeness of all items and if one item is dropped or added in the data then the average must alter.
4 It should not be unduly affected by extreme observations.
5 It should be capable of further algebraic computations, e.g. subtraction, multiplication, addition, etc.
6 ***Uniqueness:*** Average should be properly defined so that it must have only one single value for a given data. It should not depend on personal variations and investigator bias.
7 ***Sampling stability:*** It means the stability of the averages calculated from different sets of data which are collected randomly should not differ significantly. As the difference will be less the average would be called more stable and *vice versa*.

Competencies addressed: The student should be able to:
CM 6.3 and 6.4: Describe, discuss and demonstrate the application of simple-elementary statistical methods. Describe measures of central tendency.
(Application of simple/elementary statistical methods is discussed as under.)

How? The student should be able to calculate different averages and measures of dispersion from a given set of live data of students (peers).

Learning objectives: Student calculates various measures of central tendency and interprets their applications.

Summarization of Numerical Data, or Data Reduction (Measures of Central Tendency)—CM 6.4

The data which an investigator or health workers or an organization collect has to be summed up. For example, if 1000 children have been weighed in the community, each child would have certain weight and we have 1000 observations. To give value for each and every child makes little sense. If we want to give only one value for all the 1000 observations on birth weight that would be 'summary value' of 1000 children. How can we do that? We calculate the average value of 1000 observations that would be one summary value of all these observations. Thus, we can say that "average" birth weight is 2.7 kg in this community that makes a lot of sense. This value speaks of entire data.

The "average" is most typical value of the observations as most of the values of the observations would be centering around it.

But the average has to be interpreted cautiously, e.g. average birth weight of 2.7 kg of 1000 observations does not mean that every child at birth would weigh 2.7 kg. Average though a valuable summary value of data hides many things underneath it; as many children in the community would have birth weight less than 2.7 kg and it is well known fact that in India 22% of children at birth have low birth weight and weigh less than 2.5 kg and many may be less than 2 kg and so on.

The most common *averages* available in India are:

1 ***Mean or average age of marriage for girls in India:*** Mean age of effective marriage was 21.2 years. It is summary value of all marriages of girls occurring in India. It should be interpreted carefully. Nearly 23.3% got married before the age of 18 (NFHS-5); the minimum legal age at marriage for girls set by Child Marriage Restraint Act of 1976.

2 ***Mean birth weight*** in India is 2.7 to 2.9 kg. But one-fifth of births are low birth weights in India which are below 2.5 kg, which is a major public health problem and cause of infant mortality in India.

3 ***Total fertility rate*** (TFR), which is an average number of children a woman would bear if she experienced current age-specific fertility rate during her reproductive years, was 2 births per women in 2019–21. The TFR of 2.1 or less than that was observed in Kerala, Delhi, Puducherry, Tamil Nadu and Chandigarh while high TFR of 3, was observed in Bihar. The TFR which is a summary value of fertility should be interpreted carefully in the light of variations observed between different states of India.

4 ***Similarly average income of ₹ 3000/-*** per year per capita at current prices is a ***summary value of income in India*** (2002–2003). This is to be interpreted very carefully. Income of family of 5 would be ₹ 15,000/- per year. Based on this the families below poverty line (BPL) are identified for special programmes and economic uplift. The poverty line has been defined by World Bank as an income of $1/day per person or less. Planning Commission defines poverty line as a total household per capita expenditure sufficient to provide in addition, to basic non-food items—clothing-transport—a daily intake of 2400 calories per person in rural areas and 2100 in urban area. Family of 5 whose income is below ₹ 11,000/- per year are called, below poverty line families (in rural area) at 1991–92 prices. Recent estimates of poverty in India is 21.9%. Average size of household in India is 5.4 persons but average size of family is around 5 in India. However, in rural settings the average size of 7.0 person per household is not uncommon.

The common *averages* for summary values of data are:

- Mean (arithmetic mean, geometric mean, weighted mean, harmonic mean)
- Median
- Mode
- Other measures of location are quartiles, percentile, and proportions.

Arithmetic Mean

It is most popular and most widely used measure of summation of data. It provides one summary value of the observations.

Definition: Arithmetic mean is the sum of all values of a set of observations divided by the number of observations.

The arithmetic mean (AM) is denoted by $\overline{X}$.

The haemoglobin level of 11 pregnant women was measured and the values of haemoglobin were as under.

7,8,9,10,11,11,11,12,13,14,15 …(i)

The sum of all the 11 values was = 121

The arithmetic mean was 121/11 = 11

Following are the haemoglobin levels of the 30 students in a class (in g%):

11,12,8,9,9,9,9,8,10,9,10,10,11,10,11,11,11,13,13,14,

13,13,13,12,12,11,8,8,9,8 …(ii)

The simple arithmetic mean = Sum of all values/total no. of values

Sum of all values = 315

Arithmetic mean = 315/30 = 10.5 g%

Quantitative data: If the data is in the form of class intervals and frequency table, then the arithmetic mean can be calculated as follows:

Arithmetic mean of the sample = $\Sigma fm/\Sigma f$

If we tabulate the above data in the form of class intervals (Table 6.4) and prepare a frequency table then mean = 318/30 = 10.6 g%

As simple arithmetic mean discussed above gives equal importance to all the items, but, if the relative importance

Table 6.4: Showing distribution of Hb levels of students in a class (n = 30)

Class interval	*Mid-point of the class int. value (m)*	*Frequency (f)*	*fm*
8–10 g%	9	15	135
11–13 g%	12	14	168
14–16 g%	15	1	15
		$\Sigma f = 30$	**$\Sigma fm = 318$**

of the different items is different then we calculate—weighted mean. Weight—signifies the relative importance of an item.

Weighted Mean

The mean haemoglobin of all schoolchildren is found in two steps.

First step: Multiply the mean haemoglobin for each class by the corresponding number of children in each class (weights), and add-up the total thus obtained.

Class	*No. of children*	*Mean Hb levels (in g%)*
I	54	10.4
II	52	11.2
III	49	10.8
IV	48	12.1
V	48	10.7

Second step: Divide the total cumulative haemoglobin of the schoolchildren by the total number of children in that school.

Then, the mean Hb levels of all the children = weighted mean =

$$\frac{(10.4\times54)+(11.2\times52)+(10.8\times49)+(12.1\times48)+(10.7\times48)}{54+52+49+48+48} = \frac{561.6+582.4+529.2+580.8+513.6}{251}$$

$$= \frac{2767.6}{251} = 11.02 \text{ g\%}$$

Thus, the weighted mean = 11.02 g%.

The non-weighted mean ignores the fact that the number of children in each class is not the same (i.e. unequal weights). In the above example, non-weighted mean would be (10.4 + 11.2 + 10.8 + 12.1 + 10.7)/5 = 11.04 g%.

Geometric Mean

It is defined as the *N*th root of the product of *N* observations.

Geometric mean = $N\sqrt{X_1 \times X_2 \times \ldots\ldots \times X_n}$

It is theoretically considered as the best average.

It gives us an idea about the average rate of changes occurring between observations.

For example, population of India of the last 5 decades:

$$\text{Arithmetic mean} = \frac{439+548+683+843+1027}{5} = \frac{3540}{5}$$

$$= 708 \text{ million}$$

$$\text{Geometric mean} = 5\sqrt{439\times548\times683\times843\times1027}$$

$$= 5\sqrt{142238} = 677 \text{ million}$$

In this example, the geometric mean gives the better average because it considers the change in decadal growth rate as well.

Harmonic Mean

It is defined as the reciprocal of the arithmetic mean or the reciprocal of individual observations.

$$\text{Harmonic mean} = \frac{N}{1/X_1 + 1/X_2 \ldots. + 1/X_n}$$

and for continuous series

$$\text{Harmonic mean} = \frac{N}{1/f(X_1) + 1/f_2X_2 \ldots 1/f_nX_n}$$

Median

The median is that value which divides the observations or distribution into two equal halves or it is the central or middle value of a series of observations when the observed values are arranged in order of magnitude (ascending or descending order).

Haemoglobin level (g%) of 11 pregnant women was arranged in ascending order:

7, 8, 9, 10, 11, 11, 11, 12, 13, 14, 15.

In the above series of 11 values, the middlemost value is 11 g, hence the median value of haemoglobin of eleven pregnant women is 11. Median is not affected by extremes of values. If the number of observations are even then the two central values are added up then average of these two values is calculated to derive the median value, e.g. haemoglobin levels of 30 students of a class are as follows:

11, 12, 8, 9, 9, 9, 9, 8, 10, 9, 10, 10, 11, 10, 11, 11, 11, 13, 13, 14, 13, 13, 13, 12, 12, 11, 8, 8, 9, 8.

Median = Central value of orderly arranged data.
First arrange the data in ascending/descending order.

8, 8, 8, 8, 8, 9, 9, 9, 9, 9, 9, 10, 10, 10, 10, 11, 11, 11, 11, 11, 11, 12, 12, 12, 13, 13, 13, 13, 13, 14.

Total no. of values = 30.

Central value = 30/2.

Median = Value of two central observations

= ½ (value of 15th and 16th observations)

= 1/2 (10 + 11) = 21 / 2 = 10.5 g%

Merits and Limitations of Median

Merits

1 Extreme values do not affect median significantly.
2 Useful in markedly skewed distributions.
3 Most appropriate average in qualitative data.
4 Can be calculated graphically.

Limitations

1 It is necessary to arrange the data.
2 It is a positional average and value is not determined by each and every observation.
3 Not capable of algebraic treatment.
4 Value of median is affected more by sampling fluctuations.
5 It is erratic if the number of item is small.

Mode

Mode is the value of observations which occurs maximum number of times in the data, i.e. the observation with highest frequency. In the above example of haemoglobin distribution of 30 students, the mode is 11 g%.

- If the two observations are occurring with same frequency then the observations around which the values are more condensed is the mode value.
- If several observations are occurring equal number of times and there is no clear cut mode and for such type of data and other data with moderately asymmetric distribution the mode can be calculated by using formula.

$$\text{Mode} = 3 \text{ median} - 2 \text{ mean}.$$

Merits and Limitations of Mode

Merits

1 By definition—mode is the most typical or representative value of a distribution.
2 Not unduly affected by extreme values.
3 Can be determined graphically.
4 Can be determined in open end distribution.

Limitations

1 The value of mode is not unique always. In some cases may have bimodal series.
2 Not capable of algebraic manipulations.
3 Not based on each and every item of series.
4 Not a rigidly defined measure, as there are several formulae for calculating mode.

Merits and Limitations of Average

Merits

Simplest to understand and easy to compute:

- Affected by the value of every item
- Defined by rigid mathematical formula
- It is relatively reliable
- It is calculated value and not related to position of variables in the series.

Limitations

1 Very small and very large values unduly affect the value of mean for a given sample and the effect is inversely proportional to the number of observations in the group.
2 Not always a good measure of central value. In case of 'U'-shaped distribution, the mean is not likely to represent central value.

It is better to express all the "summary values" of the observation, i.e. mean, median and mode. If the distribution is symmetrical any of these (mean, median and mode) may be used. When the distribution is skewed it is better to use median.

The summary value of eleven pregnant women (haemoglobin) observations are—mean 11, median 11 and mode 11. Ideally the mean, mode and median should be at one point in symmetrical distribution. The above distribution can be called symmetrical distribution.

Advantages of Mean

The mean is most commonly used average out of all. It is most easiest to calculate and it takes into consideration all the values of observations.

Disadvantages of Mean

Mean is affected by extreme values of the variables, the value which differs too much from other values of observation affects the mean. In the above example of 11 observations if we add two more observations of lesser values, say 6 and 4, the mean value is pulled down to 10 (131/13 = 10) as is evident:

4, 6, 7, 8, 9, 10, 11, 11, 11, 12, 13, 14, 15.

The median is not affected and it is still 11. The extremes of values are very rare or occur least.

Other related positional measures:

- Besides median, the other methods which guide us about the position of the observations are also there. These are deciles, percentiles, and quartiles.
- Based on particular method the data is divided into number of parts denoted by the method respectively.

For example, in deciles, the given data are divided into 10 parts.

In percentiles, the given data are divided into 100 parts.

In quartiles, the given data is divided into 4 parts.

And each unit of that method denotes the part of data.

For example, 1st decile denotes the 1st one-tenth part of the whole data, i.e. one-tenth of the observations lie before the 1st decile and nine-tenth of the observations lie after the 1st decile.

Similarly, 50th percentile denotes that out of total 100 units in which the data are divided the 50 units are lying below and 50 units are lying above that value, i.e. the median value.

The deciles and percentiles are important positional measures in psychological and educational and health statistics. Percentile values are being used in drawing the growth chart—used for growth monitoring purpose.

On each growth chart there are three printed growth curves. The top curve on the growth chart is the median, the second curve is minus two standard deviations of the median and the third curve is minus three standard deviations of the median.

Quartiles

These are the observations in an array that divide the distribution into four equal parts.

25%	50%	75%	100%
First quartile	Second quartile	Third quartile	Fourth quartile

25% of the observations will lie below first quartile and 75% lie above it and similarly second quartile divides the observations in two halves and third quartile have 75% of observations below it and 25% above it.

Expected outcome: Student collects data (weight, height-BMI) from peer groups and calculates four measures of central location.

Competency addressed: The student should be able to:
CM 6.4: Describe, discuss and demonstrate frequency distributions.

FREQUENCY DISTRIBUTIONS OR COUNTS (Table 6.5)

Learning objective: The objective of this skill is reduction of data or summarise large number of observations into frequently distribution tables and graphs.

- Frequency means number of health events such as number of cases of a disease in population or number of measurements or observations. Frequency refers not only to the number of health events such as number of cases of diarrhoea or diabetes in a population, but also to the relationship of that number to the size of the population. The resulting rate allows to compare incidence and prevalence across different populations and geographical areas. With a large number of observations/data, picking out desired information at a glance becomes increasingly difficult. To facilitate the task, the variables can be summarized into table called **frequency distributions.** A frequency distribution displays the values a variable can take and the number of persons or records with each value.
- A frequency distribution table can be used with any type of measurement scale (nominal ordinal, interval and ratio scale).
- A frequency distribution can also be represented graphically by a bar chart for discrete data or by a histogram for continuous data.

Table 6.5: Frequency distribution for a qualitative binary variable—sex ratio of population in India 2011 census

Sex	*Frequency (in million)*	*Proportion (%)*	*Male–female ratio*
Males	623	51.5	1000
Females	587	48.5	943
Total population	**1210**	**100.0**	

Interpretation: Sex ratio of 943 for females per 1000 males during census 2011 in India was, unfavourable due to high mortality in females. There were 36 million missing females in India due to high mortality in 2011. Same data can be displayed by Fig. 6.5 using pie chart.

Using a histogram to display a frequency distribution for a continuous quantitative variable (Fig. 6.6).

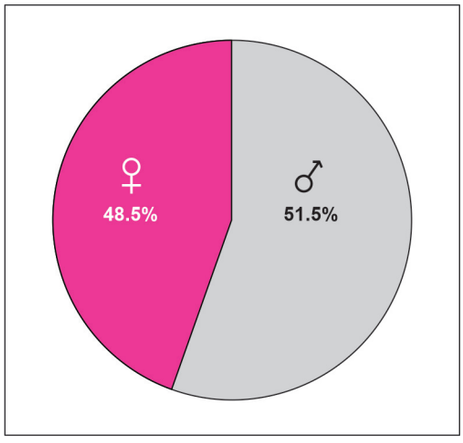


Fig. 6.5: Distribution of population of India by sex in census 2011

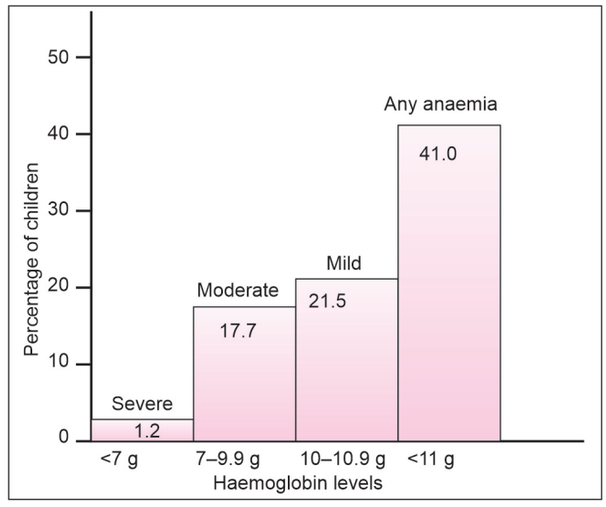


Fig. 6.6: Severity of anaemia among preschool children of 1–4 years in India. Hb levels in g/dl. *Source:* CNNS-2018

Inference: Prevalence of any anaemia to the extent of 41% in preschool children (1–4 years age group) is a serious public health problem in India (Table 6.6 and Fig. 6.6)

Table 6.6: Severity of anaemia among pre-school children of 1–4 years age in India, 2018 CNNS

Haemoglobin levels	*Percentage of children anaemic (1–4 years age)*
<11 g/dl	41.0 (any anaemia)
10–10.9 g/dl	21.5 (mild anaemia)
7–9.9 g/dl	17.7 (moderate anaemia)
<7 g/dl	1.2 (severe anaemia)

Two basic characteristics that can be used to summarize distributions for interval and ratio scale variables data are—measure of central location and measures of variability.

PROPERTIES OF FREQUENCY DISTRIBUTION

The frequency curve of a particular sample guides us about the distribution of variable in the sample and this curve may have infinite number of different **shapes**. Some important frequency distributions are as follows:

The frequency distributions have three properties:

1. Central Location or Central Tendency (First Property)

Here, the values or observations or frequency of any health/disease event cluster around a central value with progressively fewer persons on either side of this central value. This type of symmetric distribution as illustrated in Fig. 6.7 is classic bell-shaped curve, also known as normal distribution. The clustering at a particular value is known as central location or central tendency of a frequency distribution. The central location of a distribution is one of its most important properties, sometimes it is cited as a single value that summarizes the entire distribution. In symmetrical or normal distribution bell-shaped curve, the arithmetic **mean, median** and **mode** are identical or all have same value. In practice, however, observed data rarely approach this ideal shape. As a result mean, median and mode usually differ from each other.

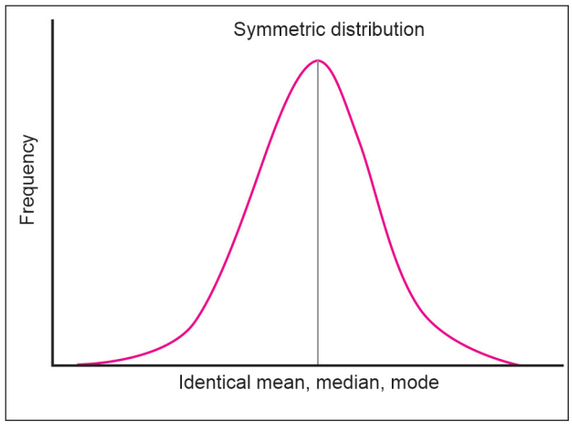


Fig. 6.7: Bell-shaped curve—the standard normal distribution

2. Spread—Second Property

Second property of frequency distribution is spread, also called variation or dispersion. Degree of spread or scattering of observations/values around the central value is called dispersion. Common measures of dispersion are range, semi-quartile range and standard deviation. Figure 6.8 illustrates two theoretical frequency distributions that have same central location but different amount of spread.

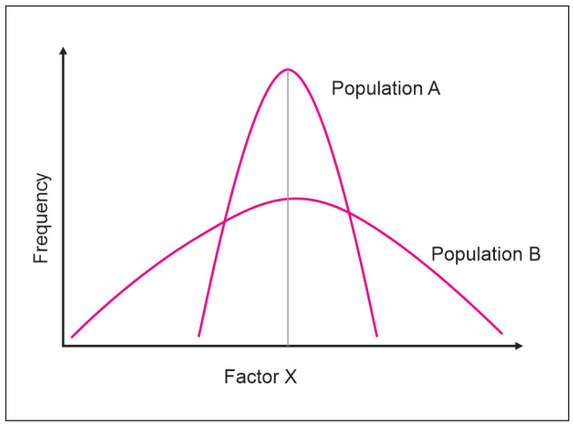


Fig. 6.8: Two distributions with same central location but different spread or variability

3. Shape—3rd Property

The pattern of scattering—a third property of frequency distribution is its **shape**. Frequency distributions of some characteristics of human populations tend to be symmetrical. Some frequency distributions are asymmetrical or more commonly referred to as **skewed**. A distribution that has a central location to the left and tail off to the right is called **positively skewed or skewed to the right**. In Fig. 6.9, distribution P is skewed to the right. A distribution that has a central location to the right and a tail to the left is said to be a **negatively skewed** or skewed

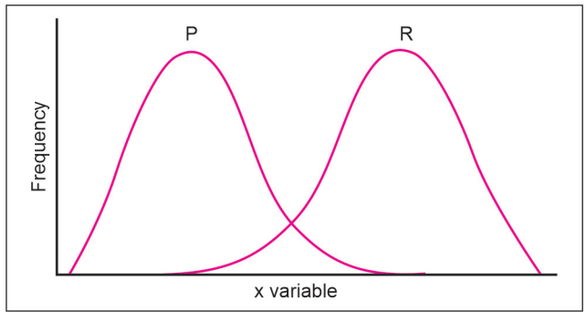


Fig. 6.9: Two distributions with skewness

to the left. In Fig. 6.9, distribution R is skewed to the left. The peaking or flatness of distribution is called **kurtosis**.

Choosing right measure of central location and spread

In summary, each measure of central location mean, median and mode is single value that is used to represent all the values of a distribution.

Measures of central location and spread are useful for summarising a distribution of data. Arithmetic mean is most commonly used measure of central location in normal distribution. The standard deviation is the measure of spread most commonly used with the mean. One disadvantage of mean is that it is affected by the presence of extreme values in the distribution. The mean is 'pulled' in the direction of extreme values. If the mean is higher than the median, the distribution of data is skewed to the right, if the mean is lower than the median, the distribution is skewed to the left (Fig. 6.10). The median is not affected by extreme values of observations. Therefore, when the data is skewed the median is representative of data than is the mean.

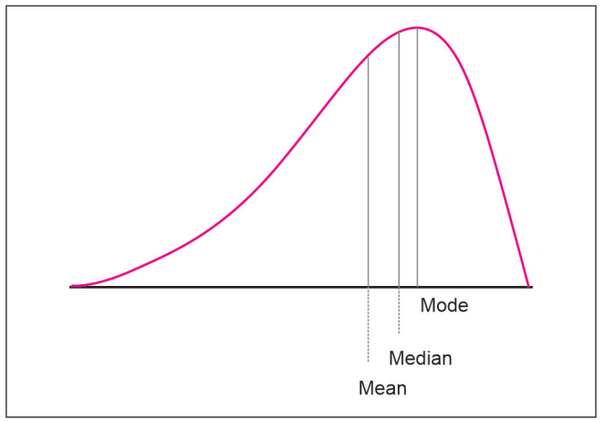


Fig. 6.10: Skewed distribution

There can be distributions with trough in the middle instead of peak called bathtub distribution (Fig. 6.12).

NORMAL DISTRIBUTION AND NORMAL CURVE

The variables or attributes which we study are generally distributed in the population/universe, in one way or the other. These are situations where study variables are of continuous nature, e.g. height, weight, blood pressure. To analyze a particular study, we need to apply some tests—tests of significance—to our study, which can be applied only if some assumption are fulfilled. One of the most important assumption is that the distribution of variable must follow **normal** or **Gaussian distribution**.

Normal or Gaussian Distribution

This is a special type of frequency distribution in a population which has following characteristics (Figs 6.7 and 6.11).

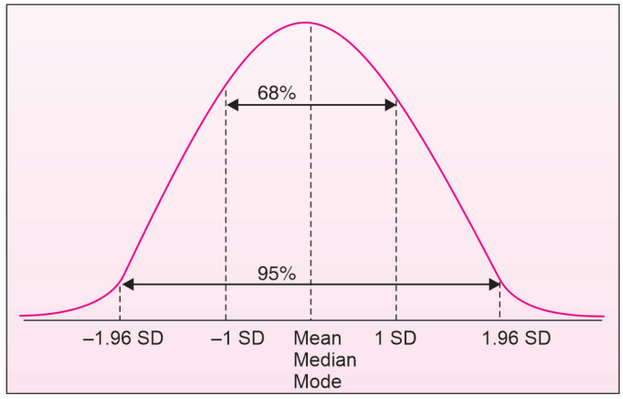


Fig. 6.11: The standard normal distribution curve

1. The curve has a peak in the centre with two tails one on the right and one on the left.
2. The mean, median and mode of the distribution coincide and correspond to the peak of the distribution.
3. The curve is bell-shaped and bilaterally symmetrical around the mean of the distribution.
4. The proportion of frequencies lying on either side of the mean follows a specific pattern—which is proportion of frequencies lying within range of one standard deviation on either side of mean is 68.27% and within range of ±2 standard deviation is 95.45% and within sum of ± 3 standard deviation is 99.73%.
5. Area under normal curve is unity (or one).
6. The standard deviation is one.

Expected outcome: Student presents the data of peer group by means of tables and graphs. Student displays and describes the properties of frequency distribution by preparing standard normal distribution curve, its spread and shape of frequency distribution.

Competency addressed: The student should be able to:
CM 6.4: Describe and discuss measures of dispersion.

Learning objective: To calculate, define and interpret four measures of variability—range, interquartile range, standard deviation and confidence interval (for mean).

MEASURES OF VARIABILITY (DISPERSION)

Variability is a hallmark in statistics. The summary values of observations, such as average (mean, mode and median) are insufficient to describe the characteristics of population. Although measures of central tendency are very useful for summarizing a frequency distribution, they do not indicate the spread of values in population or group, e.g. average birth weight or one summary value of birth weight of 2.7 kg does not explain the spread of birth weights in population or around the summary value

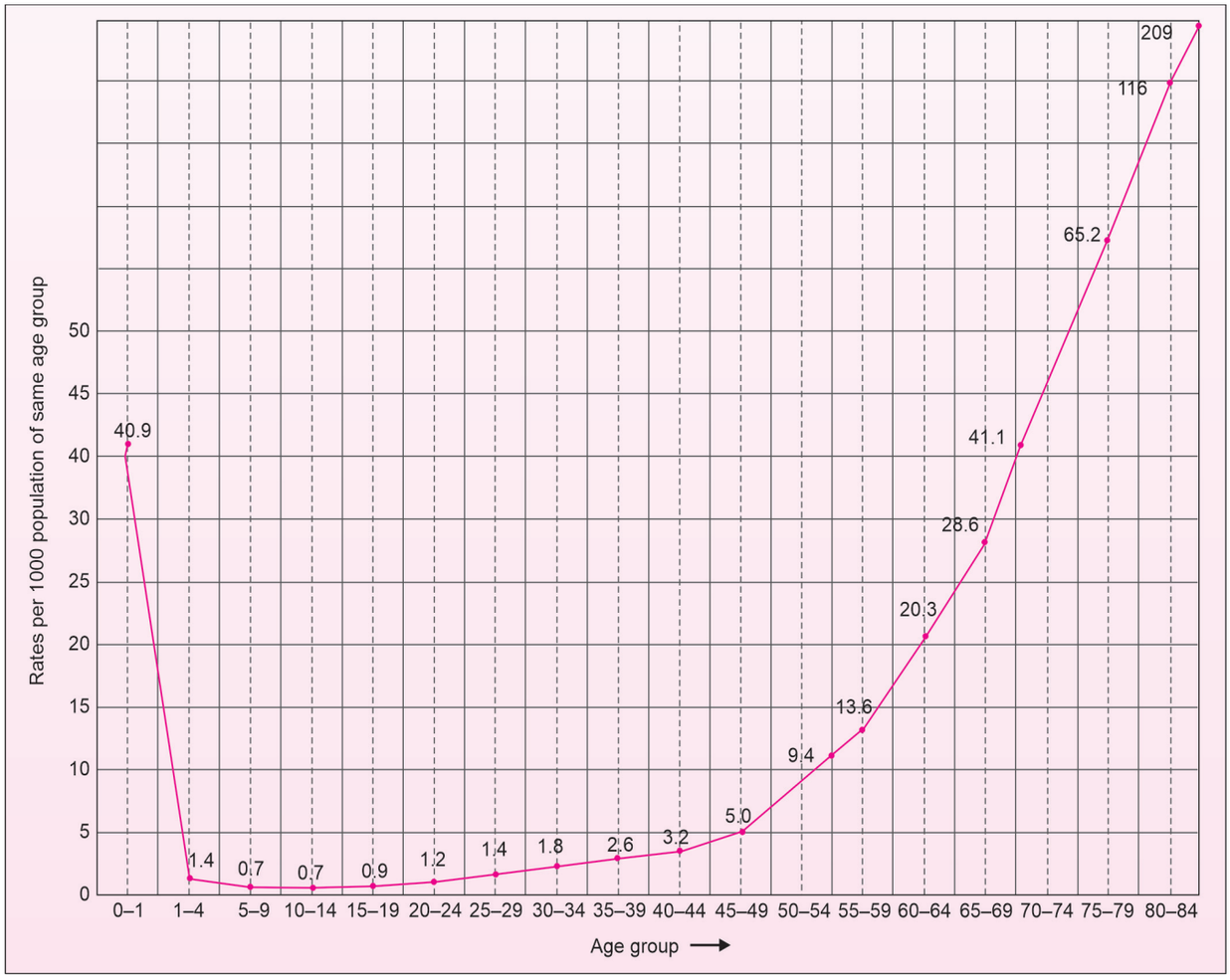


Fig. 6.12: Age-specific death rates in India—(SRS) 2015

of 2.7 kg. Medical statistics have to decide whether to classify a newborn as low birth weight or of as normal or of adequate birth weight and to classify an individual as healthy or sick, suffering from particular disease or not, needing treatment or not. We need to have "cut-off" levels of different measurements. Measures of spread of values are essential for understanding, using and interpreting the concept of "normal" values, and for a complete description of a given health data set.

Uses of Variability/Dispersion

Thus, variability helps in describing or establishing "normal values" for health data. Variability helps in setting "standard" on which **decisions** can be made for **individual patient** care or **community health programmes**. These standards are often referred to as "normal values" and are generated based on measurements made on population groups categorized as "healthy".

Statistics means sample estimates expressed as sample mean ($\bar{X}$), standard deviation (s) and p (proportion) while population parameters refers to the values in population, such as population mean (μ), population standard deviation (σ) and population proportion (P).

Population standard deviation is seldom known or not known we usually derive the results from sample statistics to represent the value of population parameters.

In medical statistics, range of "normal values" is obtained by making use of mean value and standard deviation. Mean value of measures, such as serum cholesterol, blood glucose level, blood pressure, body mass index of sufficient large sample, representative of population are calculated and standard deviations are also calculated.

Normal Range

Most of the measurements in medical sciences are expressed in range within which most **normal** or **healthy** subjects will fall. No single or point value can be fixed. From sample mean value with the help of standard deviation, we derive the range of normal value. *Normal range* is expressed as mean ±2SD, it will cover 95% of

values in the observation or 95% of healthy individuals in population will fall within this range of blood pressure, serum cholesterol and body mass index or any other measurement, provided it is Gaussian distribution or normal distribution curve where mean, median and mode are equal or near equal and standard deviation is one.

For mean ±2SD normal range there would be 2.5% of individuals on (either side) who will fall beyond the normal range. These would be labelled as abnormal values or abnormal individuals. It is quite possible that some of these individuals who have values or measurement beyond normal range may be absolutely healthy and similarly some unhealthy subjects may fall in normal range. Most of the normal range values expressed in medicine use mean ±2SD criterion.

Caution in Interpretation of Normal Range

The nature presents us with a process of continuum and not a dichotomy. Use of dichotomous labels, such as "Hypertensive and normotensive" therefore is not a description of natural order but rather a operational convenience. The relation between risk factors (blood pressure, serum cholesterol and body mass index) and disease events are continuous and most events occur in people in middle range of the risk factor distribution who are not normally judged high-risk. Following this line of thought, it becomes obvious that "deviant minority" e.g. (hypertensive and obese) who are considered high-risk is only part of the risk continuum, rather than a distinct group. This leads to one of the most fundamental axiom in preventive medicine "a large number of people exposed to a small risk may generate many more cases than a small number exposed to high-risk" (Rose). A preventive strategy focusing on high-risk individuals will deal only with the margin of the problem and will not have impact on the large proportion of disease occurring in large proportion of people who are at moderate risk, e.g. people with slightly raised blood pressure suffer more cardiovascular events than hypertensive minority. To alter the underlying cause one needs to have a **population-based strategy**.

Very often all measurements falling below/above a certain critical limit are classified as unacceptable and the critical limit is then known as "cut-off" point. The cut-off point is a selected boundary of acceptability and can be adjusted if necessary when resources for remedial action improve or diminish (Table 6.7).

Table 6.7: Some examples of cut-off levels

Measurement	*"Cut-off" point*
Birth weight	2500 g
Weight-for-age	–2SD
Height-for-age	–2SD or 90% of reference median
Haemoglobin pregnant women	11 g
BMI normal range	18.5 to 24.99
Blood pressure	140/90
Total cholesterol safe level	200 mg/dl
Fasting glucose	⩾126 mg/dl

Cut-off points are drawn after the measurements are made on healthy population. For example, median curve of birth weights (50th percentile) has been drawn by measuring weights of several well to do healthy children in reference population. In April 2006, the WHO released the "WHO Child Growth Standards" and demonstrated for the first time ever that children born in different regions of the world and given optimum start in life, have the potential to grow and develop to within the same range of height-and weight-for-age.

Two types of "normal" values are often used "point normal" values and "normal ranges". The point normal values are derived from summary values or averages (mean, median and mode). Normal ranges give the general level (in terms of an interval) of a measurement for healthy population group as described above. Some individuals in population will have exceptionally high or low value of particular measurement and still apparently healthy. These are called "outliers". Such measurements or values are not regarded as typical of population groups.

Most biomedical normal ranges have been adopted to ensure that 95% of randomly selected healthy people would fall in within the limits. The normal distribution has extremely useful characteristics. Approximately two-thirds of values under a normal distribution curve fall within one standard deviation of mean and approximately 95% fall within two standard deviations of the mean. The normal values must refer to population to which it belongs to, because population of two places may differ biologically and environmentally.

Measures of Variation/Dispersion

The following are the common measures of variations or dispersion.

1. Range
2. Interquartile range
3. Standard deviation
4. Variance

1. Range

Range is difference between highest and lowest value in series of observations. It is calculated by $R = L - S$ where L is the highest value and S is the lowest value in the observations.

In 2700 births weighed, the highest value of observation was 3.8 kg and lowest was 1000 g. The values thus ranged from 1000 to 3800 g and range is 3800 – 1000 = 2800 g.

$$\text{Coefficient of range} = \frac{L - S}{L + S} = \frac{2800}{3900} = 0.72$$

Advantages

Range is simple to calculate, easy to understand, extreme values are dependent on sample size.

Disadvantages

It is not based on all observations as it takes no account of variability of observations between the two extreme values. It is not readily amenable to mathematical treatment. It should be used in combination with other measurements of variability.

2. Interquartile Range

Here the observations are divided into four quarters. The quartile 1 (Q1) indicates that 25% of the observations fall below it and 75% are above it and quartile 3 (Q3) indicates that 25% of values are above it and 75% are below it. The interval between Q1 and Q3 covers middle 50% of values of observations in the group. Unlike the range, the value given by interquartile range is unaffected by the occurrence of rare/extreme values and thus it makes a good measure of dispersion.

3. Standard Deviation (SD)

This is the best method and widely used measure of depicting variation or dispersion. It is *root mean square deviation*, where deviations have been taken from the mean. This equals the square root of variance, expressed in the units of original observations (Table 6.8).

4. Variance

Sum of squared deviations, taken from the mean, divided by the number of observations-*n* (or *n*–1 for an unbiased sample variance), expressed as square of unit of the original observations.

Standard deviation: Following are the haemoglobin levels of the 30 students in a class (in g %): 11, 12, 8, 9, 9, 9, 9, 8, 10, 9, 10, 10, 11, 10, 11, 11, 11, 13, 13, 14, 13, 13, 13, 12, 12, 11, 8, 8, 9, 8.

Steps in calculating SD

i Depict all the values or observations in column 1.
ii Calculate arithmetic mean
iii Find out deviation from mean for each value in column 2
iv Square the *deviations*
v Sum the *square* of deviations
vi Find out the *mean* of sum of square of deviation to arrive at 'variance'
vii Square *root* of variance is 'SD'.

Advantages

SD and variance are based on all observations. The deviations are taken from mean, i.e. the summary measure of central tendency. It is most widely used because of the properties of the theoretical normal distribution curve.

Standard Error (SE) of the Mean

If repeated samples are taken from the same population the statistics or statistical measures, such as mean, median and standard deviation, vary between samples. The degree of variation depends upon both the amount of

Table 6.8: Method of calculation of SD

Observations (X) Hb levels of 30 students	*Deviation from mean* $(X-\bar{X}) = d$	$(X-\bar{X})^2$, *i.e.* d^2 *square of deviations*
11	0.5	0.25
12	1.5	2.25
8	–2.5	6.25
9	–1.5	2.25
9	–1.5	2.25
9	–1.5	2.25
9	–1.5	2.25
8	–2.5	6.25
10	–0.5	0.25
9	–1.5	2.25
10	–0.5	0.25
10	–0.5	0.25
11	0.5	0.25
10	–0.5	0.25
11	0.5	0.25
11	0.5	0.25
11	0.5	0.25
13	2.5	6.26
13	2.5	6.25
14	3.5	12.25
13	2.5	6.25
13	2.5	6.25
13	2.5	6.25
12	1.5	2.25
12	1.5	2.25
11	0.5	0.25
8	–2.5	6.25
8	–2.5	6.25
9	–1.5	2.25
8	–2.5	6.25
$\Sigma x = 315$		**$\Sigma d^2 = 97.75$**

In the above example: Mean = 10.5 g

$$\text{Variance} = \frac{\Sigma d^2}{X}$$

$$= \frac{97.75}{30} = 3.258$$

Standard deviation

$$SD = \sqrt{3.258} = 1.81$$

variation in the population and the size of the samples. One of the most important role of statistics is that, even if the underlying population is not normally distributed, the means of the samples themselves will be approximately normally distributed if the sample sizes are sufficiently large.

The standard deviation of the distribution of sample means is called *standard error of the mean*, it is calculated by dividing the standard deviation of a sample by the square root of the sample size.

$$SE = \frac{SD}{\sqrt{n}}$$

Difference between SD and SE

The standard deviation describes variability in a set of data. The standard error of the mean refers to variability we might expect in arithmetic means of repeated samples taken from the same population.

Properties and uses of SE of the Mean

The primary use of the SE of mean is in calculating confidence intervals around arithmetic mean.

COEFFICIENT OF VARIATION

Definition

Standard deviation expressed as percentage of the mean (this is independent of the scale/unit of measurement).

This is used for comparison of relative variability of two distributions. It measures level of variability in the data relative to the average value. It is independent of any unit of measurement and thus useful for comparison of variability in two distributions having variables expressed in different units. It takes into account each value of the distribution.

$$\text{Coefficient of variation} = \frac{\text{SD}}{\text{Mean}} \times 100$$

In the above example,

SD = 1.81

Mean = 10.5 g%

$$\text{Coefficient of variation} = \frac{1.81}{10.5} \times 100 = 7.2$$

Relative or Standard Normal Deviate or Variate (*Z*)

It is measured in terms of SDs and indicates how much an observation is bigger or smaller than mean in units of SD? So *Z* will be a ratio calculated by subtracting mean from the measurement and divided by the SD the value thus obtained is *Z* score.

$$Z = \frac{\text{Observation} - \text{mean}}{\text{SD}} = \frac{X - \bar{X}}{\text{SD}}$$

for non-normal distribution

$$Z\ score = \frac{(\text{observed value} \div \text{M})^{\text{L}} - 1}{\text{L} \times \text{S}}$$

where M is the reference median value which estimates the population mean. L is the power needed to transform the data in order to remove skewness (i.e. to normalize the data). S is the coefficient of variation (or equivalent).

The reference lines on the growth charts are called *Z* score lines because they are based on *Z* scores, also known as standard deviation (SD) scores. *Z* scores or SD scores are used to describe how far a measurement is from the median (average). These scores are calculated differently for measurements that are distributed normally and non-normally in the reference population (Fig. 6.13).

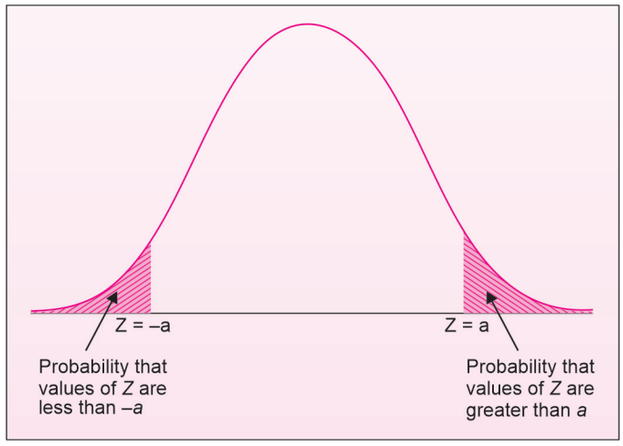


Fig. 6.13: Area under the normal curve

The total area under normal distribution curve is taken as unity or *I* with mean = 0 and SD = 1. The mean of *Z* scores is always zero and SD is always one. Area of different values of *Z* under the curve is tabulated and available for interpretation. When *Z* test is applied to sampling variability the difference observed between a sample estimate and that of population is expressed in terms of SE instead of SD. The score of value of the ratio between observed difference and SE is called "*Z*". In case, the distance in terms of SE or *Z* score falls within ± 1.96 SE (95% confidence limit) it is zone of acceptance.

Expected outcome: Student calculates measures of dispersion on peers data gathered by him or her.

Competency addressed: The student should be able to:
CM 6.4: Enumerate, discuss and demonstrate common sampling techniques

Learning objective: Student draws sample from his/her class (universe) by using different techniques and collects desired data from sample size.

COMMON PROBABILITY SAMPLING TECHNIQUES

Statistics and epidemiology deal with "population" and we are interested in "population characteristics" and results

must be applied to population, and all estimates should be related to population.

POPULATION

It means total population of a defined geographical area and it is called "Universe".

Example: MBBS students of first year.

Sample

Sample is part of population or universe. Since it is not possible to study the entire population to arrive at an estimate, we therefore take "part" of the "whole" population.

Sample is just one smaller segment of population as indicated in Fig. 6.14.

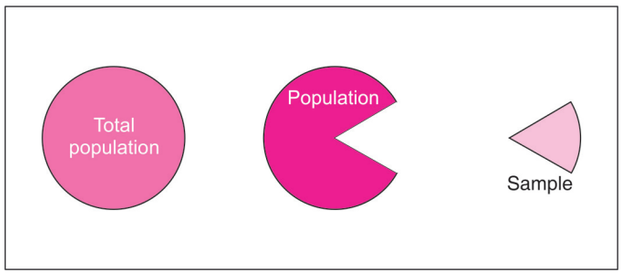


Fig. 6.14

Applications

All studies and surveys rely on "sample". It saves time, cost and results are quickly available for applications. The findings of sample will apply to population. Errors in the study may be due to small sample or biased sample (*see* errors in epidemiological studies, Chapter 7).

Sampling Unit

A household, a family, or an individual of specific characteristic are the natural units in the population. Family is the smallest unit in the population. All families in an area or a village set-up constitute units for study.

Sampling Frame

If all the natural units, say families or households, are listed and they are assigned numbers, this constitutes sampling frame. From this sampling frame, one can choose the desired number of sample units.

Ideally, every individual or family in the universe or population from which the sample is drawn should have a known chance of being included in the sample.

Sampling Fraction

It is the relation of the size of sample to the size of whole population (n/N) from which it is drawn and can be expressed in terms of proportions or percentages.

Advantages

1 Sampling reduces demands on resources, such as finance, personnel and materials.
2 Results are obtained quickly with better accuracy.

Disadvantages

1 There is always a sampling error.
2 Sampling may create a feeling of discrimination.
3 It may be inadvisable where every unit in the population is legally required to have a record.

TYPES OF SAMPLING

A. PROBABILITY SAMPLING

All individuals in the population have the known chance (probability) of selection. The probability that a particular unit chosen is n/N, where n is the size of sample and N is size of the underlying population.

1. Simple Random Sampling

Simple random sampling is the most acceptable and easy to understand method of sampling. You can consider this method to be the "gold standard" of sampling methods.

In simple random sample, every study unit has an equal chance of being included in the sample.

In this method, we list and number each unit, and mix up them thoroughly, and then select one unit at a time from the box until the required sample size is achieved. The given unit is selected only once without replacement. This strategy is an example of sampling without replacement.

Random selection from the sampling frame can be done by balloting or lottery system, by table of random numbers or employing a computer.

Advantages

1 Because every unit in the population has an equal chance of being included in the sample, the sample is assured of being representative free from bias and subject only to sampling error.
2 Estimates are easy to calculate.

Disadvantages

1 If the sampling frame is large, this method may be impracticable because of difficulty and expense of constructing or updating it in large scale surveys.
2 Minority subgroups of interest in the population may not be present in the sample in sufficient number for study.

2. Systematic Random Sampling

This is more simple and convenient method. In this, a systematic sample is formed by selecting one unit at random and additional units at evenly spaced intervals. (First requirement in this technique is to enlist the

population completely may be on the basis of alphabetical, geographical or numerical order.) The second requirement is to calculate the interval called sampling interval or sampling ratio which is calculated by:

$$K = \frac{N}{n}$$

where N = total size of population
n = sample size.

In systematic random sampling method, all the sampling units in the population are numbered serially, e.g. if there are 1000 families in a village and we wish to select sample size of 100. Divide 1000 by 100 you get the answer (sampling interval) 10, it means you select every 10th family.

Next, you draw a random number less than 10 from a currency note or by lottery say if it comes 7. The first sampling unit will be 7th household or family and then you go on adding 10 to it to select rest of the families (7, 17, 27, 37, etc.). Thus in this technique, all the sampling units had known chance to be included in the sample. You have to just choose one number and the rest get selected automatically.

3. Consecutive Sampling: A Kind of Random Sampling

For annual HIV sentinel surveillance for antenatals clients consecutive sampling method is being used to remove selection bias. It is a kind of random sampling where sampling interval is zero. All individuals attending sentinel site facility who meet the defined selection criteria should be recruited in order they attend clinic. Starting with first individual, every successive eligible individual should be recruited in HIV sentinel surveillance till the desired sample size is achieved or the desired period is over.

4. Stratified Random Sampling

When the population is not homogeneous, we use this technique. The population is first divided into groups or strata according to characteristic of interest. *Example*: In a village, it is observed that there are two strata of population one stratum comprising over landowners and well to do people and second stratum is of landless or weaker sections of the community. If we wish to study the prevalence of malnutrition in this village, we will draw sample from two different strata.

Thus, first step is formation of strata in the village and second step is preparing the sampling frame for these strata. Then a simple random sample is selected from each stratum using the same sampling fraction.

Advantages

1. Every unit in a stratum has the same chance of being selected.
2. Using the same sampling fraction for all strata ensures proportionate representation in the sample of the characteristic being stratified.
3. Adequate representation of minority subgroup of interest can be ensured by stratification and by varying the sampling fraction between strata as required.

Disadvantages

1. The sampling frame of entire population has to be prepared separately for each stratum.
2. Such a frame exists in ICDS areas but in non-ICDS areas frame has to be prepared.
3. Varying the sampling fraction between strata, to ensure selection of sufficient number in minority subgroups for study, affects the proportional representativeness of the subgroups in the sample as a whole.

5. Cluster Sampling (Probability Proportion to Size)

In cluster sampling principle of sampling with probability proportion to size (PPS) in followed.

The cluster sampling technique involves two stages. We select the clusters in the first stage and in the second stage, we select households within the cluster.

Sampling Frame

For cluster selection, we provide a list of clusters (villages for rural area and wards for the urban area) with the size of population. Once we know the number of clusters to be selected. It can be calculated randomly when the chance of every cluster being selected is equal. The chance of selecting one particular village will depend upon the population of each village.

First Stage

- The villages or wards are listed in first column, each with its "size" of population in the next column.
- In the third column, the sizes are cumulated or 'cumulated population' is worked out.
- Take the final entry in the third column (the total "cumulative size of population" and divide this by the number of clusters desired in the sample to give the sampling interval (SI). Usually we select 30 clusters but it could be any number (Table 6.9).
- Using random table number select a random number (R) between 1 and the sampling interval that has been calculated. The number you select must have the same number of digits as the sampling interval.

Find the first entry in the cumulative column which equals or exceeds R, this is the first selected cluster. Add the sampling interval to R to select the second cluster and continue to add the sampling interval until the selection is complete.

In the following example the total 'size' or cumulative population is 23455, and the number of clusters to be selected is 30, so the sampling interval (SI) is 23455 divided by 30 is equal to 782 which means the interval between one cluster and the next.

Step 1

- Using the random number table or any currency note select a random number R of three digit number which should be less than SI. In our example the random number turned out to be 690 (R).

Table 6.9: Illustration of cluster sampling technique

1 Name of village	2 Estimated population	3 Cumulative population	4 Start number	5 Selected cluster
A	802	802	690	A
B	654	1456		
C	714	2170	1472	C
D	520	2690	2254	D
E	915	3605	3046	E
F	508	4113	3828	F
G	452	4565		
H	950	5515	4610	H
			5392	H
I	344	5859		
J	3504	9363	6164	J
			6946	J
			7728	J
			8510	J
			9292	J
K	708	10071		
L	1510	11581	10074	L
			10886	L
M	600	12181	11638	M
N	432	12613	12420	N
O	310	12923		
P	424	13347	13202	P
Q	390	13737		
R	675	14412	13984	R
S	600	15012	14766	S
T	670	15682	15558	T
U	498	16180		
V	230	16410	16330	V
W	500	16910		
X	400	17310	17112	X
Y	600	17910	17894	Y
Z	912	18822	18676	Z
Za	519	19341		
Zb	880	20221	19458	Zb
Zc	920	21141	20240	Zc
			21022	Zc
Zd	514	21655		
Ze	1000	22655	21814	Ze
			22596	Ze
Zf	800	23455	23378	Zf
Total	**23455**	**23455**	**23378**	**23378**

$$\text{Sampling interval} = \frac{\text{Total cumulative population}}{30}$$

$$= 23455/30 = 782$$

- This is the first 'start number' for our **first cluster**. Find the first number in column 3 that is greater than 690 (R). This is 802 or village A of column 1 so the first cluster is located in village A.

Step 2

Now add 782 (SI) to 690 (R) to get the start number of **second cluster** (782 + 690 = 1472). The first number in column 3 that is greater than 1472 is 2170 hence cluster number 2 is located in village C.

Step 3

Adding the sampling interval (SI) 782 to 1472 (to derive 2254) to get the start number of 3rd cluster. Third cluster is located in column 3 showing population greater than 2254 that is village D. Continue adding the sampling interval to that number until you have identified all 30 clusters.

Villages having large population such as J and L are likely to have more than one start number/cluster. This in because their population are two to 5 times larger than cluster size 782 (SI). Therefore, two, three or four clusters may be in one village, i.e. probability proportion to size (PPS).

Second Stage

Once the clusters have been selected, the next step is to select the households within these clusters. The households can be selected by using the simple random sampling method. It means that you should have a list of every household in the selected cluster and use the random number table to select the individual households.

In coverage evaluation survey of immunization, seven children between 12 and 23 months of age are selected by moving in one direction till the desired number of children are completed. Randomization at household level is not done because households are not numbered but we can use randomization by using Household Survey register of *Anganwadi* or ASHA worker, which is a perfect sample frame of all households or families in a village.

The two-stage cluster sampling method has been widely used in immunization coverage and diarrhoeal disease surveys as also in leprosy elimination monitoring surveys and evaluation of national AIDS programme or other programmes.

Advantages

1. Cuts down on the cost of preparing a sampling frame.
2. Cuts down on the cost of travelling between selected units.
3. Eliminates the problem of "packing" (in health surveys, especially those involving case finding and treatment, it is not unusual for neighbouring houses not included in the sample to transfer their households temporarily to a selected house).

Disadvantage

Sampling error is usually higher than for a simple random sample of the same size.

Pathfinder Surveys

"Pathfinder" method uses stratified cluster sampling technique, which aims to include the most important population subgroups likely to have differing disease levels. These surveys are used for assessment and planning of oral health.[1–3]

Index ages and age groups: The recommended age groups are 5 years for primary teeth, and 12, 15, 35–44 and 65–74 years for permanent teeth. The number of subjects in each index age group to be examined ranges from a minimum of 25 to 50 for each cluster or sampling site, depending upon the prevalence and severity of oral disease.

6. Multistage Sampling

The selection is done in stages. Cluster sampling is an example of multistage sampling. In the first stage, an area or village is chosen and in the second stage we choose households.

7. Lot Quality Assurance Sampling (LQAS)

This technique was traditionally used for quality assurance purposes in the industry but statisticians and epidemiologists found it suitable for assessing a variety of primary health-care services, e.g. measuring immunization coverage.

In this technique, surveys would be carried in two or more sets with the same objective. All the different sets under study population will be different, i.e. belonging to different geographical areas and we will calculate the results from those sets of population with respect to defined objective and comparing the weighted results with the given assumptions which may be the same or different for different sets of population. Hence, we can find out that which set of population gives acceptable results and which set gives unfavourable results, requiring urgent interventions, e.g. LQAS was used to determine the low vaccination coverage areas in five cities in Bangladesh (Bulletin WHO, Vol. 79, 6, Geneva; 2001).

B. NON-RANDOM SAMPLING (NON-PROBABILITY SAMPLING)

In this, the probability of selection of a particular item/individual is not fixed. The sampling unit is selected at its own with some units have very high chances of selection and other have zero chances, some examples are as follows:

a. Judgment Sampling

In this method of sampling, the choice of study units depends exclusively on the judgment of the investigator. This type of sampling is useful when:

- Number of sampling units in the universe are small.
- To study effect of some unknown factors on a population whose characteristics are known.
- In solving urgent public health/policy problems or everyday business problems where we cannot wait for probability sample designs.
- But this is not a scientifically proven appropriate method and does not follow basic laws of sampling.

b. Quota Sampling

It is a type of judgment sampling and is the most frequently used sampling technique among non-random sampling techniques. In this, the population/universe is divided into quotas according to some specific characteristics, e.g. age, socioeconomic status, religion, etc. and number of study units selected within each quota depend on personal judgment of the investigator.

- This is generally used in public opinion studies.
- But this does not follow laws of sampling.

c. Convenience Sampling/Purposive Sampling

The sample when obtained by selecting a part of population on which it is convenient to carry out a study. This method is also called the *chunk*.

- The population parts which are easily accessible and those population groups in which it is easy to conduct surveys or investigations are chosen irrespective of the representativeness of the population.
- Generally used for making pilot studies to have just a basic idea about the study variable.
- Biases are maximum in this sampling method and generally the results obtained are unsatisfactory in terms of drawing conclusions.

d. Snowball Sampling

This method is helpful in situations where hard to reach population such as sex workers, drug abusers may not be forthcoming in declaring their particular status or sexual practices. Sampling frame is not available or does not exist for such population. Here the researcher selects a few known participants such as drug abusers, who then suggest others who may be willing to participate in the study. Thus, the investigator snowballs from one participant to next to recruit adequate sample size.

Sample Size Determination

Sampling for a Quantitative Characteristics

When sampling for a quantitative character (e.g. the mean level of hemoglobin in a population), one needs to state:

1. How precisely one wishes to estimate this mean level, that is the amount of sampling error that can be tolerated (d), in either absolute or relative term?
2. The standard deviation(s) of the distribution of hemoglobin in the population.
3. The chance the investigator is willing to take to get an unlucky sample giving a sampling error greater than d, a 5% chance or error (i.e. a 95% confidence interval) is conventional.
4. This means that $\bar{X} \pm d$ are the required 95% confidence limits, so that $d = 1.96$ SE, where SE of mean $= s/\sqrt{n}$. Hence, $d/1.96 = s/\sqrt{n}$, and therefore, the required (minimum) sample size for a large population given by: $n = (1.96)^2\, s^2/d^2$.

Example

An investigator wishes to estimate the mean hemoglobin level in a defined community. Preliminary information indicates that this mean is about 150 mg/L with a standard deviation of 32 mg/L. If a sampling error of up to 5 mg/L in the estimate is to be tolerated how many subjects should be included in the study?

Here $s = 32$ mg/L, and $d = 5$ mg/L

If the population is assumed to be very large, the required minimum sample size would be:

$$n = [(1.96)^2 \times (32)^2] / (5)^2 = 157.4.$$

If the community to be sampled has 1000 people, the required minimum sample size would be:

$$n = (1.96)^2 \times (32)^2 / [(5)^2 + (1.96)^2 \times (32)^2 / 1000] = 136$$

Therefore, at least 136 people would have to be studied. For a larger community with, e.g. $N = 3000$ people, the required sample size would be:

$$n = (1.96)^2 \times (32)^2 / [(5)^2 + (1.96)^2 \times (32)^2 / 3000] = 149.5$$

At least approximately 150 people would have to be studied (WHO, 1999 Teaching Health Statistics).

Sampling for an Attribute or Qualitative Characteristics

When sampling for an attribute (to estimate the proportion of persons with a certain characteristic in a population) one needs to state.

- A rough approximation to the proportion (p) or prevalence rate.
- The sampling error that can be tolerated (d) in either absolute or relative term.
- The acceptable chance of an unlucky sample (conventionally 5%).

The minimum sample required for a very large population is then:

$$\text{SE of proportion} = \sqrt{\frac{Pq}{n}}$$

or

$$\text{Sample size } (n) = (1.96)^2 \, p(1-p) / d^2$$

Example

If $p = 0.26$, and $d = 0.03$, then, for a very large population:

$$n = (1.96)^2 \times 0.26 \times 0.74 / (0.03)^2 = 821.2$$

Thus, the study should include at least 822 persons.

If the sample is to be drawn from a small population of, e.g. 3000 people, the required minimum sample could be obtained from the above estimate by adjustment as:

$$821.2 / (1 + 821.2/3000) = 644.7$$

Thus, the study should include at least 645 people.

REFERENCES

1 GOI. National Child Survival and Safe Motherhood Programme—Evaluate Service Coverage. New Delhi: MOH and FW, GOI; 1992.

2 WHO. Global Programme on AIDS. Evaluation of a National AIDS Programme—A methods Package. Geneva: WHO; 1994.

3 WHO. Oral Heath Surveys Basic Methods, 4th Edition. World Health Organization, Geneva; 1997.

CONFIDENCE INTERVAL[1,2]

Once the sample has been drawn, it can be used to estimate the characteristics of the underlying population. Because estimates vary from sample to sample, it is important to know how close the estimate derived from any one sample is likely to be to the underlying population value. One way to find this is to construct a confidence interval around the estimate, i.e. to construct a range of values surrounding the estimate, which have a specified probability of including the true population values. The specified probability is called the confidence level and the endpoints of confidence interval are the confidence limits.

Population means are always derived from sample means.

Population standard deviation (σ) is hardly ever known we use the standard deviation of sample means. From the normal standard distribution we know that normal range (mean ± 2SD) covers 95% of observation values.

Confidence Intervals of Means

Same concept can be applied to sample means.

$$\text{Mean} \pm 2\text{SE}$$

It is the range that would cover 95% samples to be more exact.

To calculate the confidence limits around the estimated population mean, it is necessary to have measures of: (1) Variation, such as the population standard deviation (σ), (2) the estimated mean ($\bar{X}$), (3) the sample size (n) and (4) the specified probability of including the true population value. If we assume that the underlying population is normally distributed with a known standard deviation σ, then the formula for calculating the limits of 95% confidence interval around the mean is as follows:

$$\text{Lower limit of CI} = \bar{X} - \frac{1.96\ \sigma}{\sqrt{n}}$$

$$\text{Upper limit of CI} = \bar{X} + \frac{1.96\ \sigma}{\sqrt{n}}$$

As an illustration, suppose in a random sample of 100 factory workers, the mean blood lead concentration ($\bar{X}$) was 90 µg/L. Suppose further that the level of concentration of lead in blood is normally distributed with a standard deviation of 10% (i.e. $\sigma = 10$) then the limits of the 95% confidence interval around the estimate can be calculated as follows:

$$\text{Lower limit} = 90 - \frac{1.96 \times 10}{\sqrt{100}} = 88.04$$

$$\text{Upper limit} = 90 + \frac{1.96 \times 10}{\sqrt{100}} = 91.96$$

Thus, the confidence interval ranges from 88.04 to 91.96.

A sample estimate is usually presented along with confidence interval. It is important to realize that size of confidence interval is related to the sample size, the larger the sample the smaller is the confidence interval for a given confidence level. The size of confidence interval is also related to the confidence level specified.

Inference

Ninety-five percent chances are that the population parameter will lie within the confidence interval.

Major Uses of Standard Error of Mean

1 To work out desired confidence interval or interval estimation within which the population mean (μ) would lie: $\bar{X} \pm 2SE$.
2 Whether a sample has been drawn from a known population.
3 To determine statistical significance of difference of two means.
4 To determine sample size.

$$\text{Standard error of proportion SEP} = \sqrt{\frac{p \times q}{n}}$$

Where p is the estimated prevalence and q is $1–p$ and n is the size of sample.

Confidence Interval of Proportion

It is given by formula:

$$CI = p \pm \frac{Z\sqrt{p \times (1–p)}}{n}$$

Example

Calculation of 95% confidence interval around a prevalence estimate in STD clinic attenders who have syphilis serology, where a sample of 400 was used and 40 HIV positive sera were identified.

The prevalence is 40 / 400 or 10%, therefore, $p = 0.1$

The sample size is 400, therefore, $N = 400$.

For 95% confidence intervals, $Z = 1.96$

$CI = p \pm Z \times \sqrt{[p \times (1–p) / N]}$

$95\%\ CI = 0.1 \pm 1.96 \times \sqrt{[0.1 \times (1–0.1) / 400]}$

$= 0.1 \pm 1.96 \times \sqrt{(0.000225)}$

$= 0.1 \pm 1.96 \times 0.015$

$= 0.1 \pm 0.029$

= (0.071 to 0.129)

Multiplying by 100 to convert to percent, the 95% confidence intervals are 7.1 to 12.9% for a prevalence estimate of 10% and a sample size of 400.

Expected outcome: Student learns types of sampling by practice in live situation (peer group) and able to calculate sample size based on prevalence of disease or from sample mean and SD.

REFERENCES

1 Lwanga SK, Tye CY. Teaching Health Statistics Lessons and Seminar Outlines. Second Edn., Geneva: WHO; 1999.
2 Beaglehole R, Bonita R, Kjellstrom T. Basic Epidemiology. Geneva: WHO; 1993.

PROBABILITY

The literary meaning of probability is the chance and it is defined as "the average relative frequency with which an event is expected to occur in the given population/universe". Probability measures the degree of certainty and uncertainty.

SCALE OF PROBABILITY MEASUREMENT

Probability ranges from 0 to 1 (the minimum value is 0 and maximum is one). If an event which is sure to occur the probability is 1 and if an event is impossible to occur probability is 0. No probability is ever negative, e.g.

1 Probability of giving birth to a boy/girl in the given pregnancy is equal to 0.5.
2 Probability of getting head/tail on tossing of a coin = ½ = 0.5.
3 Probability of getting kings in a set of playing cards, etc. = 4 / 52 = 1 / 13

It is denoted by symbol **"P".**

Probability of occurrence of a particular event can be calculated by the following formula:

$$P = n_p / N$$

where n_p = no. of times the event happened/occurred.
N = Total no. of trials.

The 'Zero' represents—'absolute impossibility' of occurrence of an event and 'one' represents absolute certainty of occurrence, all the times.

It is also important to find out probabilities in complex situations where the same event is happening in more than one ways and events concerned are independent. For these conditions—two important rules of probability are helpful:

1 Addition rule.
2 Multiplication rule.

Addition Rule

If an event is occurring in mutually exclusive way in trial then the total probability of occurrence of that event in any of the trial is the sum of probabilities of the occurrence of that event in individual trials. Mutual exclusive events

follow the addition rule of probability. Mutually exclusive events—events that cannot occur simultaneously or be present at the same time. Mutually exclusive events are birth of male or female child, blood groups A or B or O or AB; Rh positive or Rh negative, etc.

Addition rule: *P(A or B) = P(A) + P(B)* if *A* and *B* are mutually exclusive.

1. Probability of getting red or green coloured balls from a set of 20 balls—5 balls of each colour—red, green, blue and yellow, respectively.

   The probability of getting red balls = 5 / 20 = ¼

   Probability of getting green balls = 5 / 20 = ¼

   As the event, is selection of either red or green balls and selection of red/green balls are mutually exclusive then the total probability of event = sum of individual probabilities = 1 / 4 +1 / 4 = 2/4 = $^1/_2$
2. In a sample of 100 individuals consisting of 50 males and 50 females, out of which 10% of each are anaemics 5 males and 5 females are anaemics. To calculate the probability of selecting an anaemics either male or female individual from that sample—following method is used.

Event—selection of anaemic individual (either male or female).

Probability of selecting male anaemic = 5 / 100 = $^1/_{20}$

Probability of selecting female anaemic = 5 / 100= $^1/_{20}$

Total probability = 1 / 20 + 1/20 = 2/20 = $^1/_{10}$

So, probability of getting anaemic individual either male or female from the given sample is $^1/_{10}$.

Multiplication Rule

Independent events follow the multiplication rule of probability.

Independent events: Two events are said to be independent, if the presence or absence of one does not alter the chances of other being present, or if the occurrence of one does not alter the chance of occurrence of the other, e.g. sex at birth and blood group and Rh blood group status.

Multiplication rule = *P(A* and *B) = P(A) × P(B)* if *A* and B are independent events.

This rule is applied to two or more than two events occurring together, but not associated with each other, i.e. the events must be independent from each other, e.g. sex at birth and Rh factor are independent events and occur in any child.

Example

What will be the probability of child being male and Rh negative?

Probability of a child born being male = P_1 = ½

Probability of a child born being Rh negative = P_2 = $^1/_{10}$ (10% of children at birth may be Rh negative)

Probability of child being male and Rh negative

= $P_1 \times P_2$

= 1 / 2 × 1/10

= 1 / 20 = 0.05

Example

What are the probabilities of getting male and female children when two children are born one after the other, sequences could be:

Both males M and M = ½ × ½ = ¼

One male and one female = ½ × ½ = ¼

One female and one male = ½ × ½ = ¼

Both females F and F = ½ × ½ = ¼

Conditional probability: The chance of a particular event happening depends on the outcome of some other event. *P (B / A)* = the probability that event *B* occurs, given that event *A* has already occurred.

If we want to determine the probability of occurrence of diabetes and hypertension both from a group of people then we have to calculate conditional probability. As, we know that a person can be diabetic and hypertensive both at a given time. So, the events are not mutually exclusive and in such conditions the probability of simultaneous occurrence of the events can be determined by calculating:

- Conditional probability.
- In these cases, the general use of multiplication rule is modified as:

Conditional probability of simultaneous occurrence of event *A* and *B*:

P(A and *B) = P(B) × P(A / B)* or *P(A) × P(B / A)*

where *P(A)* = Probability of occurrence of event *A*.

P(B) = Probability of occurrence of event *B*.

P(AB) = Simultaneous occurrence of events *A* and *B*.

P(A / B) = Probability of occurrence of event *A* given that event *B* has already occurred is given by:

P(A / B) = P(AB) / P(B)

Bayes' rule: *P(A / B) = (P(B / A) P(A) / P(B)*

Bayes' rule has been used frequently to evaluate the performance of diagnostic and screening tests, which are discussed under section of epidemiology (validity of screening test).

Binomial distribution: The binomial distribution is formed by the terms of the expansion of the binomial expression: $(p + q)^n$

When *n* = sample size, *p* = the probability of a "success", *q* = the probability of a "failure", and *p* + *q* = 1

Example

When *n* = 2 the terms of expansion of $(p + q)^2$ are $p^2 + 2pq$ and q^2

Similarly, we can calculate the probability of non-occurrence of a particular event and that will be called probability of non-occurrence, generally denoted by '*q*' and is equal to 1–*P*, where '*P*' is the probability of occurrence of the particular event.

Some Important Probabilities in Use

- Probability of surviving at various ages are depicted in life table (Table 6.9).
- Probability of developing tuberculosis diseases in infected persons in lifetime is 10% (0.1).
- Probability of perinatal transmission of HIV is 30%.
- Probability of LBW is 22% in India.

a Concept and application of probability can be linked to validity of screening tests (sensitivity and specificity), i.e. probability of a positive test in people with the disease and probability of a negative test in people without disease. Probability of a person having the disease when the test is positive (positive predictive value) and probability of the person not having the disease when the test is negative (negative predictive value). These are also examples of conditional probability.

b Similarly, probability of person not falling within acceptable range or limits (sample mean ± 2SE). It is usually 5% (0.05).

c Probability of dying and survival at various ages in life table is most relevant to the concept and application of probability.

Competency addressed: The student should be able to:
CM 6.3: Enumerate, discuss and demonstrate test of significance in various study designs.

Learning objective: To learn skill of application of tests of significance and correlation.

TESTS OF SIGNIFICANCE IN VARIOUS STUDIES

TESTING OF HYPOTHESIS

Testing of hypothesis refers to the process of selecting and using a sample statistic, i.e. mean, median, mode, standard deviation or standard error to draw conclusion about a population parameter, based on observations on a sample.

HYPOTHESIS

It is an assumption which we make about a population parameter, used as a basis for further investigation.

Assumptions

The most important assumptions to be followed by a particular sample after which we can apply tests of significance on those sample data are as follows:

i If the sample is large enough—then it must follow the principles of standard normal distribution.

ii If the sample size is small then the sample must follow the principles of some standard distribution which are not purely normal but are near normal distributions, e.g. student's 't' distribution, chi-square distribution, Fischer's "f" distribution, etc.

Different Steps in Hypothesis Testing

1 Making assumptions and setting up of a hypothesis.
2 Setting up suitable level of significance.
3 Setting up a test criterion (test of significance).
4 Computations and drawing conclusions.

1. Making Assumptions and Setting-up of a Hypothesis

First step in setting up of a hypothesis about a population parameter is that, we have to assume or estimate a certain value of population mean (μ) which is seldom available; then we collect sample data and calculate the information about that parameter, i.e. calculating sample mean. After this we have to formulate null hypothesis.

Null Hypothesis (H_0)

The hypothesis of "no difference" or more correctly, the hypothesis that the observed difference is entirely due to sampling error, i.e. it occurred purely by chance. In the test of significance, the "null hypothesis" is postulated to establish the basis for calculating the probability that the difference occurred purely by chance. When the difference is not significant, the null hypothesis is not rejected. When the difference is significant, the null hypothesis is rejected in favour of other hypothesis about the cause of the difference. The null hypothesis is never proved to be completely right or wrong, or true or false but is only rejected or not rejected at the probability level of significance concerned, e.g. 0.05 or 0.01. Thus a null hypothesis either rejected or not rejected. If the H_0 is rejected, the alternate hypothesis is not rejected.

- Null hypothesis (H_0) is hypothesis of "no difference". It is denoted by H_0. It means there is no difference between sample mean and population mean $H_0 = \mu$
- The alternate hypothesis is denoted by (H_a) and the sample mean is different or not equal to population mean $H_a \neq \mu$.

If null hypothesis (H_0) is rejected then the alternate hypothesis is not rejected and vice versa.

2. Level of Significance

It is the maximum tolerable probability of type I error. Since the type I error is quite serious particularly in the field of medicine when a therapeutic trial is done and a drug which is not effective is accepted on the basis of null hypothesis trial results. It is, therefore, necessary to fix a level of significance well in advance of the trial being conducted. We fix maximum tolerable probability for type I

error (α) say 5% which is known as predetermined "level of significance" for α error (type I error).

The predetermined level of significance of α is the maximum tolerable chance of type I error.

What is p value: The *p* value is the actual probability of committing type I error.

- *p* value is based on statistical calculation, whereas level of α is fixed in advance or predetermined.
- If calculated *p* value is less than or equal to α result is inferred as statistically significant and we reject the null hypothesis (H_0).
- If *p* is greater than α, we do not reject hypothesis (H_0).

Type I error (α) is also called "rejection error".

3. Setting up of a Test Criterion

Next and the most important step is to select a proper test of significance which when applied to the given data give the results accurately. To select a particular test of significance, it is necessary to identify the probability distribution of the sample and appropriate test statistic is selected.

Example Student's 't', Fischer's 'f', 'chi-square', etc.

4. Computations and Drawing Conclusions

Final step in the testing of hypothesis is doing computations and drawing conclusion. In computation, the selected test statistic value is calculated, and is compared with the table value pertaining to that statistic at a given level of significance corresponding to the degree of freedom of the sample. Then we have to see whether the computed statistic values fall under zone of rejection or zone of acceptance.

- If the computed value lies in zone of acceptance then we say that hypothesis is accepted and if it lies in zone of rejection then we say that hypothesis is rejected (Fig. 6.15).
- If the value lies on the borderline zone then the best and wisest step is not to draw any conclusion but draw other sample and investigate again.

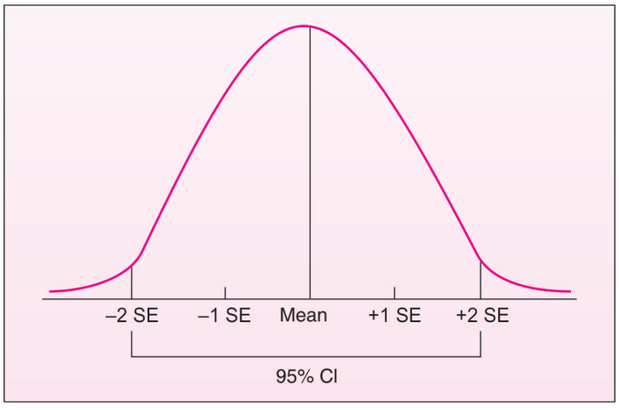


Fig. 6.15: Acceptance and rejection zone in a two failed test of significance at 95% level of significance

Errors in Hypothesis Testing

Error in hypothesis testing can mainly occur in 2 ways:

a Problems in sample selection.
b Limitation of a particular test of significance.

Errors Related to Sampling

If we want to compare the results between different samples, then we assume that all the samples drawn from the population are distributed randomly and bear same characters as the population/universe. But generally it is not true and minor variations in the 'statistic' calculated from different samples exist because the samples are not alike and we assume that distribution of the samples drawn from a population follows normal distribution called *sampling distribution* (just like normal probability distribution) and the standard deviation of sampling distribution is called standard error and is equal to standard deviation of the sample divided by square root of total no. of observations.

$$SE = s/\sqrt{n}$$

Errors Related to Limitations of Tests of Significance

There can be four possibilities in testing of a hypothesis.

- Hypothesis true—accepted—correct decision.
- Hypothesis true—rejected—type I error (α error)
- Hypothesis false—accepted—type II error (β error)
- Hypothesis false—rejected—correct decision.

Type I error is also called 'α' and is related to level of significance and type II error is called 'β' and type I error is much more serious than type II error.

Type I Error or 'a' Error (Alpha Error)

Type I (α) error is also called "rejection error". This error is committed when the null hypothesis is true and the study or trial rejects it on the basis of level of significance and *p* value. The name of type I error is an alpha (α) error and it has always a predetermined level of significance. Say at 5% (0.05). It means if we conduct repeated studies and trials there are 5% of chances that we may reject a true null hypothesis.

Type II Error or b Error (Beta Error)

When the null hypothesis is false and we have not rejected it, then type II error is committed unlike (α) error type II error has no predetermined level of significance.

STATISTICAL INFERENCE HYPOTHESIS TESTING

In hypothesis testing, the null hypothesis is either accepted or rejected, depending on whether the *p* value is above or below a predetermined cut-off point, known as the significance level of the test. If the *P* value is less than the cut-off point, the null hypothesis is rejected. If the *p* value is greater than or equal to the cut-off point, the null hypothesis is accepted. It is usual to choose either 0.05 (5%) or 0.01 (1%) as significance levels for testing the null hypothesis.

As an example, suppose it is known that in a particular country the weight at birth of male babies is normally distributed with a mean of 2.9 kg and a standard deviation of 0.5. Suppose further that a random sample of 100 male babies born to a particular ethnic subgroup was found to have a mean birth weight of 2.8 kg. We wish to determine whether the mean birth weight in the ethnic subgroup is different from the birth weight in the country as a whole. The null hypothesis would state that the mean birth weight of the ethnic subgroup is 2.9 kg.

In this example, the appropriate test statistic is z:

$$z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

where

$\bar{x}$ = Sample mean
μ = Known country mean
σ = Known standard deviation
n = Sample size.

For the above example: $z = \frac{2.8 - 2.9}{0.5 / \sqrt{100}} = -2$

The statistic z has been constructed so that if the null hypothesis were true (i.e. birth weights in the population sampled were normally distributed with a mean μ and standard deviation σ), then the distribution of z over all possible samples of size n would be close to that of a normal distribution with mean 0 and standard deviation 1. An important characteristic of this distribution is that the area under the normal curve to the right of the line z = a (Fig. 6.13) can be interpreted as the probability with which values of z are grater than a. Similarly, the area under the curve to the left of the line z = – a gives the probability with which values of z are less than – a. Therefore, the *p* value associated with a particular value z = a, is equal to the area under the normal curve to the right of z = a, *plus* the area under the curve to the left of z = – a.

For the above example, consultation of the appropriate normal distribution tables found in many statistical textbooks (which give *p* values for areas under the normal curve associated with each value of z) indicates that the area under the curve to the left of z = – 2 is 0.023. Similarly, the area under the curve to the right of z = 2 is 0.023. Therefore, the *p* value associated with this value of z is 0.046. This can be interpreted as indicating that if the null hypothesis were true (i.e. birth weights in the ethnic subgroup are normally distributed with a mean of 2.9 and standard deviation 0.5), only 4.6% of all possible samples of 100 babies would have mean birth weights differing from 2.9 kg by 100 g or more.

If we had decided on a significance level of 5% for the statistical test, we would reject the null hypothesis and accept the alternative that the mean of the population is not equal to 2.9. However, had we decided on the 1% level of significance the null hypothesis would have been accepted. The phrase "statistically significant" is used to indicate that a result has led to rejection of the null hypothesis. It is important to keep in mind that the null hypothesis is never proven right or wrong but is only accepted or rejected at a given level of significance. The small *p* value may be consistent with a weak association, and a difference between two groups may fail to be statistically significant if the sample size is not large enough.

Many statistical tests involve the comparison of two quantities (in the example above, the sample mean was compared with the known country mean). Usually the statistical test allows for the possibility of differences in both directions (either quantity can be larger than the other; the country mean might have been greater than the sample mean or smaller than it). This is known as a two-side or two-tailed test. As in the example above, the *p* value is calculated on the basis of probabilities from both tails of the sampling distribution (thus, in the above example *p* was the sum of the probability of z > + 2 and z < – 2).

However, there are some situations in which there is interest in a difference in only one direction. For example, one may wish to test whether a specific treatment is better than a placebo (the case in which the treatment is worse than the placebo being of no interest). In this instance it would be appropriate to use a "one-sided" or "one-tailed" test. The calculation of the test statistic for a one-sided test is identical to that of the two-sided test. The difference between the two types of tests lies in the calculation of the *p* value. A one-sided test is based on probabilities from only one side or one tail of the sampling distribution, whereas a two-sided test sums the probabilities from both tails of the distribution. Therefore, the *p* value associated with the one-sided test is equal to half the *p* value associated with the two-sided test.

Two types of error are associated with the decision: to reject the null hypothesis when it is true (this is called type I error or an alpha error), and to accept the null hypothesis when it is false (this is called a type II error or beta error). The probability of making type I error is the level of significance of the statistical test; which should always be stated when the results are presented. For example, randomized clinical trials of drugs can lead to both type I and type II errors. It may be concluded on the results that a new treatment is effective when in fact it is no better than the standard treatment. This type of error, which leads to false positive conclusion that the treatment is effective, is a type I error. On the other hand a new treatment is actually effective may be concluded to be ineffective, such a false negative conclusion is type II error.

The probability of rejecting a null hypothesis when it is false is known as power of a statistical test. It is equal to one minus the probability of type two error ($1 - \beta$). The power of a test depends upon sample size—the larger the sample size, the higher the power, all else being equal.

The power of test is also dependent on the significance level chosen. For any given sample size, the higher the level of significance (i.e. the lower the probability level of a type I error), the lower is the power (the more likely a type II error will be made). It is common for studies to

aim for a power of 0.8 at a significance level of 0.05. This means that the probability of a type II error (0.2) is four times the probability of a type I error (0.05), reflecting the fact that in most studies a type I error is considered much more serious than type II error. The power should be presented when a negative result is reported. The power of a test is an important consideration in the planning of an epidemiological study, since it indicates how likely the test is to have a statistically significant result under different circumstances (WHO, 1993).

Another set of useful statistical tests are known as t-tests, and are especially important for small samples. For instance, one can test the hypothesis that the mean of a population is equal to a predetermined value, μ, when the standard deviation of the underlying population is unknown, but the standard deviation of the sample is known. The appropriate formula is:

$$t = \frac{\bar{X} - \mu}{s / \sqrt{n}}$$

where 's' is the standard deviation of the sample and t has $n - 1$ degrees of freedom.

This is similar to the z-test described above. However, the z-statistic is used when the standard deviation of the population is known, while the t-statistic is used when the standard deviation of the population is unknown and estimated by the standard deviation of the sample.

When the hypothesis is true and it is rejected we call it '(α)' or type I error. '(α)' error is related to level of significance. The actual probability of committing type I error is called the p value. It is customary to attach special significance to 'p' values falling below 0.05 (5%), because it is generally agreed that less than 1 chance in 20 is a small risk of being wrong. Differences associated with p less than 0.05 are called "statistically significant" ($p < 0.05$) $p > 0.05$ means that it is "statistically non-significant" as the chances are more than 1 in 20 which is not a small risk but large risk of being wrong.

However, p value greater than 1 in 5 are usually reported as simply $p > 0.20$, because nearly everyone can agree that probability of an (α) error that is greater than one in five is unacceptably high.

Relationship between Testing of Hypothesis and Confidence Interval (CI)

The usual level of confidence interval is set up at 95%. The limits of confidence are fixed on either side of the mean, which we call as confidence limits, with predetermined probability. If the population mean has normal distribution then 95%, CI = mean ± 2SE, where SE refers to standard error of sample means ($SE\bar{x}$).This covers almost 95% of the area of the curve (Fig. 6.15).

Choice of a Test

According to Sample Size

In small samples—with sample size 30 or less generally the normality assumptions do not hold good and certain other tests are required to analyse and test these data based on their probability distribution, assuming that to be near normal.

1 Small samples—sample size less than or equal to 30. Tests of significance of choice are:
   - Student's 't' test (paired and unpaired).
   - Analysis of variance (ANOVA)
   - Non-parametric tests
2 Large samples—all tests which can be applied on small samples plus along with
   - 'z' test.
   - Chi-square test, etc.

According to Type of Data

1 Quantitative data—'t' test, 'z' test, ANOVA.
2 Qualitative data—'chi-square' test, Kruskal—Wallis test, etc.

According to Probability Distribution

1 Normal distribution—'z' test.
2 Near normal distribution—'t' distribution—Student's 't' test.
   - Chi-square distribution—chi-square test.
   - Fisher's distribution—Fisher's 'f' test.

According to Number of Samples to be Compared

1 Comparison between two samples—'t' test, 'z' test, chi-square test.
2 Comparison between more than two samples 'chi-square test' (for qualitative data) 'ANOVA (analysis of variance) test' (for quantitative data).
3 The tests of significance most commonly used to analyze small samples are:

Student's 't' test: for comparing two quantitative data and is further of two types:

1 Paired student's 't' test.
2 Unpaired student's 't' test

Chi-square test—generally for qualitative data.

Others are:

- Non-parametric tests—Mann-Whitney, Wilcoxon's rank sum test, Kendall's 'S' test, McNemar's test, etc.
- ANOVA test, Fisher's 'f' test, etc.

Example: Hb levels of 72 boys and 54 girls students of MBBS 2004 were as depicted as below.

- Test whether the mean Hb levels of boys and girls differ or not.
- Mean Hb levels for girls (X) =

$$\frac{10 + 11 + \ldots + 9.5 - 11}{54} = \frac{561.50}{54} = 10.39 \text{ g\%}$$

- Mean Hb levels for boys (Y) =

$$\frac{10 + 17.5 + \ldots + 14 + 14}{72} = \frac{1043.20}{72} = 14.49 \text{ g\%}$$

Assumptions: The sample is adequate and we assume that Hb levels among boys and girls do not differ from one another.

Hypothesis

Null Hypothesis

There is no significant difference between the mean Hb levels of boys and girls.

Hb levels of 126 students of MBBS 2004 batch

Girls (X):

10,11,12.5,10.5,12,10,12.5,11.5,11,10.4,10,9.3,11,11,9.5,11,10.5, 11.5,10,9.5,11.2,11,9.2,9.2,10,10.8,11,10.5,10.1,9,10,9.5,12,10.5, 11,10,10,10,10,10.3,10,9,11,9.5,9.5,8.5,9,10.5,10.5,10.5,12,11,9.5, 11

Boys (Y):

10,17.5,14.2,15,14.1,14,14.5,14.7,14.5,13.5,14.5, 14.5,14,15,16, 14,14,15.2,14.2,14,14.2,14,14,14.8,14,14.5,13.3,15.5,14.5,15, 15.5,14.2,14.8,14,14,15.2,14,15,14,14,15,14.2,14.5,15.2,14,14.8, 15.2,14.6,14.7,14.2,14,13.9,14.9,14.5,14.5,14.5,14.5,14.1,15.3, 14.5,14.7,15,14.5,14.2,17,14.7,14.5,14.6,13.8,14.2,15,14

Alternative Hypothesis

Mean Hb levels of boys and girls differ significantly.

Level of significance for testing above-mentioned hypothesis is fixed at 95%.

Choosing a test criterion and a test of significance. Test criterion chosen for hypothesis testing is the mean and as the data are appropriate and quantitative, so test of significance chosen is:

Unpaired 't' test/'z' test.

$$\text{'t' statistic} = \frac{\bar{X}_1 - \bar{X}_2}{s_p\sqrt{(1/n_1) + (1/n_2)}}$$

$$\text{Standard deviation of Hb levels of girls} = \sqrt{\frac{\Sigma(X - \bar{X})^2}{N_{1-1}}}$$

$$\frac{\sqrt{(10-10.39)^2+(11-10.39)^2+\ldots\ldots+(11-10.39)^2}}{54-1} = 0.9117$$

$$\text{Similarly, SD of Hb levels of boys} = \sqrt{\frac{\Sigma(y - \bar{y})^2}{N_{2-1}}}$$

$$\frac{\sqrt{(10-14.4)^2+(17.5-14.4)^2+\ldots..+(14-14.4)^2}}{72-1} = 0.8642$$

$n_1 + n_2 - 2 = 54 + 72 - 2 = 124$ df

In boys $\bar{Y} = 14.49$ and $s_1 = 0.8642$

In girls $\bar{X} = 10.39$ and $s_2 = 0.9117$

The pooled estimate: Sp = Pooled standard deviation

$$s_p = \sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}} = \sqrt{\frac{(54-1)\times(0.86)^2+(72-1)\times(0.91)^2}{52+74-2}}$$

$$= \sqrt{\frac{52.51+43.88}{124}} = \sqrt{\frac{96.39}{124}} = \sqrt{0.777} = 0.9$$

$$\text{t' statistic} = \frac{10.39-14.49}{0.9\sqrt{(1/54+1/72)}} = \frac{-4.10}{0.9\sqrt{(0.0139+0.0185)}}$$

$$\frac{-4.10}{0.9\sqrt{(0.0324)}} = -25.37$$

Degree of freedom = 54 + 72 – 2 = 124

Table value of 't' statistic at 124 degree of freedom is 1.98.

't' calculated is >'t' critical

So, the difference is real and significant and hence, null hypothesis is rejected and alternative hypothesis is accepted.

Results: The Hb levels of boys and girls in MBBS 2004 batch differ significantly at $p < 0.05$.

Chi-square Test

- It is a type of non-parametric test.
- Not based on any assumption of any variable.
- Developed by Karl Pearson.
- Important applications of this test of significance—are as a test of:
  - –Proportions
  - –Association
  - –Goodness of fit

Assumptions to be fulfilled:

1. Sample must be random.
2. Data should be qualitative.
3. Sample size should be >30.
4. Data collected should be tabulated in the form of cross tabulation 2 × 2 contingency table.
5. If sample size is less than 30, then also chi-square test can be applied but only with Yates correction (in 2 × 2 tables) but can only be applied when the expected frequency in each cell is more than 5.
6. If the sample size is small and the expected frequency in any cell comes out to be less, then chi-square test (in 2 × 2 tables) can be applied but with a modification of Fisher's exact test.

Important Steps

1. Prepare 2 × 2 contingency table.
2. Calculation of expected value for each cell: Expected value for each cell can be calculated by the following formula.

$$E = \frac{\text{Corresponding row total} \times \text{Corresponding column total}}{\text{Grand total}}$$

3 'Chi-square' statistic is calculated by the formula.

$$\text{Chi-square value } (\chi^2) = \frac{(O - E)^2}{E}$$

Where O = Observed value of the cell.

E = Expected value of the cell.

4 Fourth important step is to find out degrees of freedom so that comparison can be made with the table value corresponding to calculated degree of freedom.

Degree of freedom $(df) = (R - 1) \times (C - 1)$

where R = Number of rows.

C = Number of columns.

Example

The following data correspond to number of patients who were given treatment for tuberculosis under DOTS strategy and under non-DOTS strategy with corresponding number of cured patients.

Total patients = 310

Null hypothesis: Cure rates with DOTS and non-DOTS do not differ significantly in our study.

Alternative hypothesis: Cure rates for tuberculosis in patients receiving treatment under DOTS and non-DOTS strategy respectively differ significantly.

Levels of significance: Fixed at 95% level.

Selection of test criterion: Expected cure rate is the test criterion and test of significance chosen is 'chi-square' test because:

- Data is qualitative.
- Sample size >30.
- Data tabulated in the form of cross tabulation.
- We want to test association between DOTS and non-DOTS strategy—cure rates.

Solutions/Computations

Treatment outcome with DOTS and non-DOTS

Treatment outcome	*DOTS*	*Non-DOTS*	*Total*
Cured	140	90	230
Not cured	20	60	80
Total	**160**	**150**	**310**

$$\text{Expected value of 1st cell} = \frac{RT \times CT}{\text{Grand total}} = \frac{230 \times 160}{310} = 118.7$$

say = 119

Similarly, expected values of other cells are calculated.

Treatment outcome with DOTS and non-DOTS

Treatment outcome	*DOTS*	*Non-DOTS*	*Total*
Cured	140 (119)	90 (111)	230
Not cured	20 (41)	60 (39)	80
Total	**160**	**150**	**310**

Note: Figures in parenthesis are expected values.

$$\text{Chi-square value for 1st cell} = \frac{(O - E)^2}{E} = \frac{(140 - 119)^2}{119}$$

$$= \frac{21^2}{119} = \frac{441}{119} = 3.7$$

and similarly chi-square value for other cells

$$= \frac{(90 - 111)^2}{111}, \frac{(20 - 41)^2}{41}, \frac{(60 - 39)^2}{39}$$

= 3.9, 10.7, 11.3, respectively.

Total chi-square value = 3.7 + 3.9 + 10.7 + 11.3 = 29.6

Degree of freedom = (R – 1) × (C – 1)

= (2 – 1) × (2 – 1) = 1 × 1 = 1

Making Comparisons

Table value of chi-square at degree of freedom '1' and 95% level of significance (i.e. $p = 0.05$) = 3.84.

Calculated chi-square value is 29.6 and is >3.84.

Hence, the null hypothesis is rejected.

- Alternative hypothesis is not rejected.

Conclusions: There is a significant difference in the cure rates in patients of TB who were given treatment under DOTS and non-DOTS strategy.

DOTS regime achieves significant high cure rates in tuberculosis.

Non-parametric Tests

Most of the statistical tests of significance which we use require some important assumptions to be fulfilled, e.g.

- Distribution of random variable, either normal or near normal type of distribution.
- Estimations are based on meaningful sample statistic, called parameter and testing of the hypothesis is generally based on these estimated parameters.
- But in several studies, these assumptions are not fulfilled, i.e. distribution of a random variable is markedly skewed and sample size of the study group is very small and estimation with respect to a particular parameter does not hold true and cannot be used as a basis of significance. So, for analyses of these types of study samples, different type of tests of significance are required, these are called distribution free or non-parametric tests.

Important non-parametric tests are as follows:

1 Chi-square test.
2 Sign test.

3 Rank sum test.
- Mann-Whitney 'U' test.
- Wilcoxon's rank sum test.
- Kendall's 'S' test.

4 Rank correlation tests.

The most common of these tests is chi-square test (discussed earlier). The other important test is Spearman's rank correlation test.

Spearman's rank correlation coefficient: If we have a sample of individuals and we have two sets of values of observations of these n individuals then to see the correlation if it exists or not between these two sets of observations we calculate Spearman's rank correlation coefficient (r_s) and is calculated as:

$$r_s = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)}$$

$$= 1 - \frac{6\Sigma d^2}{n^3 - n}$$

where n = No. of individuals

d = Difference in paired ranks.

So, 1st ranks are allotted to observations according to their ranking in that particular lot.

Then pairing of ranks is done and difference 'd' is calculated, e.g. height and weight of 10 students of a class are as follows (Table 6.10).

Spearman's rank correlation coefficient

$$(r_s) = 1 - \frac{6(4+1+9+0+4+9+4+1+1\,6+0)}{10^3 - 10}$$

$$= 1 - \frac{6 \times 48}{990} = \frac{990 - 288}{990} = \frac{692}{990} = 0.698$$

Conclusion: Height and weight have positive linear correlation.

Regression

Regression analysis can be thought of as finding the best mathematical model for predicting one variable from another. One variable is considered to be dependent variable, its value varying according to one or more independent variables. The most common form of regression is linear regression in which the mathematical model is a straight line; the regression equation is the equation of the straight line that best fits the data.

Given data on a dependant variable Y, an independent variable X, regression analysis involves finding the "best" mathematical model to describe Y as a function of X or predict Y from X.

Uses

Regression analysis is a measure of the nature of association between two quantitative variables, e.g. age and blood pressure, gestational age and head circumference of newborn. Knowledge of this association helps predicting more accurately the value of the characteristic of an individual, when the value of other characteristic of that individual is known. Regression analysis helps in determining nature of association and prediction in conditions like:

Age of person and blood pressure, effect of temperature and heart rate, protein intake and growth rate of young children, intake of iron and folic acid in diet or as supplement and haemoglobin level, age and weight/height of young children.

Scatter Diagram

The weight-for-age of 12 preschool children is plotted on weight-for-age chart, we get 12 dots. These twelve dots follow a tendency on scatter diagram to cluster along a straight line, which we call as "regression line". This kind of relationship is linear relationship, i.e. as the age increases the weight also increases (Fig. 6.16). It depicts strong positive correlation. Thus, the scatter diagram indicates the nature and strength of the relationship.

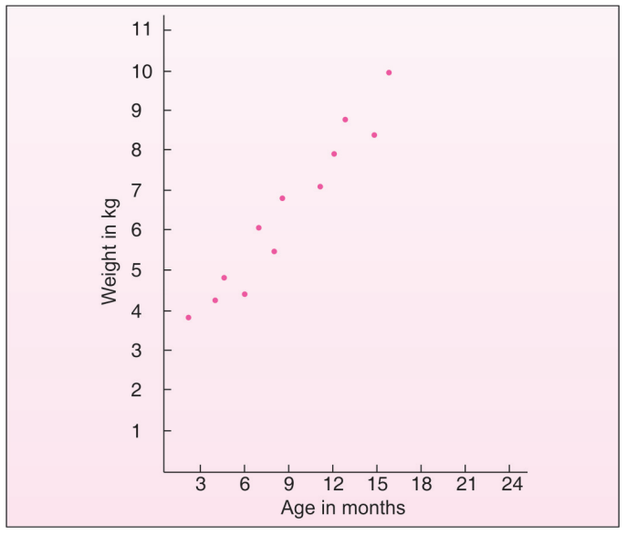


Fig. 6.16: Age and weight scatter of 12 healthy children

Table 6.10: Height and weight ranks of 10 students

Students	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
Ht (in cm)	158	155	166	154	161	156	160	168	170	171
Wt (kg)	55	56	58	54	62	60	61	63	59	64
Ranking (Ht)	7	9	4	10	5	8	6	3	2	1
Ranking (Wt)	9	8	7	10	3	5	4	2	6	1
d^2	4	1	9	0	4	9	4	1	16	0

The relationship could be strong negative correlation as depicted in Fig. 6.17.

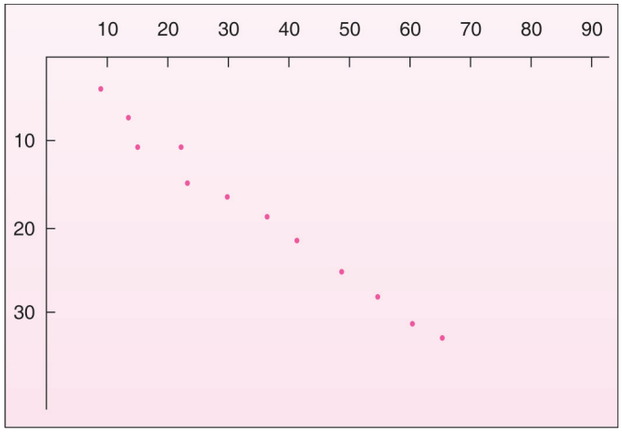


Fig. 6.17: Strong negative correlation

Regression equation: $Y = a + bx$

It is used to describe the dependence of one quantitative variable (Y) upon the other variable (x), while a and b are constants computed from data, b is the regression coefficient of Y on x.

Pearson coefficient correlation (ϒ): Pearson correlation coefficient is used as a measure of strength and direction of linear relationship. It has certain properties.

- Unit free (the coefficient r is an absolute number)
- Independent of change of origin and scale.
- Lies between – 1 and + 1.

It measures the strength of association between two quantitative variables. There are several limitations of Pearson coefficient correlation. It may conclude no relationship from zero correlation, while in fact strong nonlinear relationship may exist.

Learning outcome: Student prepares 2 × 2 table and applies chi square test and applies 't' test on quantitative data.

LIFE TABLE METHOD OF ANALYSIS

Life table is a summary measure of age and sex specific deaths in a community (country). From life table, we can derive expectation of life at particular age (say at birth, at 1,2…, age 70, etc.). Expectation of life is defined as the estimated number of years a person is expected to live beyond certain age if he/she is exposed to current risk of mortality at different ages (Table 6.11).

Table 6.11: Life table for India 2019 (sexes combined)—WHO Health Observatory Data Repository

1	*2*	*3*	*4*	*5*	*6*	*7*
Age interval x to x + n	l_x	${}_nq_x$	${}_nd_x$	${}_nL_x$	T_x	e_x^0
0–1	10000	0.0277943	2780	98054	7078755	70.7
1–4	97220	0.006213	604	387433	6980701	71.8
5–9	96616	0.002787	269	482409	6593268	68.2
10–14	96347	0.002708	261	481083	6110859	63.4
15–19	96086	0.004184	402	479426	5629776	58.5
20–24	95684	0.006485	621	476869	5150350	53.8
25–29	95063	0.007464	710	473544	4673481	49.1
30–34	94353	0.009491	895	469531	4199937	44.5
35–39	93458	0.012658	1183	464334	3730406	39.9
40–44	92275	0.016654	1537	457535	3266072	35.3
45–49	90738	0.023669	2148	448324	2808537	30.95
50–54	88590	0.038240	3387	434485	2360213	26.64
55–59	85203	0.057245	4878	413822	1925728	22.6
60–64	80325	0.084120	6757	384736	1511906	18.8
65–69	73568	0.124739	9177	344901	1127170	15.3
70–74	64391	0.186887	12034	291874	782269	12.1
75–79	52357	0.271646	14223	226232	490395	9.3
80–84	38134	0.426083	16248	150053	264163	6.9
85 +	21886	1.000	21886	114110	114110	5.21

Life expectancy at birth: Provides an indication of overall mortality of a country's population. In India, from 2000 (62.5 years) to 2019 (69.7 years), the life expectancy at birth has improved by 7.2 years. Healthy life expectancy (free from disability) improved by 6.1 years from 54.2 years in 2000 to 60.3 years in 2019

Uses

I One important use is to determine expectation of life in a country. This is an important positive indicator of health status of a community. On the basis of life expectancy, we can compare the health status of one country with the other.

II We can determine the number of survivors at different ages, which have several applications like old age pension, voters, number of women entering in reproductive health, children requiring schooling, basis of success of life insurance policies and number of adolescents requiring services.

III Life table method of analysis is used for cohort studies in medicine/health. To know survival rates after cancer or other long-term diseases like diabetes, hypertension and stroke and coronary heart disease.

IV Life table can be used to calculate the years of potential life lost (YPLL) and to calculate disability adjusted life years, i.e. DALY. If the life expectancy of a person is 63 years at birth and he dies of heart attack at 50, then he has lost 13 years of potential life as a result of premature death.

CONSTRUCTION OF LIFE TABLE AND ITS PROPERTIES

***Principle*:** The life tables are constructed after each census (once in 10 years). We usually follow a cohort of 1,00,000 newborn babies and follow them through various ages (0, 1, 2, 3, 4, 5, …, 15, …, 25, …, 85) till all die. During the course of follow-up, we also determine the number of persons surviving at exact age "x" and the total number of person years lived, to arrive at an average expectation of life.

For construction of life tables, the two basic things required are:

1 Actual population living in the specific age groups in the selected time.

2 Number of deaths occurring in these age groups in the given selected time.

Construction of life table rests on the assumption that the two distinct age patterns of mortality, i.e. observed and the standard patterns are related to each other.

The life table for combined sexes for India is shown in Table 6.11 (WHO 2019).

Column I (x to $x + n$)

Displays the age group intervals where n is the length of interval. The first one is 0–1 year, next is 1–4 years and then subsequent age group intervals are of 5 years each till 80–84 age and the last one is open ended interval with age group of 85 and above.

First two age intervals are divided so, because the mortality rate vary very significantly in first 4 years of age and we cannot assume the death rate to be equal for initial 4 years of life. Subsequently, grouping is done assuming the mortality remains equal for a particular age group interval.

Column 2 (l_x) (Number Living at the Beginning of Age Interval)

It is the cohort, who start their life at birth. It is hypothetical number. It is 1,00,000. This indicates the cohort who survives at exact age x, e.g. at birth this is 1,00,000 and at 1–4 years it is 97220.

Column 3 (q_x) (Proportion Dying)

It is the probability of dying at that age or it is the age specific death rate to which the cohort of life table is exposed to, e.g. in age group 0–1 year or during the first year of life the probability of death (infant mortality) is 27/1000 live births.

Column 4 (d_x) (Number Dying during Age Interval)

The number of deaths, i.e. 2780 is arrived at by applying current infant mortality rate of 0.0277943 to 1,00,000 which is approximately 2780 per 1,00,000. The survivors at the end of that age would be 97220 (who live to see their first birthday).

Column 5 (nL_x) (Person Years Lived)

This column provides the information on number of person years survived/lived by individuals in different age intervals. For example, during age interval 0–1 year 97220 individuals survived at the end of 1 year, since each of these 97220 persons survives for 1 year period contributes 97220 × 1 year = 97220 person years. Of 2780 infants who died, did not experience the mortality at one point in time and each one probably survived on an average of 3.3 months and hence contributed survival period of 834 years. Therefore, if we add 834 to 97220 person years lived by individuals, we get a total of 98054 person years lived during 0–1 year age interval. Similarly, at age interval 60–64, there were 80325 individuals alive at the beginning of this interval of these 80325 persons 73568 were still alive at the end of 64 years, since each of these 73568 persons survives the entire period of 5 years, contributes 73568 × 5 = 367840 person years, plus the 16896 person years contributed by 6757 persons those who died in 5 years in this age interval and adding these years to 367840 person years, we will get total of 384736 person years lived in the age interval 60–64.

Column 6 (T_x)

It denotes total number of person years lived beyond their xth birthday by l_x persons alive on that birthday. It is obtained by summing column 5 from bottom upward.

Column 7 (e_x^0)

This gives the expectancy of life at the start of a particular age group, x.

Life expectancy at birth is expressed as:

$$e_o^0 = \frac{\text{(Total number of person years lived after age x)}}{\text{Number of starters/survivors to age x}}$$

$$\text{In the table under reference (life expectancy at birth)} = \frac{\text{Total number of person years lived } (T_0)}{\text{No. of starters } (I_0)}$$

$$= \frac{7078755}{100{,}000} = 70.7 \text{ years}$$

$$\text{Life expectancy at age x} = \frac{T_x}{I_x}$$

$$= \frac{\text{Total number of person years lived beyond age x}}{\text{No. of persons entering the cohort at age x}}$$

$$\text{Life expectancy at age 1 year} = \frac{6980701}{97720} = 71.8 \text{ years}$$

Similarly, life expectancy at age 60 years

$$= \frac{\text{Total person years lived beyond age 60}}{\text{Persons entering the cohort at 60 years}}$$

$$= \frac{1511906}{80325} = 18.8 \text{ years}$$

RESEARCH METHODOLOGY

Research simply means, either application of the known scientific advances/evidence to improve the quality of life and to prevent diseases and promote positive health or it could mean gain in new knowledge/evidence for the development of mankind. Both are essential. Putting today's essential health knowledge into practice is a real challenge. Putting health knowledge at the disposal of families and communities for appropriate action is most essential for our country where resources are limited. The department of health research (DHR) was created on 5th October 2007 with the merge of ICMR.

Research can be put into the broad categories

- ***Fundamental and basic research:*** It is basic research conducted in laboratories to establish a theory which can subsequently be applied in the field. It could be a stepping stone for applied research.
- ***Applied research*** is essentially from laboratory to land/field or community. It means application of essential scientific knowledge for the development of health of community, to promote health, prevent disease, treat diseases and eradication of diseases of public health significance.
- ***Action-oriented research (AOR)*** is also an applied research wherein the data are collected, analyzed rapidly to ensure an action. Actions are concurrent with the stage of investigation and actions are modified in the existing environments and suiting to the needs of the consumer and moreover actions are user-friendly and flexible to respect the local cultural practices beliefs and faith.
- ***Operational research (OR):*** It means using a strategy or tactic to make the operation successful. Alternate strategies of healthcare are designed to achieve the results or goals. India is very large country and has lot of diverse cultures and no uniform or single strategy or tactic works.

Definition: OR is defined as "scientific method for providing executive department, a quantitative basis for decision-making regarding the operation under control." It is also defined as "the application of scientific methods, techniques and tools to operations of systems with optimum solution to the problem".[1]

Its purpose is to improve the efficiency of health system or working of the system or health teams. The technique of operational research includes network analysis, programme evaluation and review techniques (PERT), critical path analysis, linear programming, computer simulation procedures and application of queuing theory, cost-effective analysis and work study.

PRIORITY AREAS IN RESEARCH IN INDIA

The frontiers of medical science are expanding at a phenomenal pace. Priority attention would require to contain and eradicate the existing widely prevalent disease as well as to deal with emerging health problems. The basic objective of medical research and ultimate test of its utility would involve the translation of available knowhow (translational research) into simple, low cost, easily applicable low cost technologies, devices and interventions thus placing within the reach of health personnel and to the front line health workers and to the community in the remotest corners of the country. Therefore, besides devotion to basic, fundamental, high priority should be given to applied, operational research including action research for continuously improving cost-effective delivery health services.[2–4] Priority helps in correcting 10/90 gap, which relates to the fact that only 10% of funding for global health research is allocated to health problems that affect 90% of the world's population (Global Forum for Research, 2009).

Priority Areas

1 Health system research (policy and systems analysis and programme development) should have high priority which includes primary healthcare, and its different aspects such as information support, manpower development, appropriate technology, management needs assessment, training needs assessment besides communication needs assessment,

and community involvement. This essentially includes operation and action-oriented research components.

The system framework includes: Inputs → Processes → Outputs → Effects → Impacts.

2 Epidemiology is another area of significance. It is necessary to build up an adequate database for the proper development of the health programmes.

3 Basic science and fundamental research.

Basic research efforts should devote high priority to the discovery and development of more effective treatment and preventive procedures (vaccines for prevention of diseases) in respect of communicable and tropical diseases. Priority areas include HIV/AIDS, blindness, leprosy, tuberculosis, and malaria. Very high priority should be given to contraception research to improve their effectiveness and acceptance and discover new devices. Nutrition is another area of priority. The fast emerging non-communicable diseases (NCDs), coronary heart disease, strokes, diabetes, hypertension, cancer and accidents need a behaviour change or adopting healthy lifestyle. Protection of environments and ensuring safe water and sanitation remain a challenging area for research.

Department of Health Research would aim to increase share of extramural funding from the current 33 to 50% by the end of 12th Plan and beyond.

OPERATIONAL RESEARCH (OR)[5]

Directly Observed Treatment and Short-course (DOTS) has evolved through years of research—much of it was done in India. Operational research provides programme managers the data and tools they need to analyze and continuously improve the services/system they offer. The goal is to improve the diagnosis and treatment of tuberculosis by translating the results of research into policy and practice. But world-class research is not enough. Researchers must make every effort to ensure that their findings are promptly translated into more rapid and accurate diagnosis and more reliable and effective treatment of TB patient.

DOTS has become the accepted standard for diagnosis, treatment and monitoring of tuberculosis worldwide. The Director General of the World Health Organization declared "The DOTS strategy represents the most important public health breakthrough of the decade in terms of lives which will be saved." But DOTS is not new. In fact, the essential principles of DOTS are a product of India's long and distinguished tradition of tuberculosis operational research.

- National Tuberculosis Institute (NTI) at Bengaluru demonstrated the efficacy and feasibility of case detection by *sputum microscopy* and not by X-ray as tool for diagnosis.
- Studies at Tuberculosis Research Centre in Chennai demonstrated the efficiency and safety of *home treatment* of tuberculosis, the effectiveness of *intermittent chemotherapy* (medications were given two or three times a week) and necessity and feasibility of direct observation in the community.
- Thus, use of supervised treatment—now known as directly observed treatment and short-course (DOTS) in which patients are observed taking their anti-tuberculosis treatment, was shown to be essentially in India.

Thus, these three cardinal principles of DOTS were developed in India after adequate operational research studies and these were adopted the world over and in India by launching Revised National Tuberculosis Control Programme. Cure rate of TB has increased to 86–90% with DOTS strategy.

Other examples of operational researches

1 Enhancing coverage and quality of routine immunization, antenatal care, postnatal and neonatal care by integration of health and ICDS system.

2 Joint home visits of AWW and ANM to recognize community needs and effective response.

3 Promotion of institutional deliveries by setting up of delivery rooms (huts) in subcentre and PHCs.

4 Public–private partnership in healthcare delivery.

5 Devolution of powers to village *Panchayats* to manage sub-centres.

6 Alternate methods of delivery of ORS packets, vaccines diagnosis and treatment of malaria and contraceptives at village level. Operational research studies have clearly demonstrated that about 50% cases of diarrhoea in the community can be managed by mothers with home-available fluids and the rest can be treated by health guides with ORS and only a few may be required to be referred to the health facility. With the education of mothers and advance distribution of ORS packets during intensified diarrhoea control fortnight (IDCF), for use of HAF and availability of ORS packets with health guides, it is expected that diarrhoea-related mortality in children will be reduced considerably.

7 People's participation in primary healthcare.

8 Alternate model of adolescent health (teachers to adolescent, adolescent to adolescent).

ACTION-ORIENTED RESEARCH/ACTION RESEARCH[6–9]

It is research for action.

- Promoting use of home-available fluids as a first response by family or mother when acute watery diarrhoea strikes in young children.
  - Continue breastfeeding and feeding during diarrhoea and promotion of use of ORS packets.
  - Avoiding unnecessary antibiotics for treatment of diarrhoea.

These are examples of action-oriented research. When women groups and mother groups are empowered and well trained by local health workers

they themselves effectively respond to first of all to prevent dehydration and deaths due to diarrhoea and early recovery. Most mothers succeeded in preventing diarrhoea. They kept away drugs and doctors and themselves managed the diarrhoea episodes.

Promotion of sanitary latrines in rural areas: Nearly 67% of families in rural areas use sanitary latrines and the rest 33% resort to open field defecation. The programme for sanitary latrines in rural areas has not much succeeded. Action-oriented research undertaken in rural setting by non-governmental organizations and UNICEF supported projects has resulted into acceptance and use of sanitary latrines in rural areas.[8,9] Major steps involved in action-oriented research included:

- Behavioural research to promote the behaviour to use sanitary latrine to avoid excreta-borne diseases.
- To promote low cost acceptable and affordable latrines requiring least amount of water to flush.
- To generate demand for sanitary latrines.
- To involve community and community leaders for popularization of sanitary latrines.

A comprehensive baseline survey on knowledge, attitudes and practices in rural water supply and sanitation was conducted during 1996–1997 by the Indian Institute of Mass Communication, which showed that 55% of those with private latrines were self-motivated. Only 2% of the respondents claimed the existence of subsidy as the major motivating factor, while 54% claimed to have gone in for sanitary latrines due to convenience and privacy. The study also revealed that 51% of the beneficiaries were willing to spend up to ₹ 1000/- to acquire sanitary toilets.

- Keeping in view the above facts, the Central Rural Sanitation Programme which was launched in 1986 moved towards a 'demand-driven approach'. The revised approach in the programme titled 'total sanitation campaign (TSC)' now emphasizes more on information, education and communication (IEC), human resource development, capacity development activities to increase awareness and demand generation for sanitary facilities in houses, schools and villages. This approach has enhanced people's capacity to choose appropriate options with beneficiary participation to meet their demands. Subsidy for individual household latrine units has been reduced.

RESEARCH-CUM-ACTION (RCA) PROJECT OF ICMR

Number of action-oriented research/action research studies were undertaken to develop suitable rural latrines acceptable to people. Action research was directed towards developing suitable designs of latrine—type of latrine, suitable pan and trap, slab or squatting plate, pit, cost, quantity of water required for flushing, life of latrine, utilization of contents as manure, sociological factors like existing beliefs, habits and reactions of people of using the latrine and chances of groundwater pollution.

The institutes which participated in action research consisted of: The Planning Research and Action Institute (PRAI) Lucknow, Research-cum-Action (RCA) Project in 1956 by Union Ministry of Health with the assistance of Ford Foundation, Central Public Health Engineering Research Institute (Nagpur), WHO Project at Ramanagram (Mysore), and Sanitation wing at Gandhigram (Chennai). RCA did great deal of useful action research on latrines at three centres—Poonamalee (Chennai), Singur (West-Bengal) and Najafgarh (Delhi). One of the outstanding contributions of the RCA Project was the development of suitable engineering design for the rural latrine.[11]

1. As first step efforts were made to collect all the available latrine designs in the country including PRAI designs and observe the efficiency of performance in the field.
2. On the basis of field observations on their performance, composite and best design was developed towards the end of 1958 and all the observed defects were corrected.
3. Thus, on the basis of critical studies of earlier designs; a new type of latrine was finally developed known as the RCA (Research-cum-Action) type.
4. This design was further tested in all centres of RCA and other field stations in the country and found to be very satisfactory.

RCA latrine is dug well latrine which can be constructed with local resources and technology.

RESEARCH METHODOLOGIES

The research methodologies have been discussed under epidemiological studies. Broadly these are:

1. Observational Studies

a ***Descriptive studies:*** The scientist or investigator observes the occurrence of disease or an event and orients it to time, place and person distribution. The observations made on occurrence could be the first step towards scientific investigation. Observations generate hypothesis. We call this as descriptive method of epidemiology of research study.

b ***Analytical methods:*** While descriptive method describes the health status or situation (prevalence and incidence), the analytical method focuses on causes and reasons for such situations or status in the population. Analytical methods could be ecological studies, cross-sectional studies (surveys NFHS and SRS), cohort study and case control studies.

2. Experimental or Intervention Studies

Here results of intervention are evaluated, e.g. drug trial and efficacy of vaccine or other interventions like iodized salt, supplementary nutrition, safe disposal of human excreta. Details of experimental studies have been discussed under epidemiological methods.

METHODS OF DATA COLLECTION FOR RESEARCH STUDY—CM 6.2

Data on research purposes can be collected by the following methods:

1 Observation—direct and participant observation
2 Interview, Group discussion and focus group discussion
3 Health examination
4 Investigations (epidemic, surveillance and laboratory).

1. Direct Observations by Supervisors or Peer

The investigator makes observations and collects the facts. Observation could lead to community diagnosis.

Examples: Observation of health practices such as child feeding and rearing practices, excreta disposal practices, safe water storage practices, etc. Similarly, observations on resources available in the community for health work, can be carried out. Quality of services can be judged by observation mostly, one can observe the technique of immunization, antenatal check-up, etc. Supervisors can observe the work by way of checklist system (structured observations) and can give feedback to managers. Observation is thus a powerful tool to collect evidence or data on research. Observing service providers during service delivery directly assesses how well they apply their knowledge and how well the patient responds to clinical treatment and counselling.

Participant Observations

Here, the researcher/observer lives with the community for some period and becomes part of that community to understand the health/illness behaviour/practice and perception of the community members.

2. Interviews

Here, the investigator collects data by asking set of questions or by conversation in a friendly manner. Data on client satisfaction and their reactions towards hospitals, primary health centre and doctors or paramedical workers can be obtained by interview technique. Exit interviews, opinion polls and groups interviews are rapid methods of collection of data from users of services or prospective users of services. 24-hours recall method of dietary survey is quite popular to obtain information by interview on the qualitative and quantitative consumption of dietary items/foods diversity. Drawbacks of an interview are recall lapse (memory) and sensitivity level of a question.

Delphi method is also an interview technique where we get opinion or experiences of knowledgeable key informants (KI) and experts on the subject. This is the rapid method of collecting data on disease and high-risk individuals and risk factors of a disease.

In clinical practice, interview is the most commonly used method. The first and foremost step in diagnosis of disease is asking the chief complaints (symptoms) of the patients and their duration and sequence of events. This is known as history taking. Apart from chief complaints or presenting complaints, we also obtain past history of illness, family history of illness, dietary intakes, dietary habits, food avoided during illness or food preferred during illness, and lifestyles—tobacco and alcohol use, physical activity apart from KAP. Experienced doctors and experts can conduct interview easily but for a beginner it may be difficult and hence he requires training—or practice.

The quality of information generated by interview depends upon interviewer and interviewee and the sensitivity level of the information. Essential requirements for successful interview are repeated contacts building the confidence and trust of the client, and keeping the information confidential. Health workers and *Anganwadi* workers are able to obtain information on health/disease events and other relevant information on households and family members by interview technique, because of their sustained contacts with the families. Interview information depends upon memory (recall lapse), literacy level of the respondent as also on the sensitivity level of the information. Interview method is least costlier method of data collection and even paramedical health workers or trained investigators can conduct interview. Community-based assessment checklist of risk factors and WHO step-wise approach for surveillance of risk factors of non-communicable diseases makes use of interview technique to collect data on sociodemographic and behavioural aspects.

3. Health Examination

a Clinical examination of patient can collect valuable data from patient. Clinical examination is a standard practice to obtain information on physical signs such as enlargement of liver, spleen, heart sounds, murmurs, abnormal breathing, etc.
b Apart from clinical examination of patient, one can examine the health records maintained at subcentre. Primary health centre or community health centre or hospital to get an information on common diseases, trends of illness, information on fertility and mortality, availability of drug kits A and B as also equipment. This helps to assess the health needs of the community or community diagnosis.

4. Investigations

Apart from epidemic investigation and surveillance data, laboratory data, imaging and other tests provide quantitative data which can be processed to draw valuable information. The laboratory investigations help to confirm the diagnosis or disease condition in the individual or in the community.

Various epidemiological research methods described above are mostly *Quantitative Methods* of research, which collects objective or specific information and facts that can be expressed as numbers, e.g. number of children, number of household with safe water and latrines.

QUALITATIVE METHODS OF RESEARCH

The qualitative methods of research are very useful and complementary to quantitative methods of research.

Qualitative methods of research focus on subjective data:

a Attitudes, beliefs and behaviour of persons, e.g. health-seeking behaviour in relation to an illness, reasons for using, non-utilization of available health services, dietary preferences, child-rearing practices, use of sanitary latrines, etc.

b These methods collect subjective and attitudinal data—mainly to understand human behaviour, health practices, illness beliefs, etc.

c These methods explore and analyse the "top of mind of a person" or perceptions.

d These methods use purposive sampling and analyse the perceptions and personality of a person.[12]

Transact and Group Walk (TW)

Transact walks are spatial data gathering tools. With the help of health workers and community. To capture life processes of village people or urban slums one can just **walk through** the village/urban slums. One can observe access to village/slum, key facilities: Schools, *Anganwadis*, health facility, garbage and refuse disposal practices, wastewater management, ponds, wells, piped water supply, housing conditions worship places, chaupals/community centres, cropping pattern, stray dogs, cattle and pig rearing, cattle sheds, water, fuel and fodder collection by women, etc. one can prepare a spot map of village/slum area to depict various facilities on map, we call it social mapping. Health workers prepare simple local area-working maps for mass campaigns on pulse polio immunization, malaria and other national health programmes. Such maps provide an overview of the area (location of facilities) and high-risk areas and hot spots.

Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA)

This is a process of learning from, with and by rural people about rural life as a part of community diagnosis. The concept is equally useful for urban community diagnosis. PRA uses various methods for data or information collection by following techniques/methods:

- Village profile map: Resource and social mapping
- Time line/trend analysis: Village development events
- Seasonality studies: Seasonality map helps in understanding disease patterns, food and nutrition availability.
- Matrix ranking: Disease ranking as priority of community
- Transact walk: To understand community resources, health facilities, whether people seek care from the facility
- Venn diagrams (or Chapati diagrams as they are often called): It helps to study local perception of diseases and their prevalence by drawing circles of different sizes such that the greater the perceived danger the bigger the circle.
- Group discussion/focus group discussion: These are thematic discussions among programme beneficiaries to know their perception and practices about a disease—say diarrhoea.

These methods investigate individual, household/family and community health behaviours such as illness perception, opinions, attitudes and practices, motivation level of people and providers of services.

Participatory Research

Involving local communities themselves in planning the survey and doing the interview to collect information is known as participatory research.

Interview Method

The interview can be conducted by asking series of questions, or by group discussion or by focus group discussion with 'key informants'.

a. Questionnaire: Here, the investigator prepares a questionnaire (a set of questions) and arranges these questions in sequential order to elicit the responses from the subjects. The questionnaire can be close-ended or open ended. Close-ended questions are useful as they help us to count our answers easily such as yes or no or agree, partially agree or disagree. Open-ended questions elicit opinion and are useful about why a person behave in certain way. Questionnaire method can be quite useful to collect and record information on knowledge, attitudes, beliefs and practices of respondents.

To literate persons, the questionnaire can be mailed or they themselves can fill-up their responses. From illiterate respondents, the responses have to be collected by asking questions in the language and dialect they understand. The responses can be coded for quick analysis by computer.

Likert scale: A scale measuring the degree to which people agree or disagree with a statement; usually on a 3–, 5–, or 7–, point scale. This is most commonly used to assess the **attitudes** of respondents.

b. Group discussion: This is a rapid method of collection of information, e.g. *Mahila Swasthya Sangh* group members can choose and discuss a problem and express their views and opinions and can come to consensus for solution of the problem. Group discussion method can be used to assess the community health needs as also behaviour change communication (BCC) needs or needs of specific groups, e.g. needs of pregnant women, lactating mother and young children. AWWs and ANMs commonly conduct mothers meeting and group discussion to elicit community participation and to improve the service delivery.

Focus Group Discussions (FGDs)

Focus group discussions are thematic discussions among small homogenous group of potential programme beneficiaries. It is a method of learning directly from the 'clients' in the clients own words, what they think of certain products or why they uphold certain practices and what benefits they hope to experience from both. FGD is a technique adapted from applied psychology to obtain 'top of the mind' responses from clients or beneficiaries of the programme. A theme is chosen on the basis of observations made by the workers during their home visits or contact with the clients during mother and child protection sessions or contacts at subcentre or *Anganwadi*. The theme could be use of ORS to prevent dehydration and deaths in children having diarrhoea or use of home available fluids to prevent dehydration.

Participants in FGD: Their number should be 6–8. They could be young mothers with child under 36 months, whose child has had diarrhoea at sometime in the past. The FGDs are conducted by a moderator and someone takes the notes and analyses the results of discussion. Recruiters recruit the participants. This way consultation of consumers is obtained and right message for right client, at right place and right time is delivered, suited to their need and cultural practices.

FGD method is commonly used in social marketing to popularize a product or service such as contraceptives, ORS, immunizations, etc. Thus, FGD is an extremely valuable research technique and can be used along with other research techniques to collect information directly from the clients on behaviour change communication (BCC) needs. FGD help us to find out 'why' behind the problems. Survey method that relies on close-ended questions tell us 'What' the problems are.

c. Projective methods: Like FGD, projective techniques are also adapted from applied psychology to collect data on perception of individuals or more complex emotional information. The projective tests have been standardized to know the personality of a person. Standard set of pictorials are used and inferences drawn based on established criteria. We can analyse the make-up of a person by these research methods.

d. Case study: This method conducts in-depth analysis of a social unit and is widely used for learning purposes and assessing management needs (management needs assessment). Case could be an institution such as functioning of subcentre or primary health centre or it could be a person such as work schedule or home visit of health worker or it could be a disease event or beneficiary of a programme.[11]

Competency addressed: The student should be able to:
CM 6.1: Formulate a research question for a study.

Learning objective: The objective of this skill is develop scientific temper among students to pursue research in any area of medicine.

FRAMING A RESEARCH QUESTION FOR A STUDY

How? The first fundamental in research is selecting a topic or problem.

Framing a Research Question

Next step is converting research topic into answerable research question. Research question encompasses two basic elements namely:

1. **Predictor** (independent) variable and outcome (dependent) variable, and
2. **Study population—participants/population**

The predictor variable is an intervention, risk factor or an exposure while outcome variable is disease or effect such as change in knowledge, attitude or practice or coverage and utilization of services as also improvement in health status/condition, reduction of disease incidence/prevalence, etc.

Research question in essence can be framed as: Does the independent variable influence the outcome variable of interest?

Examples

Does IFA supplementation (180 tablets) improve the Hb level of severely anaemic pregnant women?

What is the prevalence of anaemia in schoolchildren in rural area?

A research question in medical sciences is usually an uncertainty that one wishes to resolve. "It can be defined as the main question the researcher wishes to answer or

question that specifically states what researcher will attempt to answer". Most often the research topic and objective tends to be the same, however a distinction must be made between the two. Research question states the problem while objective is more specific and focuses on the outcome or result/results expected from study. Research question guides to the type of study to be conducted.

Students research topic should not be too ambitious, because of shortage of time and resources. Research topic selected should be relevant to Healthcare Delivery System and Chosen in consultation with state/district programme managers, focusing on priority problem. Further it should be feasible, interesting, novel, ethical and relevant (FINER). Framing and refining a research question requires a thorough review of literature from library, journals, published reports/survey and computers and computerized electronic bases such as midline, embase, scopus, etc.

Research Protocol

Frame your research protocol in PICOT format which is based on evidence based research concept.

P: Study participants/population.

I: Interventions

C: Control group.

O: Outcome.

T: Time frame.

Protocol: Write a brief protocol on research topic and get it approved from ethical committee.

Research protocol should be written under following headings:

i **Objectives of study:** Determine the objectives of the study, i.e. the question/questions being addressed. Objective should be specific, measurable, achievable, relevant, with time frame (SMART). Limit to one or two objectives.

ii **Materials and methods:** What materials and methods are used to achieve the defined objectives.

Material means: Study population—sample frame, sample size and sampling method—cases and controls, inclusion and exclusion criteria with time frame of study.

Methods: Type of study—descriptive, analytical—cross sectional, case control, cohort, ecological. Experimental—RCT, field trial.

iii **Informed consent:** Informed consent from participant is a must.

Interventions: Specify interventions.

iv **Method of data collection by** Observation, interviews, Questionnaire, focus group, clinical examination, laboratory tests and other investigations, by surveys and surveillance.

Data processing: Various statistical methods used for data processing—summarization and data analysis and data presentation by tables and graphs/figures. Involve biostatistician right from the planning stage of protocol.

v **Results:** Interpretation of data and results.

vi **Conclusions and recommendation:** Share the results with participants and with managers of health system. Suggest future research areas based on the present results.

Note: Data could be primary generated by the investigator himself or secondary data generated by others or published data of journals or other official agencies.

OTHER EXAMPLES OF RESEARCH QUESTION

First Example

What is the burden of acute watery diarrhoea in young children?

Objective: To **estimate** incidence of acute watery diarrhoea episodes in children below 3 years of age in the last 2 weeks.

Here the investigator must define what is an episode of acute watery diarrhoea? Who are young children? What kind of study design and sample size, etc.

Second Example

Research Question

What is the efficacy of measles vaccine at field level?

Objective: To **determine** the incidence of measles disease in immunized and unimmunized children.

Third Example

What is the burden of diabetes/hypertension in adults?

Objective: To estimate prevalence of diabetes/hypertension in persons over 30 years of age.

Expected outcomes: The student completes at least one feasible assigned project in the area of action or operation research.

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CHAPTER

7

Epidemiology

"Epidemiology strikes against the health problems of entire populaton"
"Five 'Ws'—Who, What, When, Where and Why are principles of epidemiology"
"One Health Approach is Primarily Epidemiological Triad"

Competency addressed: The student should be able to:
CM 7.1: Define epidemiology and describe and enumerate the principles, concepts and uses of epidemiology.

PRINCIPLES, CONCEPTS AND USES OF EPIDEMIOLOGY

DEFINITION: EPIDEMIOLOGY—'EPI' MEANS UPON AND 'DEMO' MEANS PEOPLE, 'LOGOS' MEANS THE STUDY OF "STUDY UPON PEOPLE TO CONTROL THE HEALTH PROBLEMS IN POPULATION"

"Think epidemiologically and act socially" holds true in all situations. Teachers should strive to develop epidemiological and analytical thinking among the students.

Principles of Epidemiology

Epidemiology is the basic science of public health. this discipline is action driven based on hard data. It relies on systematic and unbiased approach to the collection, analysis and interpretation of population data to arrive at community diagnosis/health problem. Key terms in the definition reflect the important **principles** of **epidemiology**.

Study of

The epidemiology generates evidence by collecting data through observational studies (descriptive and analytical studies) and experimental studies. It draws on methods from other scientific fields including biostatistics and informatics with biologic, economic, social and behavioural sciences.

Distribution and Determinants

- Distribution means disease or health events occurrence by time place and persons. Epidemiology is concerned with the '**FREQUENCY**' and '**PATTERN**' of health events in **population**.
- **FREQUENCY** refers to not only number of health events but also to the relationship of that number to the size of the population.
- **PATTERN** refers to occurrence of health related events by time, place and person (TPP).
- **Time** pattern may be annual, seasonal, daily weekly fortnightly or monthly or even hourly.
- **Place** pattern includes geographic variation of disease, in rural and urban areas, state to state variation within the country and district to district variation within a state or block to block variation in district.
- **PERSON** pattern includes variation of disease by age and sex, literacy, income and life styles (demographic, socio-cultural and behaviour of person).

Time, place and person (TPP) distribution is a function of descriptive epidemiology.

Determinants: Determinants mean causes or risk factors of health events and health states. *Why* did the event occur? Or *what* causes the event to occur is a function of *analytical* epidemiology which is concerned with the search of causes or risk factors.

Application

Epidemiology is not just "the study" of health in population, it also involves applying the knowledge gained by the studies to control and prevent disease in the community by appropriate, practical, acceptable, and cost effective interventions.

How the health event can be controlled and prevented is the function of *experimental* or *intervention* epidemiology.

Five Principles of Epidemiology

The science of epidemiology focuses on "human population". There are 5 Ws in epidemiology.

1 *What* is the problem?
2 *Who* suffer most?
3 *Where* does it occur?
4 *When* does it occur and?
5 *Why* does it occur (causes) and *how* to control it?

USES AND APPLICATION OF EPIDEMIOLOGY

The epidemiology is useful in:

1 Search of cause/causes of disease/diseases.
2 Helps to describe the health status and disease burden of population or groups.
3 Helps to discover and bridge gaps in natural history of diseases.
4 Helps in controlling the diseases to break the weakest link in chain of transmission of communicable and non-communicable diseases.
5 Helps in planning of health programmes on evidence basis and setting up of health priorities.
6 Helps to evaluate health programmes and interventions.
7 Helps to determine the chances or probability of occurrence of disease/deaths and disability.
8 Helps in better management of health services and hospital services.
9 Helps to set-up cut-off levels between normal and abnormal population and establishes trigger levels for action or intervention.

Competency addressed: The student should be able to:
CM 7.3: Enumerate, describe and discuss the sources of epidemiological data.

Sources of Epidemiological Data

There are two main sources of epidemiological data—(A) Routine or regular systems and (B) Adhoc surveys. Routine reports are incomplete, inaccurate and less reliable but most valuable at local level planning and evaluation. Adhoc National Health and Demographic surveys at regular interval are more reliable. Following are the sources.

i Civil registration system—registration of births and deaths under 1969 Act.
ii People themselves—report outbreaks, diseases, births and deaths and unusual events.
iii Health information of India—published by CBHI. Sample Registration System (SRS) of Registrar General of India—once a year provides information on fertility, i.e. birth rates, death rates at state and national level.
iv Routine regular records and reports of a health facility—sub-centre, PHC, CHC and hospitals.
v Annual Households and Facility survey data of ASHA, AWW and ANM.
vi Disease notification at national level (20 diseases) and at international level (cholera, plague, yellow fever, etc.
vii Cancer registry/disease specific registry.
viii Data of specific National Health Programme. Published in annual reports by DGHS.
ix Survey data, of National Sample Survey Organization (NSSO).
- Integrated National Family Health Survey data (NFHS).
- General and special health surveys (Singur, Calcutta) Tuberculosis-1958 and national prevalence survey on annual risk of tuberculous infection 2002 and national TB survey, 2019–21.

x District level household surveys data under reproductive and child health—every alternate year—as also facility survey data besides annual district health survey data (now stopped).
xi Surveillance data, e.g.
- HIV annual sentinel surveillance data.
- National polio surveillance project reports.
- Malaria surveillance and IDSP.

xii Census data (population count) after every 10 years.
xiii Media reports.
xiv World Health Reports: Weekly epidemiological reports, annual statistical reports, etc.
xv Outbreak/epidemic data
- Methods of data collection by **interviews, questionnaires, observations, health examination, laboratory investigations,** and group **discussions,** by **surveys** and studies and routine reports.

People First

People themselves are great source of information and most of the time people report the events first, the official machinery comes to the scene much late. People's resources must be used. Rumour register kept at PHC level records rumours of disease/outbreaks which can be subsequently verified by health workers. This system was used in smallpox and guinea warm eradication programme.

EPIDEMIOLOGY OF COMMUNICABLE DISEASES (CCDs)

The objective of understanding epidemiology of CCD is to reduce the incidence and prevalence of these diseases and it may help to eradicate a disease or eliminate a disease from the globe or geographical area, e.g. India.[1]

DEFINITION

A communicable or infectious disease is an illness caused by transmission of a specific infectious agent or its toxic

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products from an infected person or an animal to a susceptible host, either directly or indirectly through an intermediate, animal host, vector or inanimate environment (Last 1995) (Fig. 7.1A).[1]

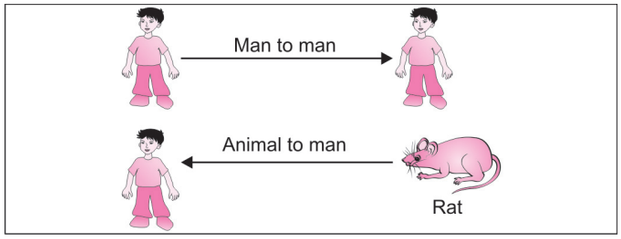


Fig. 7.1A: Disease transmission

Disease burden due to communicable diseases is colossal and these diseases cause heavy mortality, disability and economic loss to the country. CCD burden in India accounts for 32% of *DALYs* losses. CCDs continue to present the most important *acute health problems* in all the countries in the form of outbreaks and epidemics.

CHANGING PATTERN OF INFECTIOUS/ COMMUNICABLE DISEASES IN INDIA

- While smallpox, guinea worm, and yaws have been eradicated, leprosy has been eliminated, maternal and neonatal tetanus eliminated and WHO has certified India as polio-free since 2014.
- The incidence of measles, hepatitis B and rheumatic fever has been significantly reduced.
- Diarrhoeal diseases, acute respiratory infections, tuberculosis and dengue incidence remain high with reduced mortality.
- Some infectious diseases like hepatitis B and C as also, HIV, HPV and JE have long-term consequences like chronic hepatitis, cancer and mental health.
- The emerging and re-emerging infectious diseases are global phenomena and most of these diseases result in widespread epidemics, with high mortality and morbidity. In addition to the immense suffering to the mankind these diseases especially the epidemics, disturb international trade and economic development.

Emerging Infectious Diseases (IDs)[2, 3]—New IDs

Emerging infectious diseases are newly identified and previously unknown infections, or those spreading to new geographical areas, which cause public health problems either nationally or internationally. These include:

- HIV/AIDS burden: 2.40 million in India (2020).
- Severe acute respiratory syndrome (SARS).
- Covid-19 Pandemic 2019.
- Middle East respiratory syndrome (MERS).
- Bird flu or avian influenza (H5N1 virus).
- Pandemic influenza (H1N1), 2009.
- Multidrug resistant tuberculosis (MDR/XDR).
- Hepatitis C, B and E.
- Japanese encephalitis.
- A new form of cholera—*Vibrio cholerae* 0139.
- Leptospirosis.
- *Nipah virus disease:* A recently emerged, zoonotic paramyxovirus was implicated as the cause of a highly fatal febrile human encephalitis in Malaysia and Singapore in 1991, Bangladesh in 2001–2004. Outbreaks from India have been reported from West Bengal in 2001 and 2007, recently in Kerala in 2018 killing 16 people and it revisited Kerala in 2019 and 2021.
- A variant of Creutzfeldt-Jakob disease: A disease of central nervous system.
- Zika virus infection is linked to microcephaly in newborn.
- Haemolytic uraemia syndrome caused by *E.coli* 0157: H7.
- Ebola viral disease or Ebola haemorrhagic fever. Ebola virus spread in 'Congo' was declared as an emergency of international concern in 2019 July.
- Hantavirus: Haemorrhagic fever with renal syndrome.
- A highly fatal respiratory disease caused by virus called Sin Nombre virus.
- Lassa fever.
- Crimean-Congo haemorrhagic fever (CCHF).
- Melioidosis caused by bacteria Burkholderia pseudomallei with CFR of 16–50%.

Re-emerging Infectious Diseases[2, 3]

Re-emerging infectious diseases are known infections which had ceased to be major public health problems and now reappearing, often in epidemic proportions. These include:

- Tuberculosis due to its close association with HIV infection, a leading killer of adults in India, accounts for one-fourth of global incidence. Around 3.2 million is disease burden of pulmonary TB in India.
- Cholera: Occurs in epidemics.
- Dengue: Dengue haemorrhagic fever and dengue shock syndrome.
- Malaria: Drug resistance and rising incidence of malaria in some areas.
- Chikungunya: Occurs in outbreaks.
- Plague: Outbreak was reported in India in 1994.
- Kala-azar: Endemic in four states of India.
- Meningococcal meningitis: Outbreaks.
- Diphtheria: Outbreaks.
- Monkeypox

Neglected Tropical Diseases

These diseases are group of CCDs that prevail in 149 tropical and subtropical countries and affect more than a billion population. These diseases have long term

consequences in terms of disability, stigma, physical capacity and economic losses. These diseases are:

Dracunculosis, echinococcosis, sleeping sickness, dengue and chikungunya, kala-azar, soil transmitted helminths, taeniasis, yaws, trachoma, shistosomiasis, onchocerciasis, leprosy, mycetoma, and filariasis.

Major Reasons for Emergence of Infectious Diseases

- High population growth, and density, uncontrolled and unplanned urbanization, deforestation.
- Poor environmental impacts and loss of biodiversity—climate change.
- Migration of population.
- Natural disasters.
- Growing international trade, tourism and rapid travel.
- Alterations in micro-organisms.
- Resistance to antimicrobials/antibiotics misuse.
- Insecticide resistance.
- Weak public health system and dysfunctional governments.
- Illiteracy and ignorance.
- Increased human and animal contacts.

The World Health Day on 7th April 1997 chose a theme "Emerging infectious diseases—global response—global alert". Now 'One Health' a renewed approach to ensure measures to protect the health of animals, humans and environment is under way.

Emergence and re-emergence of many infectious diseases has resulted in more serious health problems in India as compared to many other developing nations. These diseases are responsible for significant number of deaths and illnesses and have caused massive disruption in the national economy.

Competency addressed: The student should be able to:
CM 7.2: Enumerate, describe and discuss the modes of transmission of communicable diseases.

MODES OF TRANSMISSION

The communicable disease occurs as a result of the interaction of infectious *agent*, the transmission process, the *host* and *environments* as shown in Fig. 7.1B.

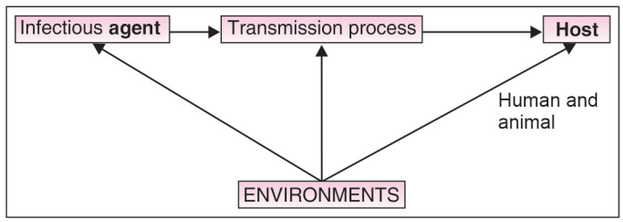


Fig. 7.1B: Components of chain of infection in CCD (epidemiological triad) interaction between humans, animals and environments (one health).

Epidemiological Triad or Triangle (Fig. 7.1B)

The epidemiological triad consists of an external *agent*, a *susceptible host* and an *environment* that bring the host and agent together. The disease results from the interaction between the agent and susceptible host in an environment that supports transmission of agent from source to host.

The *environments* influence all the three components of chain of infection. Knowledge of each component of chain of infection is helpful to understand the natural history of CCD and NCD for effective intervention and control of communicable diseases and NCD.

Competency addressed: The student should be able to:
CM 1.3: Describe the characteristics of agent, host and environmental factors in health and disease and multifactorial etiology of disease.

(A) CHARACTERISTICS OF EXTERNAL AGENTS

A large number of agents like microbiological organisms (**biological agents**) are responsible for infection and occurrence of communicable diseases. These organisms live or develop and multiply in various hosts or in environments. Knowledge of these microorganisms helps to control the infection and CCD. The micro-organisms belong to different categories like bacteria, parasites, viruses, fungi and rickettsial organisms; besides spirochaetes. Characteristics of various agents have been described in chapter on CCDs and NCDs (*see* Chapter 8).

OTHER AGENTS

i Physical agents—heat, cold, radiation, noise injuries, and air pressure in working environment.

ii Chemical agents—lead, silica, and asbestos.

iii Unhealthy lifestyles in non-communicable diseases.

iv Deficiency or excess of nutrition/food or calories.

Pathogenicity

Pathogenicity of an agent is its ability to produce disease which can be measured by the ratio of number of persons developing clinical illness to the numbers exposed to infection.

Virulence

It is a measure of severity of disease, which can vary from high to low. A severe disease causes high mortality.

Infectivity

Infectivity is the ability of an organism to invade and produce infection in the host.

(B) TRANSMISSION PROCESS

This is the second important link in the chain of infection.

Transmission is defined as "spread of infectious agent through the environment, to another person, or from the reservoir and source".

Modes of Transmission

There are two major modes of transmission of an infectious agent:

1 Direct
2 Indirect

Direct Mode of Transmission

Here the method of transmission involves intimate or close contact between the infected person or reservoir of infection with susceptible host. Direct transmission occurs by:

- Touching infected objects and then touching eyes, nose and mouth.
- Kissing
- Sexual intercourse
- Childbirth
- Breastfeeding
- Airborne, short distance via droplets (by coughing, laughing, sneezing, spitting).
- Transfusion of blood and by unsafe injection
- Transplacental from mother to foetus
- Bite by rabid animal
- Organ transplantation
- Soil transmission (hookworm)

Indirect Mode of Transmission

- Vehicle-borne transmission (by contaminated food, water, and blood).
- Vector-borne transmission
- Airborne transmission
- Fomite transmission
- Unclean hands

Direct Transmission

Here the method of transmission involves direct and intimate contact or close contact between the infected person or reservoir of infection with the healthy susceptible person. The infectious organisms get transferred from an infected person to the healthy person. Best example of contact transmission is by sexual intercourse, when a healthy person with a high-risk behaviour indulges into unsafe sex with multiple sexual partners or with commercial sex workers, who may harbour HIV infection, may acquire HIV infection. Healthy persons get HIV infection from HIV-infected persons like commercial sex workers or other persons known to have HIV infection. In an infected individual, the HIV is present in body fluids and secretions including semen and vaginal secretions. The HIV infection gets transmitted from men to women, women to men and men to men by unprotected sexual intercourse (heterosexual and homosexual). Over 85.8% of HIV transmission is through unprotected sexual intercourse. People infected with HIV are both infected and infectious for life. Thus, HIV infection in nature is being maintained in human population by direct transmission of virus from person to person. The virus is fragile and cannot survive outside human body for long (Table 7.1).

Table 7.1: Diseases and sources of infections

Disease	*Source*
HIV/AIDS	Blood, semen, vaginal fluids and breast milk
Cholera and hepatitis A and E	Contaminated water and food
Tuberculosis	Sputum
Food poisoning	Contaminated food

All sexually transmitted infections (STIs) like syphilis, gonorrhoea, trichomonal infections, human papillomavirus are transmitted by unprotected sexual intercourse. Other example of close contact transmission are Covid-19, influenza, SARS, tuberculosis.

Implications

The implication of sexual transmission involves modification of risky sexual behaviour of young people, which is an uphill task. Adolescents and young people account for 20% of all new HIV infections and hence changing their sexual behaviour is a significant strategy in control programme of HIV epidemic, unless that happens the epidemic will continue to spread. HIV/AIDS has no cure.

Nosocomial Transmission (Hospital Acquired Infections)

It is cross infection acquired in a hospital. Infections are considered nosocomial if they appear 48 hours or more after hospital admission or within 30 days of discharge. This could be due to lack of practice of universal precautions by providers of health services.

Transfusion of Blood—Transfusion Transmissible Infections (TTI)

HIV and AIDS can also be transmitted through unsafe blood transfusion. Other diseases, which can be transmitted by unsafe blood transfusion include malaria, hepatitis B, hepatitis C, syphilis and HIV.

Screen all the blood collected in the blood bank before transfusion and discard those, which are positive for HIV, hepatitis B, hepatitis C, syphilis and malaria.

Transplacental (Vertical) Transmission

HIV can also be transmitted from HIV positive pregnant mother to foetus through placenta before birth and during the birth through vaginal secretions and through breast milk after the birth of child.

Risk of mother to child transmission (MTCT) can be controlled by multidrug ARV prophylaxis to HIV positive pregnant women for lifelong period and nevirapine to newborn daily for six weeks. Breastfeeding to baby is not indicated if mother is HIV positive.[4] Syphilis and toxoplasmosis can also be transmitted through placenta.

Transmission in Tuberculosis (Airborne Transmission)

TB like common cold is an airborne infection. TB spreads through air from one person to another when a person with tuberculosis of lung (open case) coughs, sneezes, talks or even sings or laughs, the bacteria are sprayed out into the air as infectious droplets. These droplets dry up rapidly and the smallest of them remain suspended in the air for several hours. People nearby (as household or family contacts) may inhale these bacteria and become infected. Exposure to an infectious case of TB is a prerequisite for acquiring TB infection. If there is an open case in the family and he indiscriminately coughs, he can infect others in the family and most susceptibles are **young children** and other contacts in the family. Thus, tuberculosis spreads through close contacts as also the infection can spread to long distances. Droplet nuclei disperse rapidly throughout the air in a room and can be carried wherever air currents take them.

Implications

Preventing infectious cases from producing droplets by covering mouth and nose during coughing is very effective method of reducing the probability of transmission. Collection of sputum and its safe disposal prevents spread of tuberculosis. Person should spit in sputum cups, which can be burnt in a pit at a safe distance from home.

There is no need of isolation of a case of tuberculosis. Similarly, opening windows during and after cough inducing procedures or in hospital wards is one of the most efficient means of reducing probability of exposed persons becoming infected.

Every sputum positive patient can infect 10–15 individuals in a year, if left untreated; hence early treatment and regular treatment with DOTS strategy makes 80% of persons non-infectious within two months of treatment, thus it reduces the pool of infectious cases in the population.[5]

High density of population and overcrowding in urban slums increases the chances of spread of tuberculosis. These populations are risk population for tuberculosis apart from many other respiratory diseases.

Similarly, scabies spreads from person to person contacts and rabies by rabid animal bite.

Indirect Transmission

Vehicle-borne Transmission

Drinking unsafe water contaminated with human and animal excreta, by agricultural and industrial activities are common features in India and other developing countries. Polluted and contaminated water becomes major source of disease transmission in urban and rural areas. Human beings are the biggest polluters of water supplies and sources of water. Human beings and animals can act as hosts to bacterial, viral or protozoal organisms that cause many diseases. Indiscriminate defecation is quite common. The city of New Delhi alone dumps 200 million litres of raw sewage and 20 million litres of industrial wastes into Yamuna River everyday as the river passes through the city on its way to the Ganges.

Worldwide 2.3 billion people suffer from diseases that are linked to polluted water problems. Water-related and waterborne diseases kill millions of people each year. Nearly half of the urban residents in Asia suffer from one or more of the main diseases associated with inadequate provision of water and sanitation. Problem of sanitation is acute in rural areas and waterborne diseases include diarrhoeal diseases, cholera, typhoid, dysentery, hepatitis A and E and polio. Diarrhoeal diseases are the major water-borne malady responsible for 90% of the health problems related to water supply and sanitation. An estimated 4 billion cases of diarrhoeal diseases occur every year, causing 3 to 4 million deaths, mostly among children. Other diseases like cholera and hepatitis A and E may occur in epidemics and become endemic when there is poor food hygiene, lack of sanitation or unsafe drinking water. Contaminated food can produce food poisoning and many other diseases.

Implications

The implications of vehicle transmission (transmission through contaminated water and food) are quite serious. The challenge is to provide safe water, free from germs with safe levels of fluorides, heavy metals and other contaminants, to people. "Safe water for all" is the biggest challenge. Every year in India, many areas report occurrence of outbreaks of hepatitis E, A and cholera as also diarrhoeal diseases apart from food poisoning. These occurrences indicate regular and continuous contamination of water supplies.

The problem of safe disposal of human excreta is quite acute. There are no easy solutions because of rising population.

One observes defecation grounds everywhere and anywhere leading to widespread soil pollution and water pollution. Treatment and safe disposal of sewage is complex and costs lot of money and unsafe disposal to watercourses, rivers, or canals or to fields poses problem of water pollution and soil pollution. Faecal matter comes back to us through water and vegetables. Hence, vehicle transmission in epidemiology is a substantial challenge.

Vector-borne Transmission

Diseases, which are spread by insects, are called vector transmission or vector-borne diseases (Table 7.2).

The disease-producing organisms live, multiply, develop and complete the part of their life cycle in a vector. The **infected vector** spreads these organisms to human beings by injecting these to human circulation.

Table 7.2: Important vectors in India

Infected of vector	*Disease transmitted*
Anopheline mosquitoes	Malaria
Aedes aegypti	Dengue haemorrhagic fever and dengue shock syndrome, zika virus and yellow fever (not present in India)
Culex vishnui	Japanese encephalitis
Culex quinquefasciatus	Filaria (Bancroftian)
Sandfly	Kala-azar (Leishmaniasis)
Rat flea (*Xenopsylla* genus)	Bubonic plague
Body louse	Typhus fever

A disease-producing organism may simply multiply in the vector such as dengue virus multiplies in *Aedes aegypti* mosquitoes and *Pasteurella pestis* multiplies in rat flea and these vectors spread these organisms to healthy human beings. This is called *propagative transmission*.

A disease producing organism such as microfilaria undergoes development in the body of *Culex* mosquito but does not multiply in vector. Such a spread is known as *cyclo-developmental transmission*.

A disease producing organism like malaria parasite undergoes development as well as multiplication in the body of Anopheles mosquito and mosquitoes spread the disease from one person to another. We call this transmission as *cyclo-propagative transmission*.

Vector-borne diseases like malaria, filaria, kala-azar, Japanese encephalitis, dengue haemorrhagic fever (DHF), and dengue shock syndrome (DSS) and chikungunya are examples of vector-borne or vector-transmitted diseases. These diseases are significant problems in India and pose constant threat of epidemics and outbreaks leading to high mortality and economic loss. Malaria and filaria are endemic in India.

Houseflies transmit diseases by *mechanically* transporting infected organisms from faecal matter to uncovered food and eatables.

Implications

Vector-borne disease transmission in India is quite rampant. Vector-borne diseases like malaria and filaria are major public health problems in the country. Malaria is endemic in the country and 1.13 million cases were reported in the year 2015. Of these, 0.75 million were due to *Plasmodium falciparum* (Pf). Outbreaks of malaria have come to surface every now and then. In view of significant problem of vector-borne diseases, national vector-borne disease control programme (NVBDCP) has been launched in the year 2003–04 by convergence of ongoing programmes of national anti-malaria programme, filaria, Japanese encephalitis (JE), kala-azar, dengue and dengue haemorrhagic fever (DHF) and chikungunya.

Vector control is the major strategy in all the above mentioned vector-borne diseases. Anti-vector measures include source reduction, i.e. controlling breeding places, anti-larval measures and anti-adult measures besides personal protection measures like use of impregnated bed nets. Integrated vector control measures involve biological control measures as well; which are environment-friendly. The major challenge to control vectors of diseases is to *control the environments*, i.e. waste water management in urban and rural area. Insecticides as weapon against malaria vectors have become blunt due to development of **resistance**. Anti-larval measures are extremely costlier and labour intensive.

Airborne Transmission

Tuberculosis spreads through fine droplets in those persons who are close by to a case of tuberculosis if the open case does not observe precautions. However, tuberculosis is not as easily transmitted as certain other air-borne infectious diseases like Covid-19 and influenza. Most TB infections are acquired by continued exposure rather than casual contact, because respiratory defence mechanisms can kill small number of mycobacteria.

TB bacilli can remain viable in wet sputum for months and in dried sputum for weeks. Fine droplets containing viable TB germs can reach through air far away from index case to distant place and affect the people who are not close to the index case. Therefore, it becomes imperative that indiscriminate spitting by open cases should be controlled and sputum disposal should be appropriate and most important is to put the persons on treatment and make them non-infectious to reduce the pool of infection in the community.

Influenza is another example of airborne transmission.

Parenteral (Blood Borne) Transmission

Parenteral transmission occurs by use of common needles and syringes or sharing of needle and syringe amongst **injecting drug-users.** This is the common mode of spread of HIV in some of the North-Eastern states of India. Overall 1.7% of HIV infections are transmitted by this way. Apart from HIV, many other dreaded diseases like hepatitis B and hepatitis C are also transmitted by unsafe injections and unsafe blood.

Implications

The implications of such a transmission are to control the drug menace, change the behaviour and provide safe needles and syringe services and safe blood.

Fomite Transmission

Fomite transmission means transmission of CCDs through contaminated articles—instruments, linen, dressings, beddings, soiled clothes, handkerchiefs, toys, books, currency notes and utensils. “Contamination” means the

presence of infectious agent or matter on human body/animal body or surface. To prevent fomite transmission it is essential to use sterile linen and instruments and disinfect the contaminated articles and observe personal hygiene above all.

Hands (Hand Hygiene)

Unclean hands or soiled hands often transmit faeco-oral diseases. Children quite often put their soiled and dirty hands, fingers in their mouth and similarly if adults do not wash their hands after defecation, they are liable to eat with dirty hands and thus ingest dangerous germs and get diseases—most often diarrhoea and worm infestation. Handwashing also reduces the risk of transmission of Swine flu and influenza besides Middle East Respiratory Syndrome, and Covid-19. "Namaste" is much better than "Handshake" and well accepted in Indian culture.

Implications

Handwashing practice should become universal in children and adults before eating and after defecation. Handwashing itself reduces incidence of diarrhoeal diseases by about one-third. World Handwashing day is celebrated every year on 15th of October.

(B) HOST IN CHAIN OF INFECTION (🧍) (HOST FACTORS)

The host is the third link in the chain of transmission. Host is a person or animal that provides a suitable place for an infectious agent to grow and multiply under natural conditions.

Reservoir and Source of Infection in CCD

The reservoir in CCD is a **person** or an **animal** or an insect, plant, soil or substance who harbours the infectious organism of a CCD and acts as a source of infection in the community.[6–8] The disease producing organism lives, multiplies, develops and depends primarily for its survival in the reservoir. The person who harbours disease-producing organism is called **host**. The reservoir acts as natural habitat of the organism. The natural habitat of an infectious agent is called its "reservoir" and it may be **humans, animals** and **environments** (one health-approach).

The "reservoir" is defined as "man, animals, arthropods, plants, soil or inanimate organic matter/substance (or combination of these) in which the infectious agent lives and multiplies, and depends for its survival, reproduces itself in such a manner that it can be transmitted to susceptible host". Man himself is the most frequent reservoir of infectious agents pathogenic for man.

"Source" of infection is the person (living) or object (non-living) from which the host acquires the agent.

or

"Source of infection: The thing, person, object or substance from which an infectious agent passes immediately to a host."

Knowledge of both the reservoir and source is necessary for control measures.

Common reservoirs and sources of infection, some examples:

Disease	*Reservoir*	*Source*
Covid-19	Man	Respiratory droplets and droplet nuclei
Tuberculosis	Man	Sputum
HIV/AIDS	Man	Body fluids and secretions
Malaria	Man and mosquito	Infected mosquito
Rabies	Dog and other animals	Saliva
Measles	Man	Droplets
JE	Pig and birds	Infected mosquitoes
Cholera	Man	Unsafe water and food
Plague	Rodents	Infected flea
Typhoid	Man	Unsafe water and food
Tetanus	Soil	Soil

Significance

If we know the reservoir and source of infection, the chain of infection can be broken and CCD can be effectively controlled. Where man is the reservoir of infection of CCD the attempt is made to treat man to eliminate the infectious organisms or reduce their population to such a low level where they cannot produce disease.

Example: In tuberculosis we treat the reservoir (men/women suffering from tuberculosis) by chemotherapy or DOTS to render the reservoir non-infectious.

Treating malaria in man means controlling infection in the reservoir to make man non-infectious.

If the reservoir and source of infection is an animal or an insect, attempt is made to kill insects with insecticide or not to allow breeding of mosquitoes (source reduction) and control the animals population by various methods (e.g. sterilization of dogs, or vaccination of dogs against rabies or licensing of dogs, and killing of rodents).

Where the source of infection is inanimate reservoir like contaminated water, we treat the water by boiling or by chlorination to destroy the disease-producing organisms in order to prevent the water-borne diseases. Safe water supply to community means prevention of many water-borne diseases.

Host factors are important in distribution and determinants of communicable disease and NCDs. Host factors include age, sex, marital status, nutritional and immunization status, apart from literacy, occupation and past experience or exposure with infection and risk behaviour and life style. The occurrence and distribution of CCD vary in persons. All are not at equal risk. This can be better understood by some examples. Who is at

risk of contracting HIV and tuberculosis? The answers are as follows:

Age and Sex

Young people are disproportionately affected by HIV and AIDS. Around 20% of all new HIV infections are in young people aged 15–24 years, the range in which most people start their sexual life.

High-risk Groups

For HIV and AIDS, high-risk groups are injecting drug-users (IDUs), commercial sex workers and persons who receive repeated blood transfusion, persons having tuberculosis and persons having sexually transmitted diseases and men having sex with men.

Implication

Targeted interventions are focused on high-risk groups under the National AIDS Control Programme.

Presence of STD

There is strong evidence that men and women with genital ulcer disease or urethral discharge are at increased risk of acquiring and transmitting HIV. High prevalence of STD means high prevalence of unprotected sexual intercourse.

Behaviour of Host

Pre-marital sex, extramarital sex and having multiple sexual partners are risk factors in HIV and AIDS. Cultural and behaviour pattern of host-like men having sex with men also contributes to HIV transmission.

Immunity and Nutritional Status

HIV destroys the immune system. There is no immunity against HIV infection. Host immunity is a mechanism, which protects it from diseases.

Immunity is acquired by having natural infection, e.g. an attack of measles confers lifelong immunity provided the child survives after an attack of measles. Similarly, immunity can be acquired by having measles immunization at the age of 9 months, and at 16 months of age. It provides sufficient immunity against measles. Improved nutritional status also builds to fight infection in a better way. Therefore, unimmunized children are susceptible hosts for occurrence of communicable diseases.

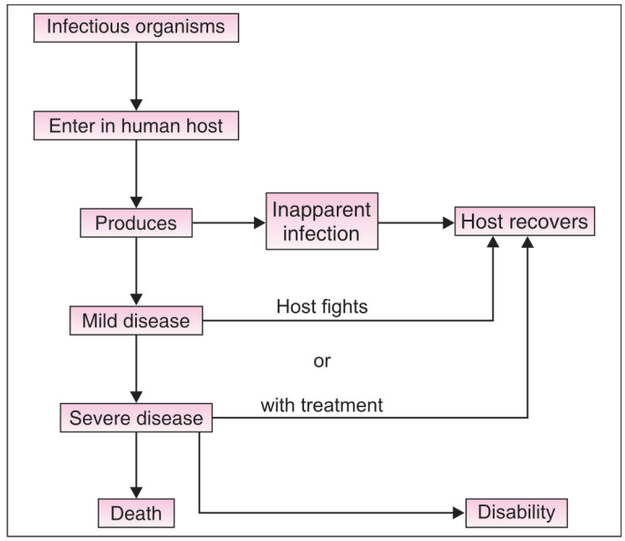
Mechanism of Entry of Infectious Organism in Host

- The infectious organism can enter in the body of host through intact skin and mucous membrane. Hookworm larvae can penetrate intact skin. Rabies virus can enter the body through wound and intact mucous membrane.
- Through oral cavity and gastrointestinal tract, contaminated water and food having infectious organisms enter through mouth and gastrointestinal tract.
- Through respiratory system: *Mycobacterium tuberculosis* enters through respiratory system.
- By insect bite, the disease producing organisms can be injected to bloodstream.
- Parenteral transmission occurs by use of unsafe needles and syringes as also through unsafe blood transfusion and through needle stick injury. Thus, the disease-producing organisms enter human host through several routes specific to each disease.

Host Reactions

Once the infectious organisms enter human host, the host reacts and host defence system comes into action. There are following possibilities (Flowchart 7.1).

Flowchart 7.1: Host reactions



Infection

The infection is not equivalent to disease. Infection means the entry, development or multiplication of an infectious agent in the body of man or animal that may constitute a public health risk. Infection is not synonymous with disease as explained below.

TB Infection

Once a person breathes in, the air that contains droplets contaminated with TB bacilli, most of the larger droplets settle in the nose or throat where they are unlikely to establish infection. However, fine droplets containing as few as 1–3 TB bacilli may reach the alveoli. Within alveoli, the bacilli are ingested by alveolar macrophages and other phagocytes. Live virulent bacilli multiply within macrophages, which get destroyed in the process. The bacilli are subsequently ingested by other tissue

macrophages. Bacterial multiplication cannot be stopped within those non-activated macrophages. Within 2–4 weeks after infection, the host mounts a specific cell-mediated immunity that will arrest TB infection in more than 90% of infected individuals.

TB infection means that tubercle bacilli are viable within the body but are not multiplying and causing disease due to body immune system. People who have TB infection but not TB disease are not infectious; in other words, they cannot spread the infection to others. They look and feel quite healthy persons. Infection in a person can be detected by tuberculin test. Prevalence of TB infection in India is about 40%.

TB Disease

Only 10% of TB infected persons have the chances of developing disease in their lifetime; however, if HIV infection occurs to infected people, it enhances the risk of lifetime occurrence of disease to 60%. HIV and TB infection is a deadly combination.

In tuberculosis disease, a person develops pulmonary tuberculosis or brain tuberculosis, bone tuberculosis or tuberculosis of any other organ. The course of disease depends upon treatment and intervention. The severity of disease will depend upon host factors and agent factors.

Carriers

In some situations, the inapparent infection in host leads to carrier state. Carriers are infected persons who are apparently healthy persons, do not shows any clinical signs and symptoms of disease but harbour disease producing organisms and continue to discharge the organisms from their body. Various types of carriers have been described.

Incubatory, Convalescent, and Chronic Carriers

Incubatory carriers are those who shed the disease-producing organisms during the incubation period of disease, convalescent carriers are those who continue to shed the organisms during the recovery stage of the disease.

In some diseases like typhoid fever, the carrier state may persist for a very long time and such persons are called chronic carriers. Chronic carrier state persists in hepatitis B and C.

(C) ENVIRONMENTS IN CHAIN OF INFECTION (Δ)

Climate change and Environment is critical link in disease transmission and occurrence of epidemic/pandemic.

Environments (Δ) (Environmental Factors)

It is an aggregate of all the external conditions and factors, which affect the life and development of an organism. Environmental degradation is leading to development of many of the diseases. Protection and promotion of healthy environments is a global concern in "one health approach".

Environment is getting worse because of rapid population growth, and increased pressure on natural resources; threatening public health and development. The most important concern is water shortages, soil exhaustion, loss of forest leading to air and water pollution, besides soil pollution and degradation of coast lines. As the population grows, improving living standards without destroying the environments is a global concern. The environments can be categorized into *physical* environments (water, air, temperature, humidity, radiation, etc.), *biological* environments (all living organisms, plants and animals), *chemical* environments (agriculture and industrial chemicals) and *social* environments (men around men).

Environments are the major *determinant of health* and *disease* in the chain of infection. The environment affect the life and development of infectious organisms or agents of disease, it influences the transmission process and also affects the host. Environments form the *fulcrum* in chain of infection. Environments can tilt the pendulum of chain of infection to favourable or unfavourable side. Over 60–80% of infectious diseases are related to bad physical environments like contaminated water supplies, poor drainage system, widespread filth and insanitary conditions and indiscriminate defecation. This leads to faeco-oral transmission of diseases in epidemic form and many diseases get rooted as endemic diseases. Soil pollution has led to soil transmitted helminthic diseases apart from killer diarrhoeal diseases in children.

Implications

The challenge is to provide safe drinking water, safe disposal of human, and animal excreta, source reduction or control of breeding of insects or vectors of disease transmission. In summary, protection of environments and population control is a global emergency. In controlling communicable diseases treating environments becomes a necessity in addition to treatment of sick people. Hospitals treat **patients** while an **epidemiologist treats** both environments and patients and biggest concern is to keep the **people, animals and environment healthy-free from disease**.

LEVELS OF DISEASE OCCURRENCE

1. Sporadic

Sporadic occurrence refers to a disease that occurs infrequently and irregularly.

2. Endemic

It means stable pattern of occurrence of a disease in a given population. It refers to constant presence and/or **usual prevalence** of a **disease** or **infectious** agent in a population within a geographical area. It signifies that factors and conditions for survival of infectious agent of that disease are always favourable in that community and regular transmission goes on with some seasonal variation. The prevalence and incidence is maintained at expected level.

Examples: Malaria and tuberculosis are endemic in India and similarly leprosy and filaria are also endemic.

3. Hyper-endemic

Refers to persistent high level of disease occurrence.

Level of Endemicity

The level of endemicity of a disease is not uniform in all the geographical areas, some geographical areas show high level of endemicity or prevalence while other areas may show low level of endemicity. For example, Haryana is low endemic area for leprosy. Some other states like Chhattisgarh, Odisha, Uttar Pradesh, Bihar, Maharashtra have very high prevalence rates, while the states like West Bengal, Andhra Pradesh have high prevalence rates of leprosy. Level of endemicity can be determined on the basis of prevalence rate or incidence rates (for cholera, malaria and diarrhoeal diseases, etc.). When conditions become favourable or if the number of susceptible persons in the population increase or in conditions like heavy rains, floods and other natural disasters the **endemic disease becomes epidemic** in endemic areas. Outbreaks of cholera, diarrhoea and malaria are quite common in India.

4. Epidemic of CCD

An *epidemic* or outbreak is the occurrence in a community of illnesses of similar nature, clearly in excess of normal expectancy and derived from a common or propagated source.

While an *outbreak* is usually limited to a small focal area, an epidemic covers large geographical area and has more than one focal point.

There is yet another definition of an *outbreak*—"Occurrence of two or more epidemiologically linked cases (occurrence at the same time and same location as other confirmed cases) of a disease of outbreak potential (e.g. measles, cholera, dengue, JE, AFP and plague)".

The number of cases indicating presence of an *epidemic* varies according to the infectious agent, size and type of population exposed, previous experience or lack of exposure to the disease, and time and place of occurrence. Epidemicity is thus relative to usual frequency of the disease in the same area, among the specified population, at the same season of the year.

A single case of wild poliovirus is an epidemic or outbreak, because of its significance and rapid spread and many inapparent infections in the community. If an unknown disease or disease which is absent from an area for quite long time is introduced, even a single case of that disease will constitute an *epidemic* occurrence.

Example: HIV epidemic, hepatitis E and A epidemic and JE epidemic.

Epidemic Patterns of CCD

Point common source epidemic

In a point source epidemic, the susceptible individuals are exposed more or less simultaneously to one source of infection. This results in very rapid increase in the number of cases often in a few days/hours. The cholera outbreak is an example of point source epidemic. Similarly, hepatitis E and A are point source outbreaks. If the population is exposed over a relatively brief period, so that everyone who becomes ill does so within one incubation period. The resulting **graph** or **epidemic curve** has a steep rise and gradual decline.

In some common source outbreaks, cases may have been exposed over a period of days, weeks and longer. In a continuous common source outbreak, the range of exposure and range of incubation period tends to flatten and widen the peaks of epidemic curve. The epidemic curve provides vital clues of an outbreak.

Interpreting an epidemic curve (Fig. 7.2A to C)

Shape: An epidemic curve that has a steep rise and a more gradual decline is characteristic of a **point source epidemic** in which persons are exposed to the same source over a relative brief period. In point source epidemic, all the cases occur within one incubation period. If the duration of exposure is prolonged, the epidemic is called a **continuous common source epidemic** and epidemic curve has a plateu instead of a peak.

- An intermittent common-source epidemic (in which exposure to the causative agent is sporadic over time) usually produces an irregularly jagged epidemic curve reflecting the intermittence and duration of exposure and the number of persons exposed.
- **In theory a propagated epidemic**—one spread from person to person with increasing number of cases in each generation–should have a series of progressively taller peaks one incubation period apart, but in reality few produce this classic pattern. One can deduce likely period of exposure from the epidemic curve.

Contagious Epidemic (Propagated Outbreak)

In this epidemic or outbreak, the disease is passed or propogated from one person to other person and the initial rise in the number of cases is slower. The examples are measles mumps, influenza, SARS, and Covid-19. These infections occur in epidemic/pandemic form. Transmission occurs from human to human by droplets/aerosoles easily. Outbreaks, epidemic or pandemic occur in waves till all or most of susceptible persons are affected leading to herd immunity. Measles outbreaks are commonly observed in children who have not been immunized against measles. In the urban slum areas having dense population, the children are exposed to more risk of outbreak of measles if they are leftover for measles immunization. In propagated outbreaks, increasing number of cases in each generation—should have a series of progressively taller peaks or waves, one incubation apart (10–14 days apart) see Fig. 7.2C.

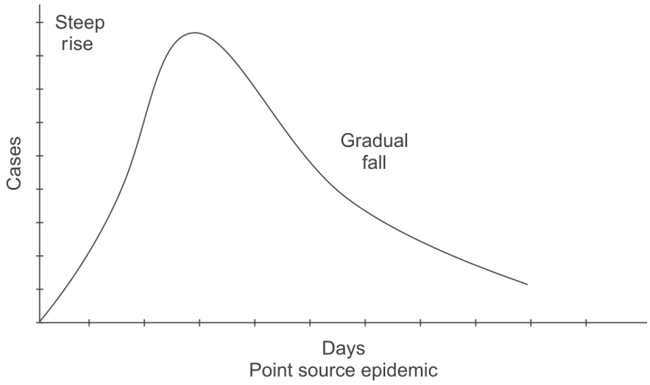


Fig. 7.2A

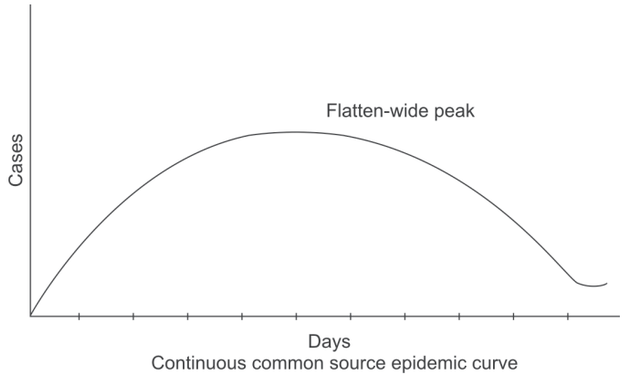


Fig. 7.2B

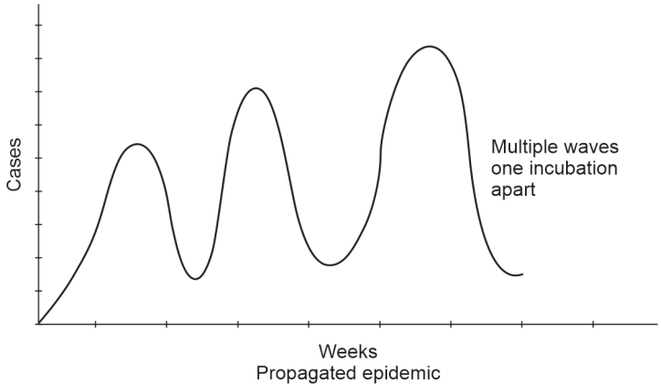


Fig. 7.2C

Vector-borne Epidemics/Outbreaks

JE produces sporadic cases, one or two cases in a village but these are widespread while DHF and DSS outbreaks produce many cases and affect all persons.

Outbreaks of vector-borne diseases may result from sufficient presence of vectors, sufficient prevalence of infection and human vector interaction.

5. Pandemic

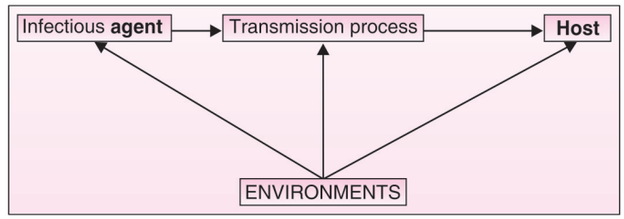
When the epidemic occurs in more than one country or widely spread over the globe it is called pandemic. HIV/AIDS and Covid-19 are global in distribution and several countries of the world are in grip of these epidemics. Over seven pandemics of cholera have been witnessed in the world. Influenza spreads like wild fire and it sweeps over different countries very rapidly. Pandemics have been correlated with rapid movements of persons from one country to another by air, sea and land routes. Recently, Covid-19 and SARS pandemic affected in several countries and bird flu pandemic is yet another example besides swine flu pandemic and ebola pandemic.

Competency addressed: The student should be able to:
CM 7.2: Enumerate, describe and discuss measures for prevention and control of communicable diseases.

PREVENTION AND CONTROL OF COMMUNICABLE DISEASES (CCDs)[8]

Knowledge of the chain of infection helps us to control communicable diseases.

The control of CCD has received priority attention right from independence. Vaccines and effective antibiotics for prevention of CCD were the major factors responsible for steep decline in crude death rates. However, morbidity due to CCD continues to be high. Deteriorating urban sanitation, poor liquid and solid waste management and overcrowding have contributed to increasing incidence of CCD. Emerging antibiotic resistance is a serious problem.



Epidemiological triad (triangle)

Control of Infectious Agents in the Environments

The infectious agent of a disease after exit from host lives, multiplies and develops in environments and gets transmitted through the environment readily to human host. Therefore, control of the infectious organism at source is an important strategy. This means *treating* the *environments* (water and excreta).

1. Controlling Sources of Infection—Health Promotion

i Supply of safe drinking water by treatment and chlorination of water, and pasteurization of milk.
ii Safe disposal of human excreta and animal excreta by sewerage system, sanitary latrines, compost pits/manure pits and sewage treatment.
iii Integrated control of vectors of diseases—by source reduction and anti-larval and anti-adult measures.
iv Animals—vaccinate dogs against rabies and animal birth control—healthy animals.
v Rodent control measures—trapping and killing.
vi Hospital waste management.
vii *Disinfection:* The killing of infectious agents outside the body by chemical or physical means is known as disinfection. Concurrent disinfection is the application of disinfectant as soon as possible after the discharge of infectious material from the body of an infected person. All soiled articles with secretion, excretions of infectious patient are treated with suitable chemical, e.g. hypochlorite solution 1% or other suitable chemicals: Phenol, cresol, dettol, cetavlon, savlon, alcohol and iodine. Washing with detergents, bleaching powder solution, steaming, sun drying and autoclaving are common methods of disinfection of soiled articles. If one can afford these can be burnt or incinerated as dangerous waste material. Sunlight is natural disinfectant.

2. Immunization Against CCDs—specific Protection

Massive programmes of immunization for vaccine preventable diseases (VPDs) have been launched in the country to control communicable diseases like polio, measles, whooping cough, diphtheria, tetanus neonatorum and tuberculosis. Hepatitis B vaccine has been launched in India. Newer vaccines against other diseases have been launched. The purpose of immunization is to ensure high level of coverage and to prevent outbreaks as also to reduce the incidence of disease and ultimately to eliminate and eradicate the communicable diseases.

3. Control of Infectious Agent in Host—Early Diag and Trt

Reservoir control: To reduce the pool of infected persons and cases of communicable diseases like tuberculosis, leprosy, filaria, malaria, early diagnosis and complete treatment is the strategy under various national programmes of CCDs. Complete and early treatment of disease by standard treatment protocol in man renders the reservoir non-infectious.

4. Practice of Chemoprophylaxis and Chemotherapy

Mass chemoprophylaxis or chemotherapy or campaigns are not related to individual case management. They deal with community to ensure protection of community. These programmes do not require clinical or parasitology investigation. Under various national health programmes mass chemotherapy for filaria, malaria, worm infestation, and isoniazid prophylaxis in HIV is being used. Pre-exposure prophylaxis in HIV is being used by high risk groups (FSWs, MSM, IDU).

Use of isoniazid as prophylaxis: In children under 5 years of who are in contact with sputum positive case, use of chemoprophylaxis is well established. Six months of daily isoniazid alone or 2 months of rifampicin and pyrazinamide are both found to be useful regimens for these children.

5. Education and Behaviour Change

Improving personal hygiene practices like washing hands, physical distancing, eating clean food, drinking clean water, wearing shoes and safe sex will prevent many communicable diseases. Use of impregnated bed nets prevents bite of mosquitoes and prevents vector-borne diseases.

6. Food Safety

Washing hands, cooking thoroughly, keeping food at safe temperature, using safe water and clean utensils and pasteurization of milk.

7. Blood Safety

Screen blood for, HIV, syphilis, hepatitis B, C and malaria parasite before transfusion.

8. Surveillance

Surveillance means detection of cases at the earliest and treat them promptly at home or at the facility (hospital, health centre and sub-centre).

a **Surveillance of CCD:** The purpose of surveillance in CCD *is to collect information on CCDs for action*. National surveillance programme for malaria control, polio-eradication and control of HIV/AIDS has already been mounted in the country. In addition, all institutions in India are required to report cases and deaths of 20 communicable diseases every month to the next higher level. The state bureau of health intelligence/vital statistical units consolidate this information to transmit to Central Bureau of Health Intelligence (CBHI).

Integrated disease surveillance programme (IDSP) for communicable and non-communicable diseases has been initiated in the year 2004 to predict and control outbreaks/epidemics.

The basic purpose of surveillance at local level is to initiate prompt action to control outbreaks of diseases

and prevent occurrence of epidemics. Epidemiological unit at the level of district plays pivotal role to build local support to all Peripheral Units (PHC and CHCs). Routine reporting system at village, sub-centre and PHC level is critical for early detection of outbreaks and action at local level by rapid response teams.

b Entomological surveillance and vector control measures.

c Environmental surveillance: Isolation of polio-viruses form sewage samples, air samples, water samples, etc. for air and water pollution respectively.

9. Environmental Modification and Manipulation

10. Notification of Diseases

When reporting is required by law, the diseases or conditions to be reported are known as *notifiable* diseases. Cases and deaths of 20 communicable diseases in India are reported every month by all health facilities. It helps to control the spread of diseases. Cholera, yellow fever and plague are internationally notifiable diseases, besides other public health emergencies of international concern. TB is also notifiable disease. Involve private health sector for notification and standard treatment protocols.

11. Quarantine

a *Complete quarantine:* Quarantine means limitation of freedom of movement of such well persons or domestic animals, who have been exposed to communicable disease, for a period of time equal to the longest usual incubation period of the disease, in such a manner as to prevent effective contact with those not so exposed.

b *Modified quarantine:* It is a selective, partial limitation of freedom of movement of persons or domestic animals. Examples are exclusion of children from school, restriction of military population to the post or to quarters.

c *Isolation:* Practice of isolation applies to *cases* of communicable diseases. "Isolation" means separation for the period of communicability of infected persons from other persons, in such places and under such conditions as will prevent the direct or indirect conveyance of the infectious agent from infected persons to persons who are susceptible or who may spread the agent to others. This also applies to animals, affected baggage, containers, goods, etc. Isolation of patients has but a little effect in limiting the spread of many diseases for instance poliomyelitis, and tuberculosis. Practice of isolation is limited. Some states have infectious disease hospitals and others practice isolation in segregated rooms.

12. Community Involvement and Participation for Controlling Vectors, Sanitation and Safe Water

13. Control of Outbreaks of CCD (Emergency Epidemiology/Public Health Emergency)

Communicable diseases like malaria, JE, DHF and DSS, hepatitis E and A, hepatitis B and diarrhoeal diseases quite often occur in epidemic proportion. Many local and focal outbreaks are being reported quite frequently; hence, control of outbreaks of these diseases is an essential requirement. Local capacity should be built in for rapid response and recognition of outbreaks. Standard protocols have been evolved for control of outbreaks and general guidelines issued by NICD should be followed.

14. Other Measures

Legislation: Epidemic disease Act of 1897, and notification helps control of CCD. The 125 year old Act of 1897 is being replaced by Public Health Act of 2022 (prevention, control and management of epidemics, bioterrorism and Disaster Management for adequate response to public health emergencies—epidemics and pandemics.

Observe international health regulations (IHRs): Observe international regulations on notification, immunization and quarantine measures. Internationally notifiable disease, include cholera, plague and yellow fever besides notification of an event/events that may constitute a public health emergency of international concern (WHO, 2005). All nations are required to report these diseases to WHO regularly. The diseases like louse-borne typhus fever, relapsing fever, paralytic polio, malaria and viral influenza are under WHO surveillance. IHR have been revised in 2005 and the scope has been enlarged to cover public health emergencies to ensure **Global health Safety**.

15. Observing universal practices and precautions

Prevents occurrence and spread of CCD

- Train and employ more epidemiologists and public health experts.
- Strengthen health systems.

Competency addressed: The student should be able to:
CM 7.2: Describe and discuss measures for prevention and control of non-communicable diseases.

EPIDEMIOLOGY OF NON-COMMUNICABLE DISEASES (NCDs)

As a result of ongoing epidemiological, demographic and lifestyles transition in the country, NCDs have emerged as major cause of morbidity and mortality. NCDs have emerged in epidemic proportion globally.

Non-communicable diseases cover wide range of heterogeneous conditions affecting different organs and systems of different age and socio-economic groups. Over the last two decades, Disease burden (morbidity and mortality) due to cardiovascular diseases, obesity, diabetes

and hypertension, mental disorders, cancer and trauma have been rising due to following factors.

1 Rise in life expectancy and increasing number of senior citizens.
2 *Changing lifestyles:* Faulty diet, use of alcohol, sedentary life—physical inactivity and rising stress-leading to obesity and stress-related problems.
3 Use of tobacco.
4 Exposure to environmental risk factors—air pollution.
5 Increasing population of vehicles, automobiles and trauma incidence.

MULTIFACTORIAL ORIGIN

Causes of NCDs are multifactorial. Range of lifestyles: Risk taking behaviour, changing dietary pattern, physical inactivity, use of alcohol and tobacco and stress in life have been incriminated.

Data from NSSO, 52nd round showed that tobacco use (smoking and smokeless-tobacco) and alcohol use are higher in the poorest 20% of income quintile and hence, the prevalence of tobacco-related non-communicable diseases is likely to be high in this income group.

Prevention and Control of NCDs

In view of the chronic morbidity and high cost involved in the management of non-communicable diseases attention need to be focussed on Primordial and primary prevention to develop "Healthy lifestyles right from childhood" besides early detection by community based screening and appropriate management. Further, these diseases cause lot of disability and dependency and disease burden[9] (*see* Chapter 8 for details).

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MEASURING DISEASE AND DEATH FREQUENCY

Epidemiology measures occurrence of disease, death, disability and health status in the community with a view to control the disease/diseases and to eliminate and eradicate disease from the globe or a defined territory.

Objectives of Health and Disease Measurement

The objectives are:

1 To determine disease burden in community (incidence and prevalence) and measure trends.
2 To measure the health status of community.
3 To plan, implement and monitor the programme (allocation of funds).
4 To evaluate the intervention or programme we use incidence and prevalence of disease.
5 To know the changing pattern of diseases.

Competency addressed: The student should be able to:
CM 7.4: Define, calculate and interpret morbidity indicators based on given set of data.

Learning objective: The objective of this skill is to assess the disease burden in community in a defined geographical area.

How? Use live data of an annual report of health facility or NSSO, NFHS data or national health programme data to achieve this competency.

MEASUREMENT OF DISEASE OR MORBIDITY BURDEN

The disease definition should be clear. It means one needs to define a case of disease. Operational definition of a case must be worked out. Some of the examples of case definitions have been given under epidemiological surveillance of diseases. The International Classification of Diseases-10th Rev. (ICD-10) and WHO guidelines on definition of diseases is followed to arrive at uniformity and to achieve the purpose of comparison.[1]

Data on morbidity is generated through sub-centres, primary health centres and community health centres. The quality of the data may be poor but it does serve useful purpose at local level. Use these data for 7.4 competency.

Secondary and tertiary level care institutes also generate lot of data on diseases. It should not be mixed with primary healthcare as each has its distinct significance. Private health sector also generate lot of data on disease. Involve them in healthcare system.

However, in India, reliable information on overall morbidity is not available. In the absence of reliable

morbidity and mortality statistics, survey and surveillance data have formed the basis on which policy makers and managers evolved public health programmes and allocated funds. Statistical units involved in morbidity statistics should include:

- Number of sick persons, incidence and prevalence
- Proportion of persons those responded as ailing (PPRA) in a 15 days period in 2017–2018 was 7.5% (8.3% female and 6.7% female)—Source: NSS 75th Round.
- Number of illnesses
- Spells or episodes
- Period of sickness or average duration of sickness per spell of sickness
- Proportion of time lost due to sickness (days, months, etc.).

DEFINING, MEASURING AND INTERPRETING MORBIDITY INDICATORS

Count

Morbidity measure could be simple counts of a disease or diseased persons.

This is the simplest type of measure of disease or sick person just count the number of events or subjects.

Example: Number of patients seen at a facility per week, per month or per year; number of fever cases and malaria positives detected per month by surveillance programme. Simple count helps to know if disease is increasing or falling. This indicates **trends** and helps in forecasting the development of outbreaks. WHO weekly epidemiological report relies on simple count of international notifiable diseases (cholera, yellow fever and plague).[2]

Rate

It is a measure of the frequency with which some event occurs. To determine the rate, we require the information on:

- Occurrence of an *event* or disease (numerator)
- *Population* at *risk* (denominator) to that event or disease
- *Defined area*, where the event occurred
- *Time period* of occurrence of event or disease.

The population at risk means the individuals or people, or group of people who are exposed to the risk of that disease or event. Knowledge of population at risk helps to use this figure as denominator for calculation of rates.

In some diseases, total population is at risk, e.g. malaria, while for maternal deaths only women who become pregnant are at risk of maternal deaths and not the whole population. At risk population for HIV/AIDS is sexually active persons in the age of 15–49. For senile cataract, people above the age group of 50 are at risk. Rate allows epidemiologist to **compare** disease occurrence across different populations and geographical areas.

Ratio

A ratio places in relation two quantities that may be unrelated. It is quotient of two numbers, numerator not necessarily included in the denominator. Examples: Current male female ratio in India 1000:1020, doctor population ratio and waist hip ratio, maternal mortality ratio, intelligence quotient, and urban, rural population ratio, odds ratio and risk ratio (relative risk).

Proportion

It is a special type of ratio expressing a relationship between part and the whole. Here numerator is part of denominator. All proportions are ratios but all ratios are not proportions. Proportion always ranges between 0 and 1.

For example, proportion of a disease to total disease load or proportional mortality ratio due to a disease. The other examples of proportion are one-third of births are low birth weight babies, one-fifth are adolescents.

Percentage

A proportion multiplied by 100, e.g. 22% of births in India are low birth weights. Over 50% of pregnant women are anaemic and 69% of people live in rural areas.

Prevalence

The prevalence means the number of existing cases (new and old both) of a disease in a given population in a geographical area at a specified point or period of time. Prevalence is a static measure taken at point of time.

Factors that influence prevalence: Duration of illness—lifelong chronic illness can accumulate to build up high prevalence, for example, diabetes and hypertension.

Uses

- Prevalence measures disease burden/load in population to assess healthcare needs and helps to justify allocation of resources. Some diseases are highly prevalent in India.
  Malnutrition, tuberculosis, blindness, and endemic goitre are highly prevalent and other noncommunicable diseases like cardiovascular diseases, diabetes and hypertension are showing rising prevalence in India due to unhealthy lifestyles and longer survival.
- Prevalence also helps to identify high-risk population, geographical areas affected most and planning health services.

Incidence

It is the number of new cases, which occur in a given population at a specified point or period of time.

Uses

Incidence measures occurrence of new cases and it is helpful in evaluation of programme as an impact indicator.

The purpose of primary prevention is to reduce incidence of disease.

Incidence is usually calculated for acute disease lasting for a short period, e.g. fever incidence, flu, acute watery diarrhoea, injuries, and death, etc.

DIFFICULTIES IN MEASURING MORBIDITY

The disease or sickness has a period and it runs a variable course, some diseases are subclinical, still others are at early stage and not detectable so easily while some diseases manifest signs and symptoms which are quite obvious and visible. Thus, for a single manifesting case there may be many persons who may have inapparent infection of disease or at sub-clinical stage.

Further one person may have multiple sicknesses (e.g. old people have multitudes of diseases). Some patients have several other diseases apart from the presenting problem. Sickness also occurs in spells and some sicknesses occur again and again, doctors or a facility cures the person, the person returns to the same environments and gets the disease again and again.

In view of demographic and epidemiological transition the disease pattern is changing and the country is facing much more problem of non-communicable diseases and some of the lifestyle diseases already are showing their ugly heads (accidents, cardiovascular diseases, cancers, diabetes and hypertension). Right now, we have the problem of double burden of disease: Communicable diseases, maternal and child health problems besides non-communicable diseases.[3]

$$\text{Prevalence rate} = \frac{\text{Total number of cases of a disease (new and old both) at a specified time}}{\text{Population at risk at the specified time}} \times 100$$

Example

i Total population of India in 2000 at risk = 1000 million

ii Total no. of tuberculosis cases in India in the year 2000 = 14 million or prevalence of tuberculosis was 1.4% (14/1000) × 100 = 1.4%.

iii Prevalence of sputum positive cases 0.4%.

Sputum positive cases = 4.0 million (4/1000) × 100 = 0.4%.

With this level of prevalence, it can be stated that tuberculosis is a major public health problem in India because of high prevalence and high burden of disease. Of all tuberculosis cases nearly one-fourth are infectious cases (prevalence rate of sputum positive cases is around 0.4% in population). Because of heavy burden of tuberculosis, high priority has been accorded to control the disease by DOTS strategy[4] and its elimination by 2030.

$$\text{Prevalence of infection due to tuberculosis} = \frac{\text{No. of persons showing tuberculin positive tests}}{\text{No. of tuberculin tests done}} \times 100$$

$$\text{Example} = \frac{314}{1000} \times 100 = 31.4\%$$

31.4% of persons ≥ 15 year age in India have tuberculous infection. They are infected but not diseased (Fig. 7.3).[5]

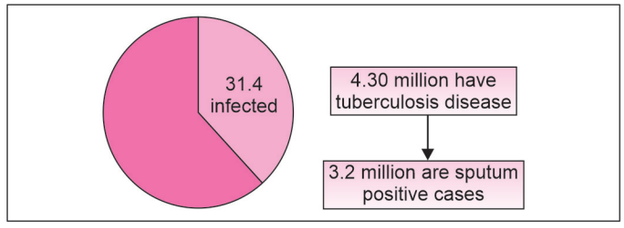


Fig. 7.3: Prevalence of tuberculous infection

Prevalence rate for leprosy[6] in India is 0.66/10,000.

Prevalence of a disease quite often relates to a period prevalence.

Point prevalence means total number of existing cases of a disease (old and new) at one point in time per 100 or per 1000 people at risk at the specified time.

$$\text{Point prevalence} = \frac{\text{Total number of cases of a disease at a point in time}}{\text{Number of people at risk at that point in time}} \times 100$$

Period Prevalence

The period prevalence from 1.1.2004 to 31.12.2004 would be 6 persons (students) which include no. 1, 2, 3, 4, 5 and 6 (Fig. 7.4).

Point Prevalence

Say on 31st Dec 2004, it would be 3 (student no. 1, 2 and 6) as shown in Fig. 7.4.

Incidence

New cases between 1st Jan and 31st Dec 2004 would be 3 (student no. 2, 3 and 6) as shown in Fig. 7.4.

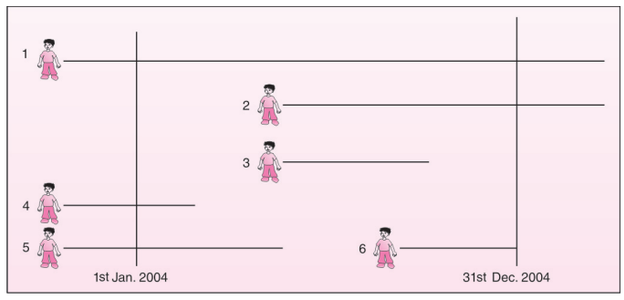


Fig. 7.4: Six students who start their sickness at different points in time

INCIDENCE OF A DISEASE

Definition

Incidence means new cases of a disease that occur in a defined period in population at risk.

$$\text{Incidence} = \frac{\text{Number of new cases of a disease in one year}}{\text{Total population at risk in that year}} \times 100$$

Example

$$\text{Fever incidence} = \frac{\text{100 million fever cases were reported in the year 2000 in India}}{\text{Population at risk was 1000 million in that year}} \times 100$$

$$= 10\% \text{ per annum.}$$

The incidence of fever in community in the year 2000 was 10% per year.

$$\text{Annual parasite incidence (API) of malaria in India in the year 2000} = \frac{\text{2 million cases of malaria in the year 2000 in India}}{\text{Population at risk 1000 million in year 2000}} \times 1000$$

$$= \text{API} = 2$$

The annual parasite incidence for malaria was two in the year 2000 in India. The incidence of malaria can be obtained every fortnight, every month, or every year under the national malaria elimination programme. The data are generated by regular surveillance of fever in the community. The population at risk of fever in this example is the total population of the country (1000 million) in the year 2000 because whole population was under surveillance and exposed to the risk of malaria.[6,7]

At risk population usually is seldom available precisely and therefore the mid-year population or total population of area constitutes population at risk in malaria, this may be true for many other situations.

The **incidence** is determined usually by **cohort study,** by longitudinal follow-up of healthy subjects. For example, 20 healthy children between 1 and 2 years of age group were followed for 4 weeks period, of these 4 developed acute watery diarrhoea at the end of 4 weeks of follow-up. We can calculate incidence of diarrhoea by knowing person **weeks of follow-up** in these 20 children.

Three children were followed for all the 4 weeks and hence they contributed 12 weeks of follow-up, 4 children were followed up for 3 weeks, they contributed 12 weeks, 3 children could be followed up for 2 weeks they contributed 6 weeks and 10 children were followed up for one week they contributed 10 weeks of follow-up. Total person weeks of follow-up were 40 weeks (Table 7.3).

This method is most appropriate as in this **cohort** of 20 children all could not enter the study at one point in time

Table 7.3: Four weeks follow-up 20 healthy children

No. of children	*Total weeks of follow-up*	*No. of child weeks*	*Developed diarrhoea*
3	4	12	1
4	3	12	1
3	2	6	0
10	1	10	2
20	**10**	**40**	**4**

$$\text{Incidence of diarrhoea} = \frac{\text{No. of children who developed diarrhoea}}{\text{Total child weeks of follow-up}} \times 100$$

$$= \frac{4}{40} \times 100 = 10 \text{ per 100 child weeks of follow-up}$$

and further all could not be followed up for all the 4 weeks, some left the study area and were away to relatives. In short, risk time of each child is calculated in terms of weeks or days a child is observed or followed up. The unit of time depends upon the nature of study.

The incidence of this cohort study can be expressed by *cumulative incidence* (CI) rate.

$$\text{CI} = \frac{\text{No. of children who experienced diarrhoea during 4 weeks of follow-up}}{\text{No. of children who were free of diarrhoea at the beginning of the study}} \times 100$$

$$= \frac{4}{20} \times 100 = 20\%$$

It means 20% of children experienced diarrhoea in four weeks of follow-up.

Further, the duration of diarrhoea in 4 children was 14 days. The average duration of disease was 14/4 = 3.5 days or half week.

Interrelationship of Prevalence and Incidence

The **prevalence rate** is dependent on both **incidence rate and duration** of **disease** provided that the prevalence rate is low and does not alter much with time.

P = Incidence rate × average duration of disease

From the above example of incidence of diarrhoea and average duration of diarrhoea (one episode), the prevalence can be arrived at by:

= 10/100 weeks × half week (3.5 days)

P = 5 cases per 100 children between 1 and 2 years.

Attack Rate

It is also an expression of incidence of a disease. It is special incidence rate when a particular disease occurs in an **epidemic proportion** or outbreak in population we usually

calculate attack rate, e.g. in the year 1996 out of 4000 population in a village, 2800 persons were affected with fever from mid-August to mid-September, it was an outbreak of malaria.

It means 70% of people of that village were attacked by fever proved to be malaria.

$$\text{Attack rate} = \frac{\text{No. of persons who had fever from mid-August to mid-September}}{\text{Total population exposed to risk in the same period}} \times 100$$

$$= \frac{2800}{4000} \times 100 = 70\%$$

Secondary Attack Rate

In outbreak situation like measles, cases start occurring one after the other in the family. The primary case in the family spreads infection to other members of the family. The secondary attack rate measures the **contagiousness** of a disease.

Secondary attack rate is defined as number of exposed individuals who develop the disease within the expected range of incubation period of that disease following exposure to primary case.

In the secondary attack rate, the contacts (children) who have not been immunized against measles are at risk of developing measles if they come in contact with a case of measles.

The contacts can be within the family, in the neighbourhood, or in an extrafamilial institution. Secondary attack rate in measles is very high (90%).

$$\text{Secondary attack rate} = \frac{\text{Number of contact persons who developed the disease within the range of incubation period following exposure}}{\text{Total number of exposed/ contacts}} \times 100$$

MEASURING THE BURDEN OF DISEASE

Relative importance of different diseases is based on how many deaths they cause. This convention has certain merits as death is an unambiguous event and many countries collect these statistics routinely.

There are, however, many diseases or conditions which are not fatal but are responsible for great loss of healthy life, e.g. chronic depression and paralysis caused by polio. Therefore, World Bank and WHO jointly undertook an exercise and recommended DALYs as measure of disease burden.

Disability-adjusted life years (DALYs) have been used to assess the disease burden in the community.

One DALY is equal to the loss of one year of healthy life, e.g. a person who lives up to 70 years but suffers an incapacitating stroke at age 65, has lost 5 DALYs.

DALY combines: (a) Losses from premature death, which is defined as the difference between actual age at death and life expectancy at that age in a low mortality population, and (b) loss of healthy life resulting from disability. The global burden of disease is measured in units of disability-adjusted life years (DALYs). Worldwide 1.36 billion DALYs were lost in 1990, the equivalent of 42 million deaths of newborn children or of 80 million deaths at age 50.

Premature deaths were responsible for 66% of DALYs losses in developing countries. The comparison of absolute number of DALYs may be misleading because of variation in size of population of a country. India lost 344 DALYs per 1000 population in the year 1990.

The World Bank report 1993 estimated that in India 50.5% of DALYs loss was due to communicable diseases, 40.4% of DALYs loss was due to non-communicable diseases, and 9.1% of DALYs loss was due to injuries and accidents (Fig. 7.5A).[3]

Expected outcome: Student calculates prevalence and incidence rates of live data of a national health programme to assess disease burden and impact of interventions.

Competency addressed: The student should be able to:
CM 7.4: Define, calculate and interpret mortality indicators based on given set of data.

Learning objective: The objective of this skill is to identify impact indicators of a programme/intervention.

How? Use SRS data and data of national health programmes or data of a health facility (Annual Report).

DEFINING, CALCULATING AND INTERPRETING MORTALITY INDICATORS

The mortality rates and ratio are outcome indicators or **impact indicators** and are used to measure the long-term impact of the programme or an intervention. Traditionally, policy makers have used mortality statistics for identifying major public health problems. In India, reliable age specific mortality data is available through SRS, though there are lacunae in the system to ascertain **cause of death**.

If mortality rates are collected over a long period, we get the secular trends of mortality. Mortality rates can be compared between various states, regions and districts, at the same point in time or over the different points in time of the same area. Unlike morbidity, the mortality is unambiguous, easy to define and can be collected even by lay persons. Mortality statistics are somewhat easier to collect. Compulsory birth and death registration Act in India is there but its implementation is tardy and consequently the routine registrations of deaths are always incomplete and causes of death are not recorded or are incorrect. Therefore, we rely on alternate system of getting accurate and reliable account of deaths through sample

registration system (SRS). The most common mortality rates used in the country are:

Crude Death Rate (CDR): Incidence of Deaths

This is the most common measure of mortality available and used for several purposes. Mortality is one of the basic component of population change. It is easiest to compute. In epidemiological terms, crude death rate is speed of death or *incidence measure* during a specified time period, usually a year.

Definition

Crude death rate (CDR) is defined as total number of deaths in population over a period of one year in an area, divided by total population at the middle of the year. Mortality is calculated using population as denominator to reflect burden.

$$\text{CDR} = \frac{\text{Total number of deaths in one year}}{\text{Mid-year population}} \times 1000$$

Limitations

The CDR does not take into account the age and sex composition of the population. It is an established fact that the mortality rate during the first year of life, early childhood period up to 5 years of age and mortality in elderly people are much higher than other age groups. Similarly, death rates among female and during reproductive period tend to be higher. Thus, it is imperative to interpret crude death rates with composition of population. For example, Kashi and Haridwar in India are religious places for Hindus; many of the old people make these towns as home after attaining old age and prefer to die at holy place. The population composition of these towns is likely to change and crude death rates may be much higher.

The SRS provides reliable estimates of crude death rate in the country by statewise, every year. The death rates can be compared between various states and union territories of India. Rural rates are higher in comparison to urban rates. Over the years, India has achieved reduction of death rates from 27.4 in the year 1951 to 6.0 in the year 2020, which is a significant milestone of overall development and quality of life (Table 7.4). Thus, the crude death rate in spite of various limitations is useful to measure the progress of a nation or state.[8,9]

Table 7.4: Trends of crude death rates in India

Year	*Crude death rate*
1901–11	42.6
1911–21	47.6
1921–31	36.3
1941–51	27.4
1971	14.9
1981	12.5
1991	9.8
2003	8.0
2006	7.5
2007	7.4
2008	8.0
2009	7.3
2010	7.2
2011	7.1
2013	7.0
2018	6.2
2019	6.0
2020	6.0

Source: SRS Bulletin—2005, Oct 2006 and Oct. 2007 to 2020

Standardization

Standardization of crude death rates is done to achieve comparability between different populations over the same period. This is done by direct and indirect standardization methods.

Standard million: Population distribution when calculated for each age and sex group in such a manner as to give a total of 1 million persons, preserving the same

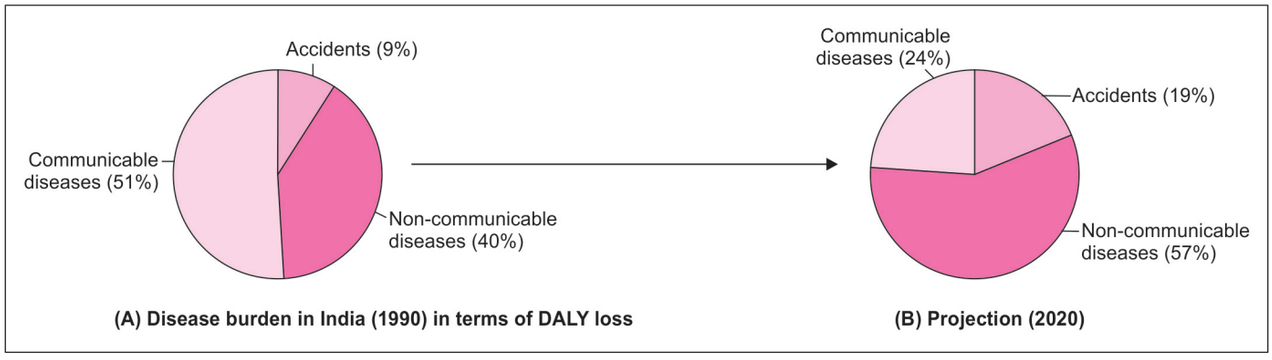


Fig. 7.5A and B: Disease burden and projection in India (*Source*: World Bank report-1993)

proportional age and sex distribution as in the total population. This is called "Standard million population".

Direct Method

Age and sex specific death rates of a local population are applied to standard million population of male and female to arrive at adjusted or standard death rate. Age and sex specific deaths rate of local population is very very difficult to obtain.

Indirect Method

Here the specific death rates of standard population are applied to local population to arrive at expected standard death rate in that population. Even age and sex composition of local population may be herculean task to obtain. It can be obtained for a district or state from census data as rough approximate of the population where one is interested to arrive at such rates.

Since crude death rates need to be refined by **age** and **sex specific** death rate to get more reliable indicators of measuring health status of the country or an area, the following **age specific mortality** rates are widely used to measure the health status and quality of life and overall development of a nation.

Infant Mortality Rate (IMR)

It is age specific mortality. It measures speed of death during the first year of life. It is considered to be most sensitive and reliable index of level of health or health status of a community.

$$\text{IMR} = \frac{\text{Number of deaths below one year of age in a geographical area}}{\text{Total number of live births during the same year in a geographical area}} \times 1000$$

Infant mortality is sensitive to health programmes and interventions as also to socio-economic changes in the country. In calculating IMR, we use live births as denominator since it is difficult to obtain the population of 0–1 year age in the community (Table 7.5).

Table 7.5: Trends of IMR in India

1980	*1985*	*1990*	*2003*	*2006*	*2009*	*2012*	*2020*
114	97	80	60	57	50	42	28

Infant mortality rate has decreased to 28 in 2020. There were wide variations of IMR statewise in India. District level data are not available through SRS. Target is to achieve IMR of 28 by 2025. India has achieved this target in 2020.

Under-five Mortality

This is a composite measure of mortality, again a very sensitive and reliable index of human development and health status of the country or an area. This has been explained in the section of childhood mortality.

The other measures of mortality are mortality in age bracket 1–4, maternal mortality rates, which have been explained in respective chapters.

Case Fatality

Case fatality is calculated using cases as denominator to reflect severity. If the disease is severe, the case fatality is high, e.g. JE (Japanese encephalitis has high case fatality).

This is the proportion of cases of a disease who experience death within a specified period of time.

$$\text{Case fatality} = \frac{\text{No. of deaths from a disease in a specified period}}{\text{Total number of cases diagnosed in the same period}} \times 100$$

Case fatality due to JE in year 2000 was 670/2241 × 100 = 30%. In rabies and AIDS cases, fatality is 100%.

During the year 1996, the outbreak of dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS), there were about 10,000 cases and 400 deaths.[10] The case fatality due to dengue outbreak was thus 4%.

$$\text{Case fatality due to dengue in National Capital of Delhi} = \frac{\text{Deaths due to DHF and DSS from mid-Aug. to Nov. 1996}}{\text{Total cases of DHF and DSS from mid-Aug. to Nov. 1996}} \times 100$$

$$= \frac{400}{10000} \times 100 = 4\%$$

Case fatality ratio (CFR): It is number of deaths from a disease divided by cases of disease, e.g. in measles outbreak 2 deaths, in 200 cases CFR is 1:100.

Proportional Mortality Rate/Ratio (PMR)

This is expressed as:

$$\text{PMR} = \frac{\text{No. of deaths from a specified disease in a specified period}}{\text{Total number of deaths from all causes during that specified period}} \times 100$$

The proportional mortality rate due to diseases of respiratory system was 29.47%. It means in this area over 29% of deaths were due to respiratory diseases including tuberculosis, or else we can say major killers in this area were respiratory diseases followed by digestive disorders and accidents. It is an evidence which diseases should get our attention most in rural areas (Table 7.6).

Proportional mortality due to prematurity in infants (rural area) in 1994 was determined in India. 46.4% of

Table 7.6: Distribution of deaths by major cause group in a rural block—1996–97[11]

Major cause group	*Proportion of deaths*
Cough (disease of respiratory system)	29.47
Digestive disorders	13.45
Accidents and injuries	12.87
Fevers	10.88
Other clear symptoms	8.54
Causes peculiar to infancy	7.95
Senility	7.13
CNS disorders	4.80
Disorders of circulatory system	4.68
Childbirth and pregnancy complications	0.23
Total	**100.00**

infant mortality in India was due to prematurity. It signifies that to reduce infant mortality, one has to focus on reduction of prematurity (Fig. 7.6).[11]

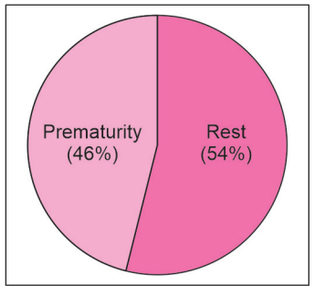


Fig. 7.6: Causes of infant mortality in rural area 1994 (SRS)

The proportional mortality rates of different age brackets in a rural block in the year 1996–97 is presented for clear understanding (Table 7.7).

The proportional mortality rate (ratio) for infants in this block was 19.42%, though the infants constitute 3% of total population but experience almost one-fifth of total deaths. It means the mortality effects are much more in the first year of life. Proportional mortality rate for persons age 60 and above was 44.56%. It means that over 44% of deaths were experienced by persons above the age group 60. Thus, the mortality was highest in extreme of age (highest in first year and above 60 years). This also speaks of vulnerability of infants and aged people who were most vulnerable to mortality. It also raises the question of where to invest? Prevention of infant and child mortality clearly is overriding priority.

Table 7.7: Proportional mortality rate of rural block—1996–97

Age group (years)	*Total deaths*	*Proportional mortality rate (%)*
Below one year	166	19.42
1–4	42	4.91
5–14	32	3.74
15–44	161	18.83
45–59	73	8.54
60 and above	381	44.56
All ages groups	855	100

Causes of Death Statistics: Million Death Study

The causes of death statistics are essential to capture the leading killers diseases and disease burden estimates, in order to prevent and control these diseases. Cause of death till 1994 were being generated by SRS by using lay diagnosis reporting system from rural areas under model registration scheme, however, the scheme was suspended. It has now been revived to capture causes of death by v**erbal autopsy,** since 1999 in urban and rural areas.

Over 75% of the 95 lakh annual deaths in India occur at home and majority of these do not have certified cause. Recognizing the need for better data, the government has undertaken the world's largest study to track the causes of death in the country called the "prospective study of one **million deaths** in **India**". The study lasted for 16 years (1998–2014). This is known as "Million Death Study" (MDS) undertaken by sample registration system. The verbal autopsy (VA) called "RHIME" or Representative, Re-sampled, **Routine Household Interview** of **Mortality** with Medical **Evaluation** method to determine the causes of death. Causes of neonatal mortality in India in 2005 as per million death study (MDS) were prematurity and low birth weight 14%, birth asphyxia and birth trauma 8%, neonatal infection 12%, neonatal tetanus 1%, diarrhoea 1% and others 7%. Causes of child mortality—pneumonia 16%, diarrhoeal diseases 13%, other infectious diseases 11% and others 17%.

A robust cause of death reporting system is needed for disease burden estimates. However only 22% of deaths in India in 2015 had their cause reported in medical certification of cause of death system.

Cause of death is also obtained from hospital statistics, as these deaths are attended by physicians (doctors) hence the causes are more reliable but unfortunately many of the hospitals do not adhere to ICD-10 classification of diseases and deaths, hence, value of an important source of data get lost.[12,13]

Expected outcome: The student calculates mortality rates and interprets these rates in the context of national goals for sustainable development and national health policy 2017.

Disability: Measurement[14–16]

Apart from measuring morbidity and mortality, the measurement of disability in population is significant to have an assessment of magnitude of disability (prevalence and incidence). Disability results in dependency, loss of productivity apart from social implications of disability. The measurement of DALYs proposed by WHO and World

Bank gives due importance to healthy life lost due to disability.

Year 1981 was observed as an International Year of Disabled Persons (IYDPs). Of every 10 children in the world, one child is born with an impairment or acquires it early in life.

It was estimated in 1981 that in India, there were 2 million mentally retarded, 5 lakh physically disabled, 2 lakhs deaf and 8 lakh blind children. Accidents and injuries produce disability in youth, adults, and is assuming epidemic proportion.

Common Impairments[17]

Census 2011 reveals that 2.14% of our population or approximately 26.8 million people in India suffer from severe disability.

1. ***Physical/locomotor limitation:*** Due to accidents and trauma, poliomyelitis, and leprosy. In 2011, census, locomotor disability was reported in 5,436,826 persons (20.0%).
2. ***Mental retardation:*** Due to iodine deficiency disorders, rubella infection, bacterial and viral infection, asphyxia and trauma during birth, toxoplasmosis, cerebral palsy, and genetic disorders. 1505964 persons had mental disability in 2011 (6%).

   Mental illness: 722880 (3%) most likely severe mental illness.
3. ***Blindness and visual impairment:*** Due to vitamin A deficiency, onchocerchiasis, accidents, cataract and glaucoma. 5033431 had visual disability in the year 2011 (19.1%).
4. ***Deafness/hearing impairment:*** Congenital, chronic suppurative otitis media, prolonged exposure to noise and accidents. 5072914 persons had hearing disability in the year 2011 (19.3%).
5. ***Speech:*** Due to consequences of various diseases. 1998692 persons had speech disability in the year 2011 (7.3%).
6. ***Any other:*** 4927589 (18.4%)
7. ***Multiple disabilities:*** 26814994 (8%)

The impairment, disabilities and handicap may result which may be permanent or temporary, progressive or regressive. These terms have been defined by WHO (1980) and revised subsequently. Now International classification of functioning, disability and health known as ICF is in place.

Impairment

"Any loss or abnormality of psychological, physiological or anatomical structure or function".

Example: An abnormality, a temporary or permanent loss such as a missing or defective body part (loss of limb), paralysis after polio, diabetes, mental retardation, and nearsightedness.

Disability

"Any restriction or lack resulting from impairment to perform an activity in the manner or within the range considered normal for a human being".

In other words, it is any restriction of a function considered normal for human beings resulting from an impairment. This would involve difficulty in seeing, hearing, walking, writing or speaking. Now the term disability serves as an umbrella term for impairments, activity limitation and participation restrictions.

Handicap

"A disadvantage for a given individual, resulting from an impairment or disability, that limits or prevents the fulfillment of a role that is normal (depending on age, sex and social and cultural factors) for that individual".

A disability only becomes a handicap, if it is allowed to interfere with doing what is normally expected at a certain age. Now the term handicap has been dropped.

CAUSES OF IMPAIRMENTS

- Accidents and injuries.
- Leprosy.
- Vitamin A deficiency and malnutrition in children.
- Malnutrition in mothers during pregnancy.
- Iodine deficiency disorders.
- Congenital rubella and other genetic factors.
- Infectious diseases such as polio (it used to be major cause earlier on now it has been eradicated).
- Misuse of drugs by mothers.
- Environmental pollution (noise pollution in particular) and food adulteration.
- Lack of sanitation, man-made and natural disasters.

Prevention of Impairment

1. By immunization to prevent infectious diseases like measles, mumps, rubella and poliomyelitis. Rubella infection can be prevented by immunization.
2. By regular consumption of iodized salt.
3. Improved maternal and child nutrition.
4. Vitamin A prophylaxis
5. Prevention of accidents—roadside, home and factories.
6. Avoidance of drugs and radiation during pregnancy.
7. Improved conditions and facilities during delivery.
8. Genetic counselling
9. Elimination of environmental hazards.
10. Proper care and treatment of acute respiratory infections.
11. Reduction of prolonged exposure to high noise.

Apart from primary prevention, the impairment can be controlled by early diagnosis and prompt treatment like provision of glasses for defective vision, cataract surgery,

treatment of glaucoma, diabetes, hypertension, leprosy, etc. If the impairment progresses to disability and handicap, the tertiary prevention is applicable to limit disability and to rehabilitate persons who have handicaps.

Physical Medicine and Rehabilitation (PMR). Departments in 21 Medical Colleges of the country have been set up for medical rehabilitation services.

The world summit for children included indicators of disability like disability type specific prevalence. The total number of persons with disability, specifying the number having serious difficulty in seeing, hearing, or speaking, moving, learning or comprehending, or having strange or unusual behaviour or other disability of duration of at least 6 months or of an irreversible nature, in the following age groups: 0–4, 5–14, 15–19 and 20 and over. Child-disability: One in twenty of those aged 14 years or younger live with a moderate or severe disability. Rights of persons with disability have been protected by an Act of 2016.

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RISK MEASUREMENT IN EPIDEMIOLOGY

It is a common observation that some persons have higher risk, than others, to develop or contract a disease or death, these persons, who stand to higher risk of developing a disease or death are called "high-risk individuals". *Example*—infant born with low birth weight stands to high-risk of infant death as compared to infant born with adequate weight. Thus, low birth weight is a risk factor to high infant mortality in general.

What is Risk?

The dictionary meaning of risk is danger, hazard, or exposure to mischance. Risk or hazard develops before the occurrence of disease.

Risk Factors

Definition: The risk factor is a characteristic or a circumstance of individuals or groups, which is associated with an increased "risk" of developing an untoward or unwanted outcome.[1]

The risk factors can be "causes or signals" of an outcome. The risk factors can be identified and detected before the occurrence of an undesirable event. The risk factors vary with different diseases.

Common Risk Factors

- Diet high in saturated fats is a risk factor for coronary heart disease.
- Tobacco is risk factor for lung and oral cancer and many other diseases such as heart diseases.
- Chewing tobacco is a risk factor for oral cancer.
- High blood pressure is risk factor for strokes.
- Unprotected or unsafe sex is risk factor for sexually transmitted infections and HIV.
- Physical inactivity is risk factor to obesity and heart diseases.
- Unsafe water is a risk factor for water-borne diseases.

Grading of Risk

The risk can be graded based on objective criteria and experience. According to birth weight, the infants can be graded in following categories (Table 7.8).

Table 7.8: Grading of risk

Birth weight	*Risk category*
2500 g and above	Who carry very low-risk of death
2000–2499	Low-risk of death
1500–1999	Moderate risk
1000–1499	High-risk
Less than 1000 g	Very high-risk

This is to be observed that no birth is without risk of death, some stand to very high-risk of death such as weighing less than 1000 g and high-risk in births weighing 1000–1499 g. Thus, grading helps to decide the level of management. Infants weighing between 2000 and 2499 g at birth can be managed at home by appropriate neonatal care. While infants, weighing less than 2000 g should be managed at institutional level.

Overall risk of dying within first year of life in India (in the year 2005) was 6%, i.e. out of 100 births 6 will die within first year of life. However, in 100 births with weight less than 2000 g at birth, 18 infants may die within first year of life, then the risk of death is three times if the birth weight is less than 2000 g or else, the chances of survival are much more if the birth weight is more than 2500 g.

Population at Risk

In some situations, the whole population is at risk of developing or contracting a disease, e.g. tuberculosis and malaria.

But in most situations part of the population is exposed to the risk of developing a disease, e.g. carcinoma of cervix occurs commonly in women in age group 30–49 years, therefore, the screening programme should focus only on this age bracket or on population at risk.

Application

The knowledge of risk factors helps in prevention of diseases. The primordial prevention aims at prevention of development of risk factors in population/person. If the risk factors are eliminated, the disease will not occur. Primary prevention aims at to prevent the development of disease in persons having risk factors. Attempt is made to modify the risk factors in such persons.

Uses

- Risk factor can predict the occurrence of a disease/event.
- Helps in prevention and control of disease.
- Helps in allocation of resources and determination of priorities.

Measurement of Risk

The science of epidemiology measures the risk factors and determines the chances of development of unfavourable outcome or an event. There are several measures of risk. Risk can be categorized as:

1 Absolute risk of incidence
2 Attributable risk
3 Attributable fraction
4 Population attributable risk
5 Relative risk

1. Absolute Risk or Incidence

Absolute risk is defined as the incidence of infant deaths in low birth weight babies (exposed population) over a period of one year. In Table 7.9 absolute risk can be calculated by:

$$\text{Absolute risk} = \frac{\text{Number of infant deaths in low birth weight babies in one year}}{\text{Population exposed to risk during the same period}}$$

$$= \frac{108}{900} \times 1000 = 120 \text{ per thousand per year}$$

2. Attributable Risk (AR)

In Table 7.8, we have chosen low birth weight (LBW) as a risk factor for infant deaths. There were 2700 births in a rural block, of these 1800 were of adequate weight (2.5 kg or more) and 900 were below 2.5 kg of weight at birth, the incidence of deaths among these infants within one year period was recorded. The incidence of infant death was 40/1000 among infants having birth weight of 2.5 kg or more and higher incidence of 120 infant deaths per 1000 live births was recorded in infants with birth weight less than 2.5 kg. In this situation, the risk of infant death, which can be attributable to low birth weight risk factor is as under:

$$\text{Attributable risk} = \text{Incidence of infant deaths in babies with low birth weight} \; (-) \; \text{Incidence of infant deaths in babies with adequate weight}$$

or

$$\text{AR} = 120 - 40 = 80$$

$$\text{Proportion of low birth weight babies in the community} = \frac{900}{2700} = \frac{1}{3}$$

Table 7.9: Risk of dying within one-year in infants with normal and low birth weight in a rural block

Birth weight	*Total births*	*No. died within one year*	*Incidence per 1000 live births*
>2.5 kg (adequate)	1800	72	40
<2.5 kg (low birth weight)	900	108	120
Total	**2700**	**180**	**67**

Attributable risk is also called "risk difference", i.e. difference of incidence of infant deaths in two categories: One with risk of "low birth weight" and other with very low risk, i.e. "adequate weight at birth". We can say that there is additional risk of 80 points in high-risk infants born with low birth weight.

Significance

Attributable risk is a useful measure of the extent of mortality caused by the low birth weights in the community. Incidence of 80/1000 infant deaths is attributable to low birth weights.

3. Attributable Fraction

The attributable fraction or aetiological fraction is obtained by dividing the attributable risk or risk difference by the incidence of infant mortality occurring in low birth weight babies.

$$\frac{80}{120} \times 100 = 67\%$$

Significance

Sixty-six percent of mortality in low birth weight babies is attributable to low birth weight. It means that 67% of incidence of mortality in infants of low birth weight could be reduced if the risk factor of low birth weight in the community is eliminated.

4. Population Attributable Risk (PAR)

In the present example PAR is defined as the proportion of infant deaths in the total population that can be attributed to low birth weight babies. The formula for PAR% is as follows:

$$\text{PAR} = \frac{\text{Incidence of infant deaths in total population} \; (-) \; \text{Incidence of infant deaths with adequate birth weight}}{\text{Incidence of infant deaths in population}} \times 100$$

$$\frac{67 - 40}{67} \times 100 = \frac{27}{67} \times 100 = 40\%$$

In the present example 40% or overall or total infant mortality could be prevented in the population if the risk factor of low birth weight is eliminated in the community.

PAR is more meaningful figure than relative risk in determining the need for population prevention based prevention programmes. PAR takes into account RR and incidence of low birth weights in community. It indicates the amount of reduction of infant mortality that is possible if the low birth weight factor is completely eliminated in the population.

The concept of PAR can be applied to disease, death, disability, survival or any other community event like accident, etc.

5. Relative Risk (RR)

One may ask how many times a low birth weight baby experiences mortality relative to baby with adequate birth weight? This can be answered by calculating *relative risk or risk ratio*. This is the ratio of incidence of infant deaths in low birth weight babies and incidence of infant deaths in babies with adequate birth weight. In the present example:

$$\text{Relative risk} = \frac{120}{40} = 3 \text{ or } 1:3$$

Thus, we can answer that low birth weight babies are likely to experience mortality during infancy three times higher than babies with adequate birth weight.

Significance

The relative risk measures the strength of association between the risk factor and the unfavourable outcome. A relative risk greater than 2 can be considered as strong association between the risk factor and the unwanted outcome. In the present case, RR of three means LBW as a risk factor has strong association with infant mortality. RR and odds ratio tend to be very close to each other.

Competency addressed: The student should be able to:
CM 7.6: Enumerate and evaluate the need of screening tests.

Objective: The learning objective of this skill is to rapidly select at risk persons or risk factors or behaviours as early markers of unfavourable outcomes (disease and disability).

How: Use 4Ds screening data or NCDs community based screening data.

NEED AND EVALUATION OF SCREENING TESTS

LEAD TIME

Risk factors are present before the unfavourable outcome occurs. Time taken between presence of risk factors in population/person, and development of disease/event is significant for intervention or action. The time gap between presence of risk factor and development of disease provides useful opportunity for appropriate action. Screening of population or subgroups for detection of risk factor is essential step for prevention of unwanted outcome/disease.

Focus

Screening focuses on apparently healthy persons/groups. Thus, screening is the process by which risk factors or

danger signs of unrecognized diseases/defects are identified by tests that can be applied rapidly on a large scale. Screening tests sort-out apparently healthy people from those who have a risk factor or have a chance to develop unfavourable outcome. Screening is not a final diagnosis it usually requires further tests for confirmation. Screening rates remain woefully low in our country.[1] Only 1.9% of women in India age 30–49 years have ever undergone a screening test for cervical cancer and 0.9% for breast and oral cavity examination against 1.2% men.

Criteria for Screening[2]

1 The disease should be highly prevalent and severe enough to necessitate screening, i.e. it affects large number of people and geographically widespread and is important cause of death in the country or region.
2 The gap between exposure and development of disease should be sufficient for intervention or action.
3 Availability of sensitive, specific, reliable, valid, cheap and safe test acceptable to public.
4 Effective, safe and acceptable interventions are available.
5 Screening without action or intervention is useless.

Examples: Screening for oral, cervix, and breast cancer, tuberculosis, diabetes, hypertension obesity and coronary heart disease, blood for its safety and 4 Ds in RBSK.

Objectives

The screening programme have the following objectives:
i To identify a risk factor.
ii To detect a disease at preclinical stage.
iii To detect syndrome at early stage.

Types of Screening[3]

- ***Whole population or mass screening:*** Whole population is subjected to screening. *Example:* All schoolchildren as they enter in school are examined or given a health check-up to screen out health conditions.
- ***Targeted screening:*** Screening which is directed towards a special group of population or high-risk groups—commercial sex workers, factory workers, pregnant women, infants, etc.
- ***Opportunistic screening:*** Restricting screening to patients who consult a health physician in hospital or clinic.
- ***Multiple or multiphase screening*** using multiple screening tests at the same time, e.g. testing vision, weighing, testing hearing, testing blood, at the same time.

The disease may be either present or absent and similarly the test result may be either positive or negative. There are thus four possible combinations of disease status and test result:

1 ***True positive:*** When the disease condition is present and test is positive.
2 ***True negative:*** When the disease condition is absent and the test is negative.
3 ***False positive:*** When the disease condition is absent but the test is positive.
4 ***False negative:*** When the disease condition is present but the test result is negative (Table 7.10).

Sensitivity (Table 7.10)

Sensitivity means proportion of truly disease persons who are categorized as abnormal by the test.

or

Proportion of true positive persons (who have the disease) and test is positive.

Calculation: It is calculated by a/a + c.

Specificity (Table 7.10)

Specificity means proportion of truly normal people categorized as normal by the test.

or

Proportion of true negative persons (who do not have the disease) and test is negative.

Calculation: It is calculated by d/b + d.

Table 7.10: Validity of a screening test

		Risk factor/disease		
		(Present) +	*(Absent)* –	*Total*
SCREENING TEST	+ (Positive)	a	b	a + b
	– (Negative)	c	d	c + d
	Total	**a + c**	**b + d**	**a + b + c + d**

a: Indicates number of true positives, i.e. those who have the risk factor or disease condition and test is also positive.
b: Number of false positive, who have no disease but the test is positive.
c: Indicates number of false negative, i.e. number of persons who have the risk factor/disease but the test is negative.
d: True negative—who have no disease and test is negative.

Positive Predictive Value (PPV) or Yield of a Test

This is the probability of a disease in a patient with an abnormal test result.

Calculation: It is calculated by a/a + b.

Negative Predictive Value (NPV)

This is the probability of a person not having a disease when the result of a test is negative.

Calculation: It is calculated by d/c + d.

The predictive value depends upon the sensitivity and specificity of a test and most importantly on the prevalence of disease in the community being tested. Predictive value is more important determinant of value of the test than sensitivity and specificity in view of variation in prevalence of disease from one state to another and from one region to another.

VALIDITY OF TEST

Validity is an expression of the degree to which test is capable of measuring what it intended to measure. In validity, we consider 4 elements, namely: Sensitivity, specificity, positive predictive value and negative predictive value of the measurement or test. All the available tests have their limitations; hence one should use multiple tests to increase the validity.

Typical sensitivity and specificity values for commonly used laboratory tests today for detecting HIV-1 infection (ELISA, rapid and simple test) are at 99%. The first generation ELISA had a sensitivity of 95% and the Western Blot has a specificity of 99.99% (Tables 7.11 and 7.12).

Second generation ELISA tests have high sensitivity and high specificity.

Low rate of false negative is the priority for blood transfusion safety, in contrast, if the objective is case identification, a low rate of false positive is very important.

ELISA is most commonly performed screening test for blood safety. It is easy to perform, it is sensitive and specific and cost-effective and adoptable to large number of samples. ELISA detected 5850 HIV positive out of 100000 tested.

Supplemental Western Blot of all initially ELISA positives is a confirmatory/diagnostic test. Therefore, "total population" for the Western Blot is 5850 (Table 7.12).

Table 7.11: Validity of ELISA test[4]

		True infection status		
		Infected	Non-infected	Total
ELISA RESULT	+ (Positive)	4900 (A)	950 (B)	5850 (A + B)
	– (Negative)	100 (C)	94,050 (D)	94,150 (C + D)
	Total	5000 (A + C)	95,000 (B + D)	1,00,000 (A + B + C + D)

Persons tested = 1,00,000

Prevalence of HIV infection = $\frac{5000}{100000} \times 100 = 5\%$

A: True positives, *B*: False positives, *C*: False negatives, *D*: True negatives

Sensitivity = $\frac{A}{A+C} = \frac{4900}{5000} \times 100 = 98\%$ Specificity = $\frac{D}{B+D} = \frac{94050}{95000} \times 100 = 99\%$

Positive predictive value = $\frac{A}{A+B} \times 100 = \frac{4900}{5850} \times 100 = 83.8\%$

Negative predictive value = $\frac{D}{C+D} \times 100 = \frac{94050}{94150} \times 100 = 99.9\%$

Table 7.12: Validity of Western Blot test[4]

		True infection status		
		Infected	Non-infected	Total
WESTERN BLOT	+ (Positive)	4655 (A)	1 (B)	4656 (A + B)
	– (Negative)	245 (C)	949 (D)	1194 (C + D)
	Total	4900 (A + C)	950 (B + D)	5850 (A + B + C + D)

Total population: 5850, *A*: True positives = 4655, *B*: False positives = 1, *C*: False negatives = 245, *D*: True negatives = 949

Sensitivity = $\frac{A}{A+C} = \frac{4655}{4900} \times 100 = 95\%$ Positive predictive value = $\frac{A}{A+B} = \frac{4655}{4656} \times 100 = 99.9\%$

Specificity = $\frac{D}{B+D} = \frac{949}{950} \times 100 = 99.9\%$ Negative predictive value = $\frac{D}{C+D} = \frac{949}{1194} \times 100 = 79.5\%$

Western Blot detected 4656 out of 4900 HIV infected with sensitivity of 95% and its specificity was 99.9% (949/950).

Since HIV is life-threatening infection high sensitivity and high specificity is desirable. Both ELISA and Western Blot tests are highly sensitive and have high specificity.

Decisions on appropriate criteria for screening test depend on the consequences of identifying false negatives and false positives. If it is desired to increase sensitivity and to include all true positives, this implies increasing number of false positives, i.e. decreasing specificity. Increasing the strictness of the criteria increases specificity but decreases sensitivity reducing the strictness of the criteria for a positive test increases sensitivity but decreases specificity.

SCREENING IN NON-COMMUNICABLE DISEASES (NCDs)

The following risk factors for non-communicable diseases have been identified.

Behavioural Risk Factors

- Tobacco and harmful alcohol use.
- High saturated fats and inappropriate dietary habits.
- Physical inactivity.

Metabolic or Physiological Risk Factors

- High body mass index—obesity
- Raised blood pressure
- Raised blood glucose
- Raised cholesterol

Measurements

- ***Biochemical assessment:*** By blood sugar, and blood cholesterol.
- ***Physical measurements:*** Height, weight, waist circumference, blood pressure, pulse rate.

Strategies of Screening for Non-communicable Diseases (NCDs) Risk Factors[5]

1 Monitor trends of important risk factors of NCD in the community over a period of time.
2 Evolve strategies for interventions of these risk factors so as to reduce the burden of disease due to NCD (these have been explained in the book in Chapter 8 on NCD).
3 Strengthen NCD surveillance at district level.

Integrate NCD risk factors surveillance with IDSP (integrated disease surveillance programme).

Common Screening Tests

Safe Blood

1 Screening blood before transfusion is mandatory for HIV, HBV, malaria and syphilis. Before transfusion, blood is screened for all these infections and we have now introduced screening for HCV as well.
2 *Cancer cervix:* Cervical smears (PAP test) and visual inspection with acetic acid, for early detection of asymptomatics, pre-cancerous cervical lesion usually done in married women above 30 years of age. This is the strategy adopted in national cancer control programme.
3 Screening of risk factors for epidemic of cardiovascular diseases. The major risk factors are inappropriate diet and physical inactivity (as expressed through unfavourable lipid concentration, high body mass index and raised blood pressure), together with tobacco use.
4 Screening of visual acuity in school children and aged.

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Expected outcome: The student calculates sensitivity, specificity and predictive value of a test on a data set related to national health programme.

PRINCIPLES OF PUBLIC HEALTH SURVEILLANCE

What is Surveillance?

Surveillance is information for action. This is the simplest definition of surveillance. Surveillance is a French word meaning, "watch with attention, suspicion and authority".

Centre for disease control (CDC), which defines epidemiological surveillance as "the ongoing and systematic collection, collation, analysis and interpretation of health data essential to planning, implementation and evaluation of public health practice and programmes closely integrated with timely dissemination of these data to those who need to know." The final link in the surveillance chain is the application of the information to prevention and control. A surveillance system includes a functional capacity for data collection, analysis and dissemination linked to public health programmes.[1] Surveillance is not made to "Keep statistics" but to guide decision/action to prevent and control diseases. Surveillance generates incidence data.

or

Surveillance is—"Information for Action"

Objective of Epidemiological Surveillance

The surveillance could have limited or many objectives. Some of the objectives are:

1. To determine **incidence** of disease.
2. To know the geographical distribution or spread of disease/event.
3. To identify population at risk of that disease/event.
4. To monitor trend of disease over a long-time period.
5. To capture the factors and conditions responsible for occurrence and spread of a disease.
6. To **predict** the occurrence of **epidemic** and to control epidemic at an early stage.
7. To evaluate the effectiveness of an intervention or programme.
8. To assess the disease burden in the community or health needs of community.

These are the broad objectives of epidemiological surveillance, however, depending upon the resources and needs, the objectives could be limited to one or two specific areas or these could be expanded. But keep it short and specific (KISS), limited to a few indicators.

Scope

The surveillance is an important epidemiological tool and it limits to a specific disease/diseases which is/are of national significance and has high priority in terms of control/elimination/eradication. Malaria and acute flaccid paralysis surveillance (for eradication of polio) are significant in India. Currently, the vertical national programme of epidemiological surveillance of the following diseases is going on in the country, independently without much coordination.

- Acute flaccid paralysis (AFP) surveillance to eradicate polio.
- HIV/AIDS surveillance
- National vector-borne diseases surveillance.
- Vaccine preventable disease (VPD) surveillance.
- Acute respiratory infections in children.
- Diarrhoeal diseases in children.
- Nutrition surveillance
- Sentinel surveillance for blindness control.
- Surveillance of noncommunicable diseases risk factors).

ESSENTIAL ELEMENTS OF SURVEILLANCE

A Collection of data
B Compilation and transmission of data
C Analysis and interpretation
D Action (Decision making)
E Feedback

Surveillance Methods for Data Collection

A surveillance system counts the same event consistently everyday. The commonly used surveillance methods for data collection are as under:[2]

1. Community level surveillance.
2. Routine reporting system.
3. Active surveillance and passive surveillance for malaria.
4. Sentinel surveillance.
5. Surveys and special studies.
6. Case and outbreak investigation.
7. Verbal autopsy.
8. Laboratory surveillance.
9. Entomological surveillance.
10. Environmental surveillance in polio.

1. Community Level Surveillance Training of People and Workers

People themselves (community informants) report births, deaths, outbreaks and unusual events. Informants at community level need to be contacted on regular basis by health workers.

- ASHAs, *Anganwadi* workers, self help groups and village panches/*panchayats* as also press report unusual events or significant health events. Disease surveillance system at village level is being strengthened under NRHM.

2. Routine Reporting (Institutional-based or Passive Reporting—Provider's Initiated)

In routine reporting, health staff collects information about number of cases of reportable diseases and deaths that occur in their area in relation to all national health programmes.

This system relies on government-established system of sub-centres, primary health centres, community health centres and hospitals data. Whosoever comes to these facilities are recorded and reported. This is passive routine reporting system. This is the simplest and most widely prescribed way of collecting information for action.

Medical institutions in India are required to report cases and deaths attended in the outpatients or inpatients which include the enlisted 20 communicable diseases, *every month* to the next higher level. The State Bureau of Health Intelligence/Vital Statistical Unit consolidates the data received from district health officers and transmits it to the Central Bureau of Health Intelligence (CBHI).[2]

Advantages

- Routine reporting system is simplest and least costly or inexpensive.
- It is efficient and quickest method to obtain the information.

Disadvantages

Routine reporting system provides:

- Incomplete information or reporting
- Quality of data highly variable and reliability is also variable
- These systems almost always provide incomplete picture of the total number of cases that occur. Some of the reasons of incomplete reporting are:
  - Not all cases come to health facility for treatment. Some people or most people (70%) may go to private practitioners for treatment, some may not seek any treatment, and some may go to other facilities.
  - Some diseases such as neonatal tetanus are more commonly treated at hospitals than health centres.
  - Complete and accurate reporting are always problem in PHCs and CHCs.

Nevertheless, routine reporting is the most common method used in surveillance because it is so inexpensive.

3. Active Surveillance/Active Case Detection

It is usually limited to a specific disease. However good the routine reporting system there will still be cases that will not be recorded under this system. The cases with mild or moderate form of the disease may not seek treatment from the health centre/hospital. They may stay at home or may go to private practitioners or traditional healers. These will not be recorded under the routine reporting or institutional surveillance. It is also possible that patients in severe conditions are taken to large hospital in another district for specialized care and some cases may die within a short period of onset of symptoms.

Active surveillance means actively looking or searching for a particular type or group of diseases, is useful in detecting these unreported cases, it involves active participation of health personnel as well as the community. The degree of *reporting is more complete* than by any other method, especially for the clinically distinct and easily recognizable diseases/syndromes.

i Active surveillance for malaria control/elimination programme has been the time-tested strategy but still remains below the desirable level of ABER equal to 10%. Workers have fixed beat programme and fortnightly visit to every home/household to capture all fever cases births and deaths in assigned population of 5000 in a sub-centre area, preparation of blood smears (thick and thin) and full therapeutic treatment for malaria.

ii Active search for smallpox cases was an important strategy for smallpox eradication programme. Photo flash cards were used for easy recognition of disease in the community.

iii In the guinea worm, eradication programme search was conducted twice in a year in the affected area. Photo flash cards were used for easy recognition of case.

iv Active search may be called during outbreaks to determine the extent of outbreak and to keep mortality rate low, to check the reports received by rumour register, active surveillance is also undertaken for acute flaccid paralysis (AFP) as also to confirm the absence of even a single case during **pre-certification phase** of disease eradication, as "Zero" incidence has to be maintained for a period of 3 years.

Only a few diseases should be selected for active surveillance. These should include those diseases for which control programme is operating and which are epidemic prone such as malaria, polio, diarrhoeal diseases and ARI in children. The channel of flow of community surveillance and institutional surveillance is presented to understand the system of flow of information (Fig. 7.7).

Passive Surveillance/Passive Case Detection

It means collection of data from persons, themselves reporting to a facility (hospital, clinic, sub-centre, PHC and CHC, etc.) as elaborated under routine reporting. At times during outbreak investigator may conduct what is sometimes called *stimulated* or *enhanced* passive surveillance by sending a letter describing the situation and asking for reports of similar cases.

4. Sentinel Surveillance

In sentinel systems, a small number of health units are selected to report cases of diseases and deaths that are seen or diagnosed at their facility.

These sentinel sites also collect and report additional information such as age, immunization status and other details. Staff at sentinel sites is given special training and supervised to ensure that reporting is complete and accurate.

Common Sentinel Sites

A hospital (infectious diseases, TB, paediatric hospital), health centre, antenatal clinics, sexually transmitted infection clinic, laboratory or rehabilitation centre, which attends large number of particular type of cases can be considered as a possible sentinel site/centre. Many institutions such as teaching hospitals and national institutes may already be collecting the desired information.

Advantages

- The sentinel sites collect more reliable and accurate data because trained staff and specialists handle the cases.

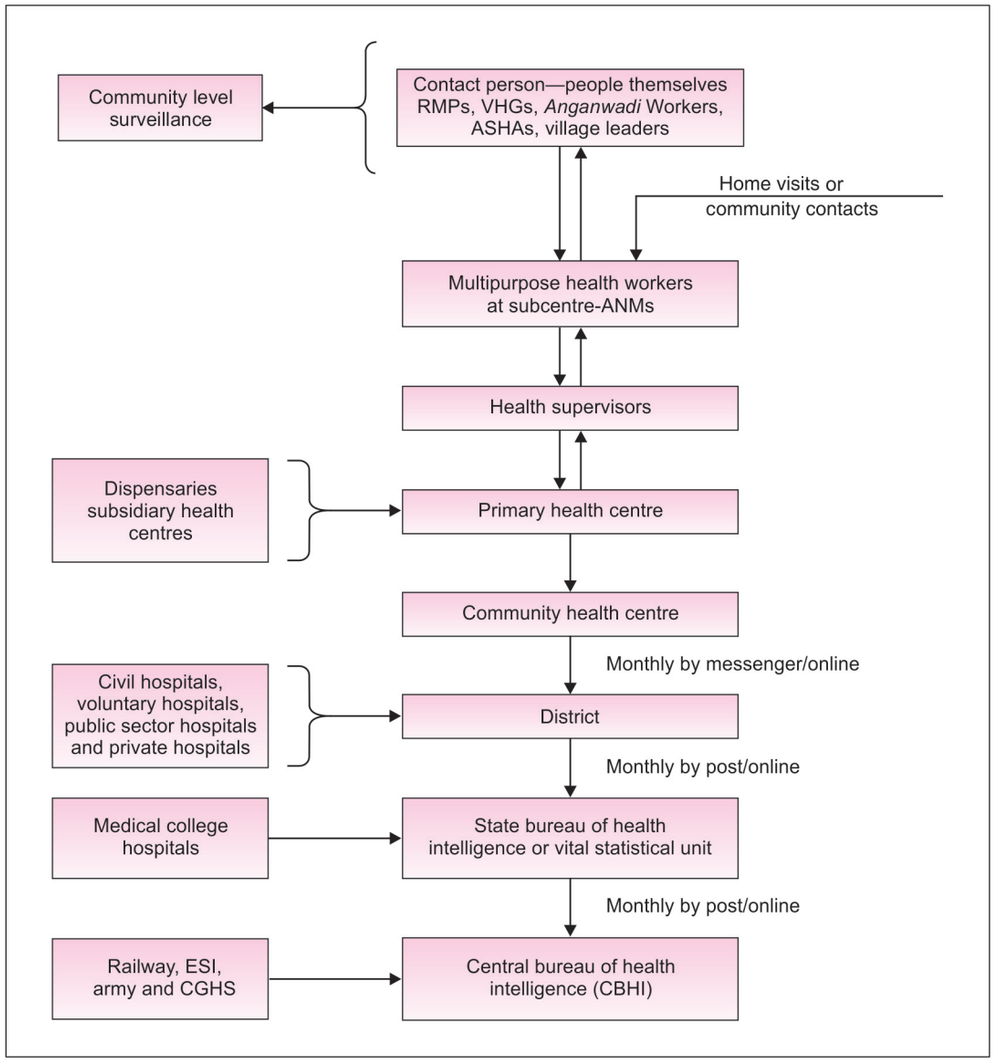


Fig. 7.7: Channel of information flow in community and institutional level surveillance

- Their records are more accurate and timely and these sites provide consistent and quality data/information. They are also relatively inexpensive to set-up and operate.

Disadvantages

A major disadvantage of sentinel system is that they are not representative of entire population at risk. We cannot calculate incidence or prevalence rates, because of lack of denominator; which are important for assessing changes in health status. The information cannot be generalized to estimate the national or state incidence rate. Another disadvantage is that population served by sentinel site may change making the study or trends invalid.

Criteria

An institution may act as sentinel centre for one or group of diseases depending upon the number and type of cases attended by them. The following minimum criteria need to be observed in selection of centre:

i Large attendance of patients with the particular disease.

ii Diagnosis is reasonable accurate and laboratory support is available.

iii Good recording and reporting facilities available.

iv Willingness to submit regular reports.

Uses

The data collected by sentinel centres can be effectively used both for immediate action in the field as well as for future plans and policy decisions.

- Reporting large number of cases as compared to corresponding period (month or quarter) of previous years serve as an early warning of a potential epidemic. An

abnormal increase in the number of cases calls for an immediate investigation and institution of necessary preventive measures by the local health officer.

- The seasonal pattern of disease is clearly established from the reports of the sentinel centres and plans for preventive programmes are made accordingly.
- The sentinel centres can serve as indicator of the impact of the services provided. For example, data can tell whether the children are getting the diseases after completion of immunization. These centres can be efficient "watch dogs" of quality of preventive health services.
- The information may indicate the shifting of disease to higher age groups or clustering of cases in selected localities. Plans can be modified according to changing pattern of the diseases.

The sentinel surveillance system was used to capture incidence of vaccine preventable diseases.

HIV *sentinel surveillance* was being carried out since 1998, to capture HIV/AIDS prevalence in the country and to determine trends, HIV load in the country as also to identify the population at risk and geographical distribution of epidemic of HIV in the country.

5. Surveys and Special Studies

Sample survey or disease survey is an active and efficient method of surveillance, which can complement the other methods. Two surveys done at an interval of several years apart may be able to demonstrate changes in disease incidence. The first survey for collecting reliable baseline epidemiological information and the subsequent one for evaluation of the control programme or intervention. In some selected instances (e.g. poliomyelitis lameness surveys), it may be possible to conduct one survey at one point in time utilizing two different age groups to collect both baseline and current performance data. In planning a national disease control strategy, survey is needed to establish priorities between various diseases.

Survey or on blindness at different points in time in India provides information on prevalence of blindness and effect of interventions on blindness.

National oral health survey and fluoride mapping provides useful information on oral health status and problems.

Survey or screening of risk factors for non-communicable diseases is being undertaken at 1–5 years interval under IDSP and National Programme of NCDs.

Limitations

Surveys are difficult to conduct, relatively expensive and call for highly skilled persons with organizational abilities. The sample size, questionnaires and forms must be well designed to avoid bias and misinterpretation of data. Some diseases require laboratory back-up for accurate diagnosis, which make the surveys even more difficult. House to house surveys require an important investment of organizational efforts; manpower and other resources. It is difficult to justify this investment merely to study one disease. With appropriate multipurpose survey designs, such as NFHS several disease conditions can be studied in the same sample population.

A simple method using cluster-sampling technique (recommended for vaccination coverage evaluation surveys by the World Health Organization) with necessary modifications has been proposed for surveys of various diseases.

6. Case and Outbreak Investigation

The major objective of an epidemiological investigation of a disease outbreak is to help control the spread of disease by indicating the most appropriate preventive measures by identifying where and to whom and how to apply these measures and subsequently by monitoring the progress of control efforts. Outbreak investigations can also provide important supplementary information, not often gained from other surveillance methods. This includes, age specific attack rates, case fatality rates, rate of serious disability and estimates of vaccine efficacy. Measles surveillance in the country is based on "measles outbreak" investigation. It also attempts to identify the causes of death and disease.

They are not alternatives to routine and sentinel systems but are used as the next step in epidemiological investigation.

Case based surveillance and focus investigation has been initiated under malaria elimination programme since 2017.

Purpose

The usual purposes of these investigations are:

1. To confirm diagnosis and determine the causes.
2. Confirm the existence of an outbreak (an increase in the number of cases/deaths than usual frequency).
3. Identify the most appropriate control measures.
4. Identify where and to whom to apply these measures.
5. Determine why the outbreak occurred?
6. Determine what can be done to prevent similar outbreaks in the future?

These investigations are conducted systematically by having a written protocol or plan to identify the underlying cause of the problem.

7. Verbal Autopsy

It is a special technique for investigation of cause of death. Trained worker or investigator conducts an in-depth investigation of the death (maternal or infant death or any other death) through interviews with the mother or any one else who was a witness to the death and the circumstances leading up to it. The investigations are done on a standard designed format or protocol.

Purpose

- The purpose is to ascertain the most probable cause of death.
- Whether the death could have been prevented or avoided by timely and appropriate measures.
- Workers can educate community as to how to prevent deaths as also common causes of death in the community.

8. Laboratory Surveillance

Laboratory testing confirms the syndromes of presumptive cases and helps in diagnosis of cases for case management.

9. Entomological Surveillance

Regular surveillance for vectors of diseases under national vector-borne diseases control programme is being done to know vector density and sensitivity to *insecticide*.

10. Environment Surveillance

Sewage samples for wild poliovirus detection besides air, water, noise and chemicals, surveillance.

NATIONAL SURVEILLANCE PROGRAMME FOR COMMUNICABLE DISEASES (NSPCD)

The Government of India launched NSPCD during 1997–98. The main objective was to strengthen the surveillance system of communicable diseases and developing capabilities at state level and district level so that disease outbreaks can be detected early in order to institute rapid response to avert morbidity and mortality. The programme was in operation in 101 districts in the country for monthly reporting of 20 CCDs. Now it has been integrated with IDSP.[3]

INTEGRATED DISEASE SURVEILLANCE PROGRAMME (IDSP)

In the year 2004, Government of India with World Bank assistance launched a project called IDSP. The project intended to cover all the states in phased manner.[4–6] IDSP is proposed to continue as integrated Disease Surveillance and Response Programme under NRHM with domestic budget in 12th plan and beyond as IDSP-Mission.

Project Objectives

- To establish a decentralized district-based system of surveillance for communicable and non-communicable diseases so that timely and effective public health actions can be initiated in response to health challenges in the country in urban and rural areas.
- Integration of surveillance activities of various health programmes and share information across all disease control programmes and stake holders, so that valid data are available for decision making at district, state and national levels.

Specific Objectives

1 To integrate all existing surveillance activities of national disease control/eradication programmes at district level. The IDSP integrates both public and private sectors, integrates communicable and non-communicable diseases programmes, integrates both rural and urban health systems with medical colleges.
2 To establish system of data collection, collation, compilation, analysis and feedback by using information technology.
3 To improve laboratory support for disease surveillance.
4 To develop human resources for disease surveillance and action (rapid response teams).
5 To involve all stakeholders including private sector and communities in surveillance.
6 To establish district epidemiology units.

Project Activities

- Upgradation of laboratories.
- Upgradation of information technology and communication.
- Human resources and development (training—consultant/contract staff).
- Operational activities and response.
- Monitoring and evaluation.

Target Diseases for Surveillance under IDSP

a *Regular surveillance*
1 Malaria
2 Acute diarrhoeal disease (cholera)
3 Typhoid
4 Tuberculosis
5 Measles
6 Polio (acute flaccid paralysis)
7 Road traffic accidents (link up with police computers)
8 Plague
9 Meningoencephalitis/respiratory distress, haemorrhagic fevers, and other unusual clinical syndromes.

b *Sentinel surveillance*
1 Integrated HIV/HBV, HCV surveillance
2 Water quality monitoring
3 Outdoor air quality (large urban centres)

c *Regular periodic surveys:* Screening for non-communicable diseases risk factors: Anthropometry, physical activity, blood glucose, blood pressure, tobacco, and alcohol use and danger signs of cancer breast, cervix and oral cavity.

Additional State Priorities

Each state may identify up to 5 additional conditions for surveillance, e.g. dengue, Japanese encephalitis, leptospirosis, filariasis, leprosy, diphtheria, leishmaniasis and tetanus neonatorum. Surveillance of ILI and SARI is in place under IDSP.

Scheme for Participation of Private Sector

It is estimated that over 70% of first contact providers are in the private sector. The IDSP envisages partnership with healthcare institutions or selected sentinel private sites (SSPS) in the urban and rural areas to improve the *coverage* and sensitivity of surveillance.

Types of Surveillance in IDSP

(S) ***Syndromic:*** Syndromic surveillance is defined as the surveillance of diseases based on the presenting symptom/s. Under IDSP, the health workers, village volunteers and non-formal practitioners are conducting syndromic surveillance. The cases identified through presenting symptoms are classified as 'suspect cases' of certain disease condition, e.g. a case of fever with rash, will be classified under the syndrome, fever with rash and not as measles. The lay case definition of disease have been widely circulated for this purpose. The clinical syndromes under surveillance are:

1 *Fever*
   - i Less than 7 days without any localized sign.
   - ii With rash
   - iii With altered sensorium or convulsion.
   - iv Bleeding from skin and mucus membrane.
   - v More than 7 days with or without localized signs.

2 *Cough:* Cough for less than or more than 3 weeks with/without fever.

3 *Acute flaccid paralysis* (AFP) in <15 years of age

4 *Diarrhoea:* Loose watery stools <2 weeks duration with no dehydration, same dehydration and severe dehydration.

5 *Jaundice:* Cases <4 weeks duration

6 *Unusual symptoms leading to* death or hospitalization. These syndromes are intended to pick up all priority diseases listed under IDSP for surveillance.[6–8]

(P) ***Probable:*** The medical diagnosis made on the basis of presenting symptoms and clinical signs by Medical Officer at a facility.

(L) ***Laboratory Confirmed:*** Clinical diagnosis confirmed by appropriate laboratory test.

Implementation: Reporting Units Participating in Regular Passive Surveillance under IDSP

The regular surveillance is passive in type and is being undertaken by Medical Officers.

For project implementation surveillance units with unique ID number have been set up at central, state and district levels (Table 7.13).

Table 7.13: Reporting units for disease surveillance

	Public health sector	Private health sector
Rural	Sub-centres, PHCs/CHCs, sub-district and district hospitals	Sentinel private practitioners and sentinel hospitals
Urban	Urban health centres, hospitals, ESI, railway and other hospitals, medical colleges	Sentinel private nursing homes, sentinel hospitals, medical colleges, NGOs and private laboratories

Data Management Weekly Reporting Formats

Under IDSP report is collected on weekly basis—every Monday. The information is collected on prescribed formats "S" (Syndromic), "P" (Probable cases) and "L" Laboratory confirmed cases filled by health workers, clinicians and laboratory staff respectively. Weekly data gives time trends. Whenever there is rising trend of an illness in the area it is investigated by Medical Officers/ Rapid Response Teams (RRT) to diagnose and control the outbreak. Data analysis and action are ensured by respective units. Emphasis is being laid on reporting of surveillance data form major hospitals both in public and in private sectors as also from infectious disease hospitals. To strengthen the transmission of data IDSP has established linkages with state and district headquarters and all Government Medical Colleges on a satellite Broadband Hybrid Network.

A 24 × 7 call centre has been established to receive disease alerts from anywhere in the country on a toll-free number, 1075 for verification and initiating appropriate action.[9]

Media Scanning and Verification Cell (MSVC)

This cell was established in July 2008 at NICD. Media scanning is one of the important systems of surveillance in detecting the early warning signals and giving feedback to surveillance units (SUs) for local action. Information published in leading national dailies on outbreak or unusual events is scanned by this cell for feedback to SUs by modern information technology. It supplements conventional disease surveillance system to detect outbreaks and appropriate action.

(A) METHODS OF DATA COLLECTION FOR DISEASE SURVEILLANCE

Data collection is the starting point of surveillance. The effectiveness of surveillance depends largely on quality

of data, regularity of reporting diseases, timely reporting and ensuring adequate coverage. A surveillance system counts the same event consistently everyday that meet case definition. The criteria for diagnosing diseases under surveillance should be uniform and therefore "standard case definition of disease" has to be evolved and practiced by all reporting units of surveillance. For the purpose of surveillance "standard case definitions" of diseases like AFP, HIV/AIDS, measles, tetanus, diphtheria, pertussis have been evolved and it is expected that all participating units adhere to these definitions. Simple, standard forms for recording and reporting cases are in place to achieve uniformity.[10] Data is collected by passive surveillance mostly. Active surveillance is mostly done during outbreak.

(B) COMPILATION AND TRANSMISSION OF DATA

The cases that have been detected and recorded need to be compiled and transmitted to the next level on regular basis once a week or daily. This should be done on a fixed date from each type of unit. All reporting units/centres will provide zero reporting if no cases were detected. Zero reporting is mandatory to confirm that the conditions were looked for and not found. Use telephone, fax, e-mail, special messenger, police wireless or any method to report immediately. The designation of the person responsible for data compilation and transmission at each level has been identified (pharmacist, computer, statistical officer, lab technician and Medical Officer). The quality of data filled up by the health staff need to be *checked/looked* into by a senior before transmission. Data transmission is not a clerical job, it requires thinking, and examination to see whether **signal** is there. Computers cannot contact physicians and laboratory to obtain missing information and are no substitute for *looking, thinking, discussing* and taking action. The health workers, Medical Officers of PHCs and sentinel private practitioners will provide regular reports on prescribed formats on every Monday.

(C) ANALYSIS AND INTERPRETATION OF DATA BY TPP

Data analysis: The process of analysis transforms raw data into *information for action.* Data are analysed by count, divide and compare (CDC) to generate information on **time, place and person** (TPP). CDC means count cases that meet case definition, divide cases by corresponding population denominator and compare incidence rates across time, places and persons (TPP).

Time analysis: By preparing an epidemic curve—histogram (graph): Incidence by date of occurrence of cases over a short time period, or by weeks, months or by years. It gives seasonality and trends of the disease (rising, declining or stable trend) (Fig. 7.8).

Interpretation of graph (histogram) of acute hepatitis (E): Cases started occurring 3 weeks after he strike at the water treatment plant as the water treatment stopped and

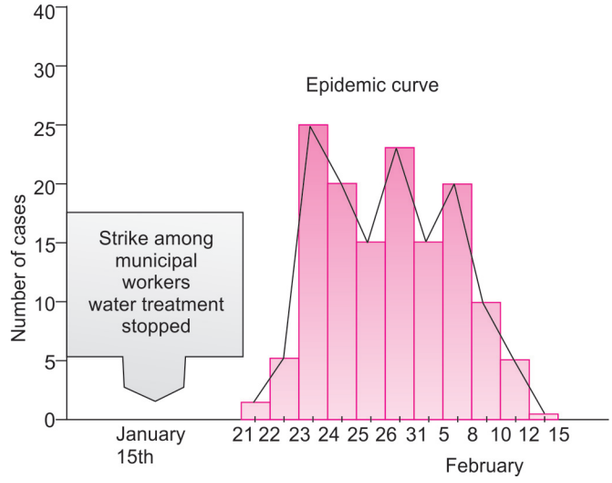


Fig. 7.8: Cases of acute hepatitis (E) by date of onset

people consumed unsafe water and suffered jaundice. The common source of infection persisted and continued to cause hepatitis E up to 12th February. After interventions the cases declined.

- The epidemic curve shows the magnitude of epidemic over times as a simple, easily understood visual.
- The *shape* of the epidemic curve may provide clues about the pattern of spread in the population, e.g. *point* versus *intermittent* versus propagated epidemic.
- The curve shows where you are in the course of epidemic still on the upswing, on the down slope, or after the epidemic has ended.
- The curve can be used for evaluation of interventions.
- Outliers—cases that do not fit into the body of the curve—may provide important clues.
- The incubation period can be estimated from the curve and epicurve can be used to deduce a *probable time* of *exposure from* the *peak* and median of curve.

Place analysis (data by incidence map):

Incidence maps take into account population size of affected block or locality as denominator (Fig. 7.9).

Interpretation of incidence map: Cases were clustered around a water source, i.e. in these blocks which draw water from river bed.

Person analysis: Incidence table by age, and sex.

Interpretation: Adults were mostly affected (Table 7.14).

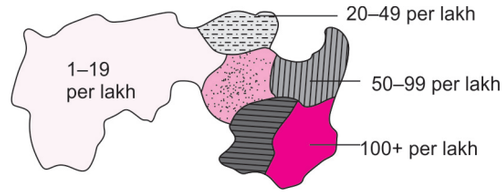


Fig. 7.9: Incidence map of acute hepatitis by blocks, attack rates per 1,00,000

Table 7.14: Attack rate of hepatitis (E) by age and sex

Age groups	*Cases*	*Population*	*Attack rate per 1000*
0–4	1	1000	1
5–9	11	21000	0.5
10–14	40	70000	0.57
15–44	400	50000	8.0
45+	70	50000	1.4
Male	400	100000	4.0
Female	122	92000	1.3

Hypothesis: Based on the investigations and analysis by time, place and person the hypothesis was generated. The river water may have been supplied untreated in the area of the outbreak because of the strike at water treatment plant.

- Risk ratio—80/10 = 8
- Proportion of cases exposed = 480/524 = 92%
- Population attributable risk = (50–10)/50 = 80%.

There was high proportion of case patients to the extent of 92% who drunk water from river bed pump (suspected source) versus 23% of controls (120/520 = 23%). Difference among cases and controls supports the hypothesis that river bed pump was the source of outbreak. Odd ratio of 37 (480 × 400/120 × 44 = 37) further strengthens the association of acute hepatitis with suspected source of water.

Results of case control study of an outbreak of acute hepatitis

Source of water	*Cases of acute hepatitis*	*Controls*	*Total*	*Attack*
Drunk water from river bed pump	480	120	600	80%
Did not drink water form river bed pump	44	400	444	10%
Total	**524**	**520**	**1044**	**50%**

- Ensure completeness and timeliness of reports by all units to interpret performance of the reporting units.
- Weekly/monthly summary reports is presented as tables, graphs and maps which are easy to interpret and visualize. Incidence rates are required to compare reporting units.
- Compare with previous weeks/months/years to capture trend of diseases overtime. Weekly analysis compare the current week with data from the last three weeks to detect the epidemics at early stage and alert authorities for immediate action. Monthly and yearly analysis gives information on long-term trends, seasonal patterns and cyclical pattern of disease.
- Compare the weekly and monthly data with established threshold levels to identify outbreaks early enough.
- Comparison should also be drawn between various units for incidence and case fatality rate for current month.
- Compare between public and private units for trends in number of new cases and deaths.
- Compare reports between public health system and the laboratory (data triangulation). Use multiple or different sources of information to cross validate data.

If there is an increase in the cases of dengue in the "p" forms check if there is surge in the number of fever cases in the "S" forms.

Thus use multiple or different sources of information to cross validate data (data triangulation).

Encourage data analysis at all the levels by medical officers, health supervisors and health workers. One can not combine cases reported on from 'S' and 'P' forms (syndromic and probable cases). The analysis is not complete until the most probable reason (hypotheses) for causation and spread of the disease is explained at each level and understood by those who collect these data. The data must be shared with people whose lives it affect most.

Ability to analyse and interpret data is an important skill in epidemiology for public health manager.

(D) ACTION (DECISION-MAKING)

Surveillance without action is useless.

Outbreak of viral hepatitis needs superchlorination of water supply or boiling of water apart from personal hygienic measures at community level. Action must be built in the surveillance system. The purpose of investigation and analysis is thus not only to determine what happened but also to decide how to control current outbreak and how to prevent further outbreak in the future.

Action for the malaria surveillance is full therapeutic treatment, radical treatment and selective spray programme and to control breeding of vector as also to educate people. Similarly, action for outbreak of polio necessitates mass polio vaccination or outbreak response immunization.

(E) FEEDBACK

To ensure that reporting units at various levels remain motivated and involved in the surveillance process, there must be regular communication back from higher levels of programme management to lower levels. This can be done through communication: in-staff meetings, preparation of brief reports and publication of newsletters. The feedback should include comments on the performance and quality in recording and reporting of cases and suggestions on solving problems in collection of data.

A newsletter is one of the best way of communication of information back to the reporting units. The newsletter may contain the collection of morbidity and mortality reports. The reader will like to compare disease trends in

their own areas with those of other districts or PHCs of the state/district.

Outbreak investigation, response and control—outbreak means unusual occurrence or unusual events. Surveillance detects the unusual by describing what is usual, everyday.

Detection of Outbreak (Unusual Events)

There are two ways to detect outbreaks

a *Event based surveillance*: Rumour register, community informants and media reports.

Rumour register is a source of information from community. Medical officers should investigate all rumours of epidemic prone diseases recorded in rumour register. Key community informants should be identified and involved in reporting of *unusual events*. Media is important source of information.

b *Case based surveillance or routine surveillance data analysis*: One of the common way to early detection is review the data from the routine surveillance and check if it crosses threshold levels and preset trigger levels in IDSP, then public health *alert* is issued.

Warning Signs of an Impending Outbreak

- Clustering of cases or deaths in time and/or space.
- Unusual increase in cases or deaths.
- Even a single case of measles, AFP, cholera, plague, dengue or JE.
- Acute febrile illness of unknown aetiology.
- Occurrence of two or more epidemiologically linked cases of meningitis, measles.
- Unusual isolates
- Shifting in age distribution of cases.
- High vector density
- Natural disasters

Threshold for disease or cut off level under surveillance that triggers predetermined actions at various levels: This is based upon the number of cases in weekly report. Trigger levels depend upon—type of disease, case fatality, incidence and trend of disease: Triggers for each disease have been worked out at state/national/international level.

Malaria Triggers: Single case of smear-positive in an area where malaria was not present for a minimum of three months or slide positivity doubling over the last three months or single death from clinically/microscopically proven malaria.

Acute Watery Diarrhoea/Cholera Triggers: A single case of cholera or epidemiologically linked case of diarrhoea/a case of severe dehydration or death due to diarrhoea in a patient >5 years old. Clustering of cases particularly in village or ward where more than 10 houses having at least one case of loose stools irrespective of age.

Viral Hepatitis: More than 2 cases of jaundice in a village or 1000 population.

Measles: Two or more cases with fever and rash per village (1000 population).

Japanese Encephalitis: Even a single case of probable JE or two cases with fever with altered consciousness/seizures in a village (1000 population).

Triggers lead to issue of an alert for actions at various levels.

Reporting of Outbreak: Health workers report to Medical Officer. Medical officer report outbreak to the district level nodal officer. The first information report (FIR) is submitted to district surveillance officer.

Competency addressed: The student should be able to:
CM 8.4: Describe the principles and enumerate the measures to control a disease epidemic.

How? Use real life situation such as outbreak of dengue fever, food poisoning or diarrhoel disease.

Principles and Measures to Control an Epidemic

1 *Verification of the outbreak:* Much time may be wasted due to false alarm. Even if the outbreak is detected from the routine surveillance data or through rumours/media, it must be verified lest it may be a data entry error. The fastest way to verify is to contact the Medical Officer nearest to the location of outbreak and request him for confirmation of outbreak. First information report (FIR) on form 'C' is filed by the reporting unit and submitted to district surveillance officer soon after the suspected outbreak is verified and actions taken at local level.

2 *Confirmation of outbreak (establish the existence of an outbreak)*: If there is an abnormal increase in number of cases as compared with past incidence or if the cases are epidemiologically linked or if some trigger events have occurred or if many deaths/hospitalization have occurred.

Increase in number of cases may be due to: Change in reporting system, changes in case definition, change in population size, and acute reporting of old chronic cases, etc.

3 *Confirmation of etiology (verify the diagnosis):* Outbreak must be investigated to identify the specific cause by RRT (Rapid Response Team). Sample from first 10 cases are enough to confirm the etiology. Do not wait to confirm etiology, action must be prompt as soon as the outbreak is reported based on clinical diagnosis. Step 2 and step 3 are addressed at the same time.

4 *Construct a working case definition and find cases systematically and record information:* Search/identify cases at health facility—clinic, hospital, PHC, CHC or by *active* surveillance or survey of whole population. Line listing of all cases by onset date, age, sex, outcome,

etc. is standard method adopted during epidemic investigation. In line-listing each column is a variable or characteristic and each line represents one person.

5 *Perform descriptive epidemiology and epidemiological investigation:* The basic aim of epidemiological investigations are to identify etiology, source of epidemic, route of transmission by using clinical diagnosis and laboratory support. Describe outbreak in terms of time, place and person (TPP) on the basis of count, divide and compare (CDC) principle.

6 *Generation of hypothesis:* The Rapid Response Team and local health teams, on the basis of TPP information gathered, will formulate a provisional hypothesis to explain the tentative cause of the outbreak. This will answers the following questions.

- What was the causal agent?
- What was the source of infection?
- What was the transmission pattern?
- Who were the people at risk?

7 *Verification of hypothesis:* This step involves case control studies. We study the chances of exposures in cases and controls in the population where epidemic has occurred. Odds ratio is calculated to establish weather association is causal or not.

8 *Response to an outbreak:* It has to be rapid response at local level; supported by rapid response teams of district or state. Action will differ with nature of epidemic (droplet air-borne water-borne, vector-borne, food-borne, and vaccine preventable disease outbreak, etc.). Control measures related to specific disease epidemic have been described in Chapter 8.

9 *Report on outbreak (communicate findings):* The detail report is prepared as to controlling the present outbreak and prevention of outbreaks of similar nature in the future.

The steps listed above may not follow the order or sequence, circumstances of the outbreak may dictate that a different order be followed. Control measures are implemented urgently.

SURVEILLANCE OF RISK FACTORS OF NON-COMMUNICABLE DISEASES[10,11]

(Tables 7.15 and 7.16)

The following major risk factors will be measured under IDSP: Tobacco use, alcohol consumption, raised blood pressure, obesity, diet, physical inactivity, diabetes mellitus and high serum cholesterol.

Definitions (American Diabetic Association): Diabetes mellitus: Fasting plasma glucose >126 mg/dl (fasting—at least 8 hours of overnight fasting).

- Impaired fasting glucose ≥111 to 125 mg/dl
- Normal fasting glucose <110 mg%
- Hypercholesterolemia: Serum cholesterol >200 mg%

Table 7.15: Definitions for categories of relative weight

BMI	*Category of relative weight*
<18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Grade 1 overweight
30.0–39.9	Grade 2 overweight
≥40.0	Grade 3 overweight

Source: WHO stepwise approach to NCD surveillance, 2005.

Table 7.16: Definitions and classification of BP levels

Category	*Systolic (mm Hg)*	*Diastolic (mm Hg)*
Optimal	<120	<80
Normal	<130	<85
High-normal	130–139	85–89
Grade 1 hypertension (mild) subgroup: Borderline	140–159, 140–149	90–99, 90–94
Grade 2 hypertension (moderate)	160–179	100–109
Grade 3 hypertension (severe)	≥180	≥110
Isolated systolic hypertension	≥140	<90

When an individual's systolic and diastolic BP falls into different categories, the higher category should apply.
Source: WHO stepwise approach in NCD surveillance, 2005.

WHO STEPWISE APPROACH FOR SURVEILLANCE OF RISK FACTORS IN NCDs

Step is sequential process of gathering information on key risk factors from persons in age 15–64 years.

Step 1: Surveillance is based on self-reported information. The core module of Step 1 comprises markers of sociodemographic profile, data on tobacco and alcohol use, diet and age, sex, family history and physical activity.

Step 2: Adds simple physical measurements (e.g. blood pressure, height, weight and waist girth) to the Step 1 data. Step 1 and Step 2 are desirable and appropriate for most countries.

Step 3: Incorporates data collection at levels 1 and 2, but adds measurements obtained from biochemical analysis, (fasting blood glucose and serum cholesterol, etc.

NCD Risk Factor Survey

The NCD risk factor survey Phase I was undertaken by ICMR in seven states (AP, TN, Kerala, Maharashtra, MP, Mizoram and Uttarakhand) in 2007–08. The risk factors included were—BMI, waist circumference, physical inactivity, diet, sociodemographic profile, fasting plasma

glucose, cholesterol and consumption of alcohol and smoking/tobacco use.[11]

Standard case definitions on CCDs and NCDs are given in respective chapters.

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Competency addressed: The student should be able to:
CM 7.7: Describe and demonstrate steps in the investigation of an epidemic of communicable disease and the principles of control measures.

Learning objective: The learning objective of this skill is to learn epidemic prone diseases, warning signals of potential epidemic and strategies of containment and prevention of epidemic under IDSP.

How? Use a real case study of a recent outbreak in an area, such as Covid-19 or dengue fever, Jaundice, etc. or any other public health emergency.

STEPS IN THE INVESTIGATION OF AN EPIDEMIC OF CCD—JAUNDICE AND PRINCIPLES OF CONTROL MEASURES

RECOGNITION OF CASES AND REPORTING (DETECTION OF OUTBREAK)—A CASE STUDY

The present situation was an urban resettlement and slum colonies. Initially, the people recognized their own signs and symptoms and reported to nearby health facility (Medical College, Rohtak and Civil Hospital, Rohtak). Subsequently, local press (newspapers) published the reports and drew the attention of civil and administrative authorities. Health workers of the urban slums like Revamping health posts and *Anganwadi* workers played marginal role in routine reporting as it was not built in the system of routine reports of urban areas. Similarly, private practitioners did not report the cases to district authorities. Press played major role in early reporting of this outbreak and district health authorities moved much later and appeared on the scene quite late. Outbreak requires recognition, reporting and rapid response; unfortunately the response of health authorities was late and people responded to their need themselves first of all. Over 400 cases of jaundice were recognized and reported from March 2000 to 30 Sept. 2000 (within a period of almost 6 months) to district health authorities from resettlement colonies (urban slums) of Rohtak town.

Verification of Outbreak

The Medical Officer of urban health post was contacted to verify the existence of outbreak. He confirmed the outbreak and identified the clustering of cases in five localities.

Establish the Existence of an Outbreak

People First

The existence of outbreak was established by ascertaining the facts from local people. People confirmed that it was an unusual occurrence, unprecedented as they recollected that such a large number of cases of jaundice have never been witnessed in the last 10 years or so. Health institutions and facilities did not provide basic epidemiological data on occurrence of jaundice of recent past (last year or preceding 2–3 years) because of nonexistence of system of surveillance in urban slums. Rapid Response Teams (RRT), which were pushed in, tracked the cases and gathered the essential data of affected persons and affected localities. Whole population of 5 localities which were affected worst, was surveyed through house to house visit in May 2000 by trained medical and paramedical personnel. Attack rates due to jaundice varied from 0.42 to 1.78% and worst affected locality was Naya Parav. Case fatality varied from 0 to 3.3% and overall case fatality was around 0.75% (Table 7.17).

Table 7.17: Place distribution reported cases and deaths due to viral hepatitis in Rohtak town from 23.3.2000 to 30.9.2000

Locality	*Population at risk*	*Cases*	*Attack rates (%)*	*Deaths*	*CFR*
Janata Colony	14420	127	0.88	2	1.6
Shivaji Colony	7625	66	0.80	0	0
Naya Parav	1856	33	1.78	1	3.3
Kamla Nagar	3947	21	0.64	0	0
Vijay Nagar	4930	25	0.42	0	0
Other localities (56)	120000	128	0.10	0	0
Total	**152778**	**400**	**0.33**	**3**	**0.75**

Confirmation of Diagnosis

Since viral hepatitis is distinct clinical syndrome, it posed no difficulty in diagnosis. Standard case definition of acute febrile illness of short duration (fever) with malaise, anorexia, followed by jaundice, hepatomegaly and abdominal tenderness in right upper quadrant, increase in serum alanine aminotransferase (ALT) >10 times the upper limit and serum bilirubin >2.5 mg% was applied, limited number of blood samples were collected and tested in laboratory of medical college, Rohtak, to confirm diagnosis.

Serological tests got done through national institute of communicable diseases indicated that outbreak was due to HEV. The samples were collected by postgraduates of community medicine and the outbreak was in fact investigated by them under the supervision of head of community medicine department of PGIMS, Rohtak. Jaundice was present in all the subjects, 74.4% of the subjects experienced fever before they noticed jaundice, 96.6% passed dark coloured urine, over 97% complained loss of appetite, vomiting was present in 69% and pain in right hypochondrium was experienced by 41% of individuals.

Characteristics of Outbreak in Terms of Time, Place and Persons (TPP) Distribution

Cases were distributed in 61 localities of Rohtak town. Spot map indicated clustering of 272 cases in just 5 localities which were adjacent to each other and had piped water supply from water works "2". Most affected localities were Naya parav and Janata colony with incidence rate of 1.78% and 0.88%, respectively. Locality-wise attack rate and case fatality is reproduced in Table 7.17.

GEOGRAPHICAL DISTRIBUTION PLACE DISTRIBUTION

The cases were plotted on spot map of Rohtak town (Fig. 7.10). This exercise indicated that the cases of jaundice were widely distributed as 61 localities were affected, however, clustering of cases was obvious in 5 localities which were contiguous to each other. Out of 400 cases, 272 (68%) cases were reported from these 5 colonies/localities. This identified worst affected geographical area. This area was dependent for its water supply from water works "2" situated about 1 km away from these localities. The piped water supply was intermittent and it was a common practice to use online booster pumps, blocked sewer lines, poorly maintained water lines, leakages and contaminated with drain waste water in the affected localities.

New Ekta Colony which had no piped water supply and was dependant on shallow hand pumps escaped from the onslaught of outbreak of jaundice, no case was detected/reported from this locality. Similarly, localities such as Medical College Campus, University Campus were free from jaundice because of independent system of water supply.

Time Orientation (Epidemic Curve)

Datewise line listing of cases of occurrence of jaundice was recorded by the investigators. From these data, weekwise occurrence of jaundice was analyzed beginning from month of March 2000 till Sept. 2000. The data of weekly occurrence was plotted (Fig. 7.11). Frequency of occurrence was plotted against that week and a curve was drawn by joining the frequencies. Cases started occurring in the month of March and peak occurrence was observed in the third week of April and another peak was observed in the first week of May. The epidemic curve indicated that maximum occurrence was in the month of April and May (over 53% of cases). These are the hot summer months when acute water shortages are experienced in the area. The decline started in the second week of May probably due to interventions. Sporadic occurrence continued even in the month of September indicating that the hepatitis has established its roots in the form of an endemic disease. Serial interval indicated average incubation period of 15 days.

Age and Sex Distribution Person Distribution

Twenty-two percent of cases of jaundice were in children below the age of 14 years. Majority of cases (78%) were above the age of 15 years. Of these 78% around 77% were in the age bracket 15–59, and the remaining 1% were above the age of 60 years. Nearly two-thirds (66.5%) were males and 34.5% of sufferers were females. Most of the households reported a single case only. Adult males were affected most.

Other Observations

Overall sanitary conditions in these localities were far from satisfactory. Piped water supply managed by public health engineering department was available to 92.5% of the households while 98% of households in New Ekta Colony were using shallow tube wells (hand pumps). Facility of sanitary latrines was accessible to 93.3% while open field defecation was practiced by 6.7% of households. 30.3% of the individuals did not wash their hands before eating,

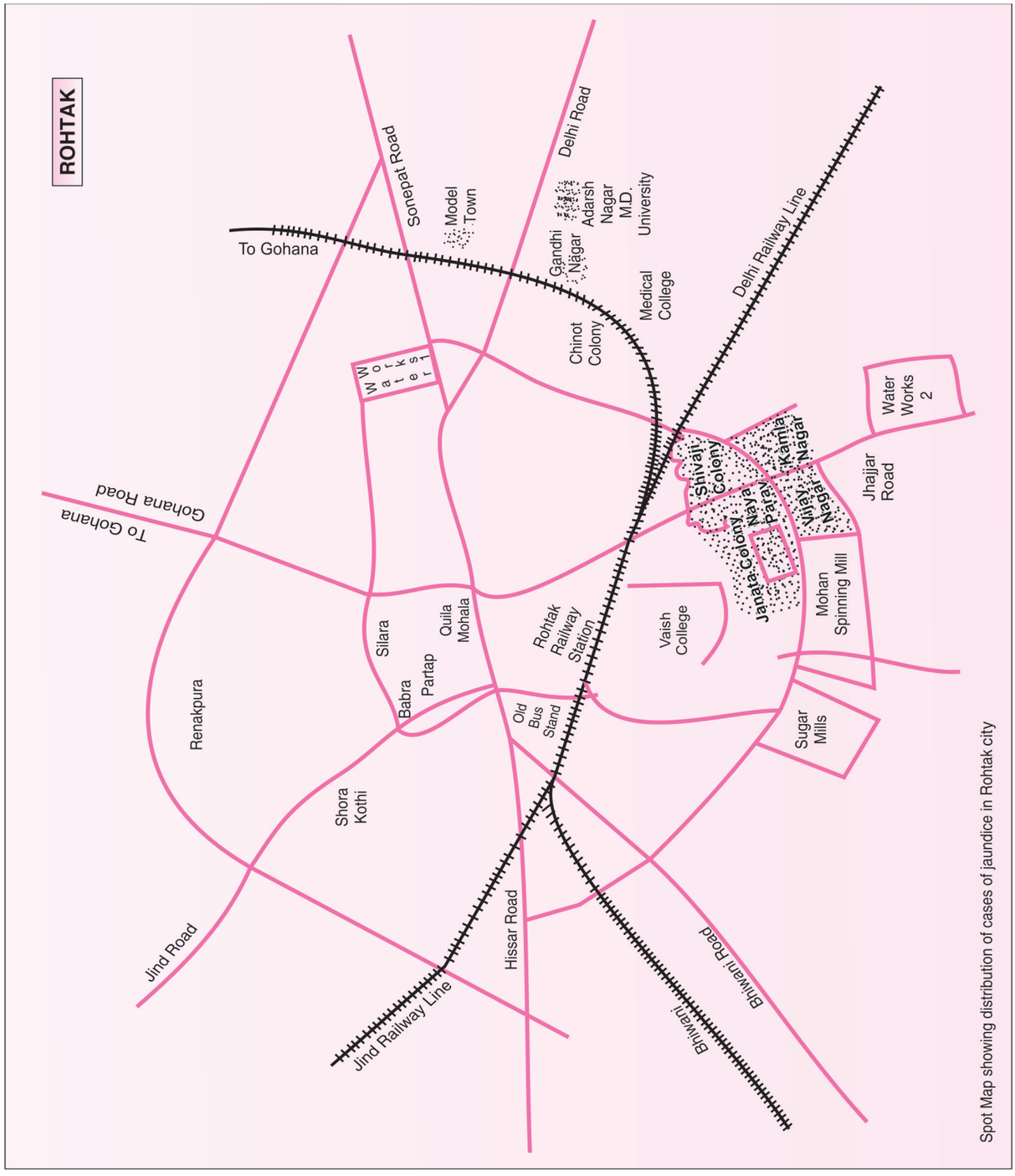


Fig. 7.10: Distribution of cases of viral hepatitis during outbreak (2000) in various localities of Rohtak city

however, 93.3% of individuals washed hands with soap and water after defecation. Drinking water was stored in pitchers by 84% of households and was drawn by dipping hands and glass, ladle was used by 27.4% of the individuals. Boiling of water during the outbreak was accepted by 15% of the families.

Laboratory Investigations and Confirmation

During the outbreak period the water samples were collected for spot test of residual chlorine by orthotoluidine test and coliform count in the laboratory. Residual chlorine was absent in nearly one-third of the samples at household level, while 3 out of 5 samples of

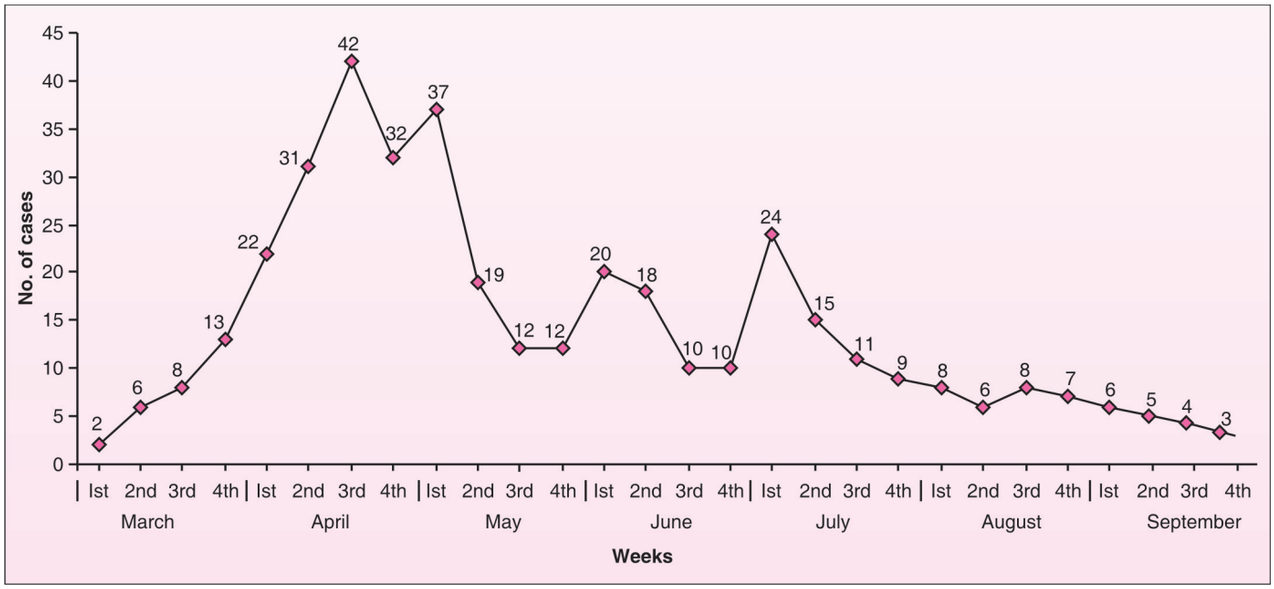


Fig. 7.11: Time distribution weekly incidence of jaundice from March to September 2000 in Rohtak town, Haryana (epidemic curve)

water were unfit for drinking because of unacceptable level of coliform organisms. District health authorities collected large number of water samples for orthotoluidine test and coliform count. Institutional investigation of admitted patients confirmed raised ALT to 10 times of upper limit and serum bilirubin to more than 2.5 mg% in many cases. Blood samples results from NICD and other laboratories indicated the outbreak of jaundice due to HEV. Out of three deaths, one death occurred in pregnant women.

INTERVENTIONS (RESPONSE TO AN OUTBREAK)

Superchlorination of water was done to ensure 0.5 ppm residual chlorine in the distribution system. Apart from this, home chlorination was resorted to whenever the orthotoluidine tests were found negative. Boiling of water at household level was accepted by literate and well to do people in these localities. People were educated to wash their hands with soap and water before eating and after defecation and also to store their water safe and draw water by use of ladle. *Anganwadi* workers of ICDS, health workers, malaria workers played pivotal role in inter-personal communication. Public health department identified and repaired the leakage, also chocked sewer were attended to urgently.

Declaring the Outbreak to be Over

In theory it is laid down that the authority should declare the outbreak to be over only when there have been no new cases for the duration of two incubation periods since the onset of last case. In the present situation outbreak was not declared as over. Active search was continued along with sanitary measures.

Even with all these measures sporadic cases due to hepatitis continued in the town. Maintenance of sanitation and sewerage system and ensuring safe water supply on sustainable basis is a real challenge. It requires regular monitoring of quality of water supply which is seldom ensured and these measures are undertaken only during outbreaks.

OUTBREAK REVISITED

In the year 2003, again 146 cases of viral hepatitis were reported in this town indicating breakdown of sanitation measures and failure of system of water supply and sanitation.

COORDINATION

The activities of investigation of outbreak of jaundice, its planning and implementation of interventions were undertaken jointly by the district health authorities, public health and engineering; ICDS sector, medical college and the people. The results of investigation were shared with all the participating sectors and with local people whose lives this outbreak affected most. The media was equal partner in dissemination of information to people. Each sector played its effective role during the outbreak and ensured utmost cooperation.

CONCLUSION

The present outbreak of jaundice (viral hepatitis) was most probably due to HEV; due to contamination of drinking water. Water works no. 2 was incriminated as those localities which drew water from water works no. 1 had very few cases in comparison to colonies which were

dependent on water works no. 2. Of 272 cases of jaundice clustered in just 5 localities versus 128 cases spread over to 56 colonies, and some localities were free from jaundice while in other localities very few cases were detected. Case control study thus incriminated contamination of drinking water of water works no. 2. It was learnt that the water works no. 2 augmented the water supply of some areas and because of that the localities such as Model Town, Gandhi Nagar, Adarsh Nagar and Sector 14 were also affected.

Expected outcome: The student prepares a histogram to show epidemic curve (time analysis), draws an incidence map (place analysis) and prepares a table of age and sex of affected persons (person analysis) of data of a case study and derives information for actions, e.g. Covid epidemic data (Chapter 20).

Competency addressed: The student should be able to:
CM 7.5: Enumerate, define, describe and discuss epidemiological study designs.

EPIDEMIOLOGICAL STUDY DESIGNS

There are various epidemiological methods used to study health problems or events in population. Some of the most commonly used epidemiological study designs are:[1]

1 Observational studies
- Descriptive studies
- Analytical studies:
  - Ecological
  - Cross-sectional
  - Case control
  - Cohort

2 Experimental or intervention studies:
- Randomized controlled trials
- Field trials
- Community trials

OBSERVATIONAL STUDIES

The observational studies collect evidence/evidences based on the direct observations on routine records, actual and routine happenings. Under observational epidemiology, an epidemiologist measures the incidence and prevalence of disease, deaths, defect or disability or any other event in the community or population and does not intervene. John Snow's Studies on Cholera in London were observational studies. The observational epidemiology falls in two compartments:

1 Descriptive studies
2 Analytical studies

DESCRIPTIVE STUDIES

The four Ws of descriptive epidemiology are:

What : Health event/disease of concern
When : Time
Where : Place
Who : Person

The descriptive epidemiology follows the principle of count, divide and compare (CDC). CDC means an epidemiologist:

Counts cases or health events and describes them in terms of time, place and persons.

Divides number of cases by the size of population in which they occurred to arrive at rates.

Compares these rates over time, place and different groups of people/persons.

In essence descriptive epidemiology describes the health events in terms of time, place and person (TPP). This can be better understood in terms of 3 Ws, i.e. when (Time) did the disease occur—Date of onset of disease, where (Place) did it occur and who (Person) were affected by the disease. Compiling, analyzing and interpreting data by time, place and person provides important clues to the causes or risk factors of disease, source of infection and mode of transmission, and these clues can be helpful in generating hypotheses.

The descriptive studies in epidemiology simply describe the occurrence of disease in the community and it estimates/measures the incidence, prevalence, trends and distribution of disease or diseases in population. Descriptive studies use data of routine reports or records or data of special surveys. Descriptive studies describe the health status of the community-based on parameters like under-five mortality, infant mortality, per capita income, life expectancy, total adult literacy, poverty rates, school enrolment, nutritional status, percentage of children immunized, percentage of population using improved drinking water sources and sanitation facilities, incidence of ARI and diarrhoea, prevalence of HIV/AIDS, etc. The descriptive studies are most commonly used to produce evidence-based data for appropriate action. Since time immemorial, the observations made on occurrence is the first step towards scientific investigations.

Time Distribution (Table 7.18)

1. Long-term or Secular Trends

Long-term study of incidence of disease is called "secular trend" of disease. The time distribution of malaria from the year 1935 to 2016 indicates that over the years the reported incidence of malaria has declined from 100 million in the past to 1.08 million cases in 2016. In India, we reached a low level of incidence of malaria in 1965 when it was just 0.1 million and it escalated to 6.47 million in the year 1976.

Table 7.18: Secular trend of malaria in India

Years	*Malaria cases in millions*	*P. falciparum cases in million*
1935	100	–
1947	75	–
1965	**0.1**	–
1976	6.47	0.75
1984	2.18	0.65
1986	1.79	0.64
1987	1.66	0.62
1988	1.85	0.68
1989	2.05	0.76
1990	2.02	0.75
1993	2.21	0.85
1994	2.51	0.99
1995	2.93	1.14
1996	3.04	1.18
1997	2.66	1.01
1998	2.22	1.03
1999	2.28	1.14
2000	2.03	1.05
2001	2.09	1.01
2003	1.87	0.86
2006	1.79	0.84
2007	1.51	0.74
2009	1.56	0.84
2010	1.49	0.77
2012	1.06	0.53
2014	1.10	0.72
2015	1.13	0.75
2016	1.08	0.71
2019	1.33	0.15 (approx)
2020	1.18	0.11

This marked the resurgence of malaria in India. After 1976, the incidence of malaria stabilized at high incidence of over 2 million cases per year and since 2002 it has shown some decline to the level of 1.84 and 1.65 million in the year 2002 and 2003 respectively; it further declined to 1.49 million in the year 2010 and to 1.08 million in 2016.[2,3] Case load declined to low level of 0.18 million in 2020.

The decline to 0.1 million cases in 1965 speaks of success of interventions of malaria control programme. The rise of incidence to 6.47 in 1976 speaks of resurgence and failure of interventions/programme.

Impact of Observations

The epidemiological observations of high incidence of malaria in 1976 necessitated change in strategy of malaria eradication programme and modified plan of operation was evolved (MPO of malaria) in 1977.

Further long-term trends of falciparum malaria (which is killer malaria) indicates rising trend over the years and now over 50% of malaria is due to *Plasmodium falciparum* or *Pf* malaria. This observation is a cause of concern. Drug resistance in *Pf* malaria and insecticide resistance in mosquitoes has added more problems. Right now the epidemiological situation of *Pf* malaria is grim.

Application

By studying the disease like malaria over the years we can determine:

- The success or failure of national programme of malaria.
- It helps for re-planning and re-thinking about the strategies.
- It helps us to know the changing pattern of disease as falciparum malaria incidence has increased significantly in India.

2. Seasonal Distribution

The incidence of malaria is not uniform all over the year. The incidence rises in the months of July to October because of favourable conditions for transmission of malaria. After rains, the mosquito breeding and density of vector increases and transmission becomes favourable, hence the incidence rises. This is known as seasonal variations in malaria occurrence. Rise of malaria in these months is a caution to get ready with the system to fight disease: Mounting spray operation well before transmission period and adequate coverage with indoor residual insecticides, stepping up operations of surveillance in these months and raising the target of active case detection during transmission season. Thus, seasonal variations of malaria help us to gear up plans to fight against malaria.

3. Short-term Variations

Day of week and time of day: For occurrence of road traffic accidents, occupational diseases/exposures displaying data by day of the week or time of the day may be more informative. Pattern of these occurrences may suggest hypothesis and possible explanation.

Epidemic curve: Distribution of cases by date of onset or by hour of onset, the epidemiologist can draw an epidemic curve or histogram. In epidemic curve 'Y' axis shows number of cases and 'X' axis shows the date of onset. The shape and other features of an epidemic curve can suggest hypothesis about the time and source of exposure and the mode of transmission.

The short-term fluctuation in the occurrence or incidence of malaria indicated that the disease has attained an epidemic proportion or outbreaks in certain years. Malaria is an endemic disease in the country. When it occurs beyond the expected level (usually compared with past year or past years occurrence) then we call this behaviour as an epidemic proportion of occurrence, i.e. "when the malaria occurrence is clearly in excess of normal

occurrence or expected occurrence then it is termed epidemic of malaria".

In the years 1994, 1995 and 1996 (Table 7.16), there were fluctuation in occurrence of malaria, as incidence of malaria in these years increased beyond two million, hence, these were the epidemic years for malaria in several places. The incidence of malaria suddenly increased as also the number of deaths.

4. Cyclical Variations

Malaria has cyclic pattern. In unstable malarious areas outbreak/epidemic occur every 8–10 years under natural conditions. In effective and efficient control programme conditions cycle may appear after 15–20 years whereas under the partial implemented control programme situation the cycle may come after 5–7 years. Cyclical variations are observed as spikes or rise in incidence of disease at regular interval of one or two years in some diseases like measles as also in smallpox which has now been eradicated. This is probably due to accumulation of susceptible individuals, i.e. young children who received no vaccination/immunization, against measles. Measles outbreaks are generally due to accumulation of measles susceptible children including both unvaccinated children and those who were vaccinated but failed to seroconvert, approximately 15% of children vaccinated at 9-month are not protected after measles vaccination. Similarly, meningococcal meningitis shows cyclic trends after every 8–12 years.

Place Distribution[4]

Distribution of disease in a district, state or country, or a geographical area is significant determinant and provides clue for prevalence of special risk factors in that area.

Malaria as a disease is public health problem in India; its distribution is not uniform all over India. Some states show high incidence while some states have low incidence of malaria (Fig. 7.12).

During 2015, close to 1.13 million cases of malaria were reported from the country with 0.75 (67%) million being those of *P. falciparum*.

Two states, namely Odisha and Chhattisgarh, contributed 50% of total malaria cases, these were the high burden states for malaria incidence (Fig. 7.12A).

Four states—Odisa, Chhattisgarh, Jharkhand and Meghalaya contributed nearly 50% cases of *Pf* malaria in India in the year 2015 (Fig. 7.12B).

These two states have high percentage of tribal people, health services are poorly developed, poor surveillance and treatment facilities not easily accessible because of lack of infrastructure facilities. Problem of drug resistance may be acute in tribal belts of these states.

Geographical mapping of malaria or geographical information system (GIS) of a disease provides useful information and helps classify the areas for different control strategies. Based on geographical distribution of malaria the problem areas were broadly classified as under.

Hard-core Areas (Tribal Areas)[5]

These are those areas where malaria control operations over the last four decades have failed to contain the disease, such areas have the following characteristics:

- These are mostly difficult terrain areas, large part of which becomes inaccessible during monsoon and subsequent flooding.
- The population is predominantly tribal.
- They have predominant *Pf* malaria.
- They have *stable malaria* with transmission period extending up to 9 months or more.
- These report bulk of deaths due to malaria in the country.

These areas comprise seven North and Eastern States, tribal areas of 87 districts of Andhra Pradesh, Bihar, Gujarat, MP, Maharashtra, Odisha and Rajasthan.

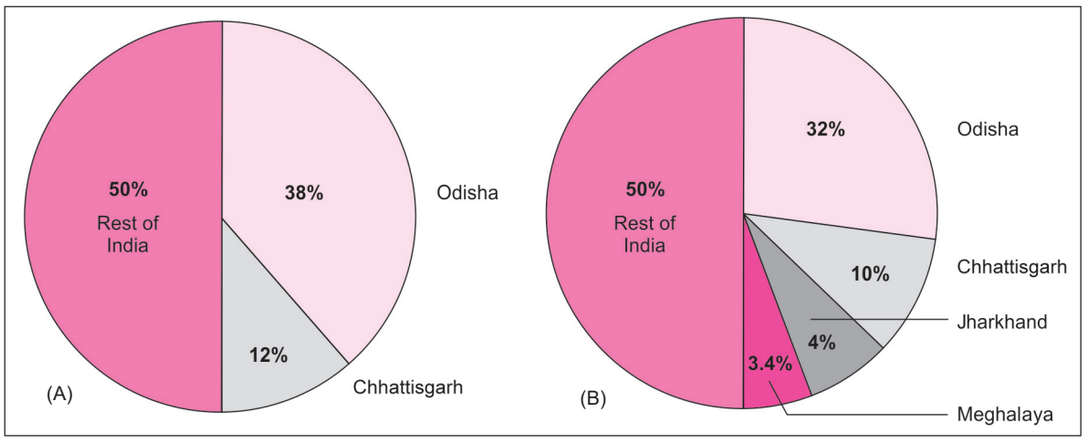


Fig. 7.12A and B: (A) Distribution of malaria cases in India 2015, (B) distribution of falciparum malaria in India 2015

Epidemic Prone Areas

High-risk areas are considered to be those which are often prone to malaria outbreaks or epidemics. The periodic fulminating malaria epidemic contributes a large number of malaria deaths. North Western plains, semi-arid climatic zone with annual rainfall up to 100 mm and Indo-Gangetic plains are identified as major epidemic prone areas. During epidemic, the malaria deaths in these high-risk areas outnumber the malaria deaths reported from the rest of the affected states. These areas have *unstable malaria,* with seasonal variations.

Project Areas

The development projects attract large number of migrant labour population from endemic areas bringing different strains of malaria parasites as well as non-immune population groups. The prolific increase in vector breeding places and increased man mosquito contact favours high transmission of malaria.

Example: Construction activities in metropolis, in and around Delhi, Gurgaon and Faridabad, migrant industrial labour and brick kiln labour are examples of project areas which become vulnerable population for many other problems apart from spreading malaria. Specific control strategies are required for such areas.

Urban Areas

Review of past data indicates that the following 15 cities are accountable for nearly 80% of cases of urban malaria scheme (UMS) of NMEP.

These cities are Delhi, Chennai, Kolkata, Mumbai, Hyderabad, Bengaluru, Bhopal, Ahmedabad, Jaipur, Lucknow, Chandigarh, Vadodara, Vishakhapatnam, Vijayawada and Kanpur. City of Chennai alone contributes half of malaria cases in Tamil Nadu.

These urban areas have unplanned and rapid growth, with prolific increase in slum population, large size of floating population, poor water management, civic by-laws for control of mosquito population are absent or not implemented and case finding mechanism is either absent or very poor and there is insufficient staff for antilarval activities. These urban areas require **different strategies** for control of malaria.

Triple Insecticide Resistant Areas

The ubiquitous rural vector, *Anopheles culicifacies* has become resistant to the conventional insecticides, namely DDT, BHC and Malathion in the Western belt of India specially Northern parts of Maharashtra and Karnataka and Southern parts of Gujarat. Alternate insecticides such as synthetic pyrethroids are considered for indoor residual spray in these areas.

Based on the observations and epidemiological situation the expert committee has used the epidemiological parameters to identify the worst affected areas in different malaria paradigms.

Rural Urban Distribution

The health indicators are usually low for rural areas as compared to urban areas. The distribution of diseases vary in urban and rural areas. Density of population is much more in urban areas, urban slums are worse than rural areas in many ways. The plan of action suggested for "high-risk" rural and urban areas for malaria is being implemented under National Programme of Control of Malaria. During the year 2013 in India, rural areas had very high share (92.6%) of malaria in comparison to urban areas (7.4%) (Fig. 7.13).

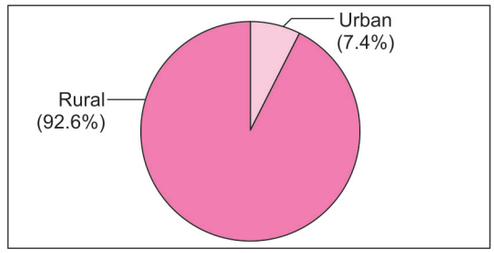


Fig. 7.13: Urban and rural malaria incidence recorded by malaria surveillance system under NMEP (2013)[5]

Person Distribution

The descriptive studies describe the distribution of disease according to characteristics of the person (host) like age, sex, race occupation, literacy, marital status, social class and health behaviour (lifestyle), resident or migrant, etc. The disease pattern varies with age of a person; diseases of infants, young children, adolescents, youths and adults and old age vary considerably. Common age classification for the purposes of epidemiology is as under: Under one year, 1–4 yrs, 5–14 yrs, 15–24 yrs, 25–34 yrs, 35–44 yrs, 45–54 yrs, 55–64 yrs, 65 yrs and over.

or

Age classification for special statistics of infant mortality: Under 7 days, 7–27 days. 28 days but under 1 year of age. For malaria control programme, age classification adopted is 0–1 year, 1–4 years, 5–8 years and 9–14 years and above 15 years for the purpose of distribution of drugs and study the incidence of fever and malaria in different age groups as also to calculate **infant parasite rate** which is an indicator of recent transmission of malaria in the community and it confirms local transmission of malaria during the current transmission period. Age incidence of a disease helps us to identify high *risk groups* or *vulnerables*, at which age to initiate immunization for measles, polio and other diseases.

$$\text{Infant parasite rate (IPR)} = \frac{\text{No. of infants found positive for malaria parasite}}{\text{Total no. of infants blood smears examined during survey}} \times 100$$

Age Distribution

Malaria affected all age groups in the rural community of this block. It means all age groups or whole of population is exposed to occurrence of malaria.

Sex Distribution

Similarly both sexes were affected, however, incidence of malaria in adult males was of high preponderance as compared to females, probably due to more outdoor exposure and outdoor sleeping habits (Table 7.19). This observation needs further studies and verification.

Table 7.19: Age and sex distribution of malaria cases in a rural block[6]

Age groups (years)	*Sex*	*Cases of malaria year 1996*
0–1	M	4
	F	10
1–4	M	116
	F	97
5–8	M	239
	F	195
9–14	M	404
	F	209
15 and above	M	1432
	F	1183
Total		**3989**

Source: Health Centre PHC Chiri Population around 1,00,000.

On the basis of observational or descriptive epidemiology, the evidence gathered *provides a ground for analytical epidemiology for testing of various hypotheses or speculations*.

Hypothesis means a tentative theory or an assumption to prove or disapprove.

From the data of national malaria control programme following *hypotheses* can be developed why falciparum malaria is showing rising trends in India. What makes malaria to stay at high annual incidence of around two million cases?

Why there is variation of incidence and distribution of malaria in different states of the country?

To answer these questions or to prove/disapprove the *hypotheses* we use the knowledge of analytical epidemiology.

ANALYTICAL STUDIES (WHY AND HOW?)

The analytical epidemiology determines the relationship between the health status (incidence and prevalence of disease) with other variables or exposures or risk factors associated with occurrence and distribution. While descriptive epidemiology describes the health status and its distribution in population, the analytical epidemiology focuses on "determinants", *risk factors* and *reasons* for such situation or status in the population. Analytical epidemiology studies **cause to effect relationship** (*why* and *how* of health event). The key feature of **Analytic Epidemiology** is a **comparison Group**.

a. Ecological Studies

Ecological studies are also known as *correlational studies*. The focus and unit of analysis in these studies is population or groups of people. These studies provide an indirect evidence or clue of some events.

1 National malaria eradication estimates on malaria morbidity (incidence) have been cross-checked, to the extent possible on the basis of consumption of antimalarials especially chloroquine phosphates and it has been suggested that a more realistic and safer assumption would be that 20–30 million episodes occur every year as against 2–3 million cases reported by NVBDCP. This provides an indirect evidence of incidence of probable malaria based on the sale of chloroquine tablets in the country.

2 The occurrence of deaths and injuries due to road accidents can be linked to increase in population of vehicles on road. For example, Table 7.20 provides clues to accidents in Delhi.

As the population of vehicles increased on roads the number of fatal accidents went up in the national capital of Delhi. Many of the deaths in 2011 occurred at "black spots" at places, which have been notorious for years.

Ecological studies are quite attractive but the results are difficult to interpret. As in the above data as the number of vehicles increased the air pollution also went up and evidence of increased respiratory infections may provide some clue and correlations.

Commercial anti-tuberculosis drug sales data in India in 2014 offered an empirical foundation for disease burden estimate of TB. It was estimated that 2.2 million

Table 7.20: Trends of fatal road accidents in Delhi

Year	*Vehicles (lakh)*	*Road length (km)*	*Population (lakh)*	*People killed in accidents*
1971	2.17	8380	43	NA
1981	5.61	15,490	62	1072
1991	19.23	22,487	94	1778
1996	27.93	25,948	114	2361
2001	35.89	25,948	137	1842
2004	44.00	25,948	160	1812
2011	72.28	Do	167	6937
2014	88.27	–	–	–

Source: Police Department, Delhi

cases were being treated in private sector, two to three times higher than currently assumed.

Ecological studies are rapid methods of getting clue for some evidences and based on the initial clues, the study can be enlarged.

b. Cross-sectional Studies

These studies are also called "prevalence studies". The hallmark of cross-sectional studies—these studies are done on part or sample of population representative of an area. In cross-sectional studies, the "exposure" and the "health effect" are measured simultaneously. In cross-sectional studies, it is not easy to measure the **cause** and **effect relationship.**

These studies are easier to conduct and results are available quickly with affordable cost.

Usefulness

- These studies provide quick estimate of **burden** of disease in the community.
- It also identifies individuals/**population** or groups at risk.
- Variation of disease or event in different **geographical** areas.

Examples of Cross-sectional Studies

There are innumerable examples. Most studies done (over 90%) are cross-sectional in nature. The major cross-sectional studies conducted in the country are:

1. National family health survey (1–5) done once in five years. These provide data on key health and family welfare indicators such as fertility, use of contraception, mortality, coverage and quality of maternal and child health services by states. Integrated NFHS is new being done every three years.
2. National sample surveys (NSS).
3. District level rapid household and facility surveys, under reproductive and child health programme, every alternate year, to know the utilization of services and coverage of services for mothers and children.
4. Sample registration survey (SRS) done every year provides state level estimates on birth, death and infant mortality rates.
5. Another example of cross-sectional survey is outbreak investigation and response.

c. Case Control Studies (CCS)

Purpose

The purpose of case control study is to determine or investigate the **cause** or **probable exposure** or risk factors for that disease.

1. Case control studies focus on disease or sick persons. These studies are also simple and economical to carry out.
2. In addition to **cases** of disease, a suitable comparison or **control group** is also chosen/selected. Control group consists of people who are healthy and not affected by the disease, which is being studied.
3. The occurrence of **possible cause/exposure** is compared between **cases** and **controls**.
4. The case control studies collect data at more than one/different points of time and are thus longitudinal in contrast to cross-sectional studies, which collect data at one point of time. CCS Produce moderate evidence of **cause** to **effect** relationship.

Steps in Case Control Study

The case control study follows the following steps.

- It begins with selection of cases of a disease. To select "case", we must adopt a standard case definition and include cases in the study who meet standard case definition. *Example:* All adults 15–49 years who are HIV positive or adults who are positive for malaria parasite.
- The cases can be selected from a hospital or from the community.
- Selection of controls or healthy people: Again, controls can be close relatives of case or the controls can be selected from community or hospital/clinic (attendants coming with patients).

Controls should match with cases in respect of age, sex, social customs, culture and economic status and belong to the same background from where patient or case is selected. Preferably, controls should be chosen from the same population from where the cases are chosen.

Classical example of case control study is a marriage party of 150 men (Table 7.21).

Table 7.21: Association between ice cream consumption and development of diarrhoea and vomiting in the year 2004 in a marriage party

Disease		*Exposure (consumption of ice cream)*		
		Yes	*No*	*Total*
VOMITING AND DIARRHOEA	Yes	80	20	100
	No	20	30	50
	Total	**100**	**50**	**150**

Out of 150 persons who took part in marriage party, many suffered due to vomiting and diarrhoea and others escaped. Those who suffered were *cases* and those who did not suffer acted as *controls*.

Principles of Association

In most case control studies, the population is not well defined and the total number of people exposed or unexposed to a suspected food item/risk factor is not known. Without a proper denominator attack rates can not be calculated. For a case control study, the measure of association of choice is the **Odds ratio**.

The association of occurrence of vomiting and diarrhoea, with ice cream consumption can be measured

by calculating the odds ratio (OR), which is the ratio of the odds (chances) of exposure amongst cases to the odds of exposure amongst *controls*. Odds ratio is sometimes called the *cross product ratio*.

From the data in Table 7.21, the odds ratio can be calculated by:

$$(80:20) \div (20:30)$$

$$\frac{80 \times 30}{20 \times 20} = 6$$

Measure of Association

It means that the cases were 6 times more likely than the controls to have consumed ice cream. Here in this example these were the natural controls who did not consume the ice cream. The association between consumption of ice cream and development of vomiting and diarrhoea is **causal** as the size of the risk ratio is more than 2. The odds ratio is very similar to risk ratio. Here there were natural controls, who did not consume ice cream.

In a rural community development block, 2700 births occurred in 100,000 population in the year 1996 of these 900 births weighed below 2.5 kg and the rest 1800 had birth weight of 2.5 kg and above (Fig. 7.14). We wish to test the following hypotheses:

- To determine or ascertain the **causes** or **risk factors** of low birth weights in this block.
- Could it be due to moderate or severe anaemia in pregnant women, or could it be due to high parity (4 and above) or less birth interval. Are low birth weights common to primipara or to girls marrying in teen ages and having teen age pregnancy? To answer these questions or to test these hypotheses, we carry out **case control study.**

Definition of Case

- In this setting, the case is a live birth weighing below 2.5 kg.
- Controls—live births in the same area weighing above 2.5 kg.

We study the attributes or exposures like anaemia, parity, age of marriage, parity of women who gave birth to these children by interviewing or looking at the records and obtaining the history of these exposures. After ascertaining these exposures in *cases* and *controls* the data are compiled and analysis done.

In this **contingency table** of 2 × 2 (Table 7.22), we depict the respective frequencies or numbers and calculate the odds ratio. The odds ratio of 5.44 indicate that mothers of low birth weight babies have over 5 times more chances of severe anaemia as compared to mothers of babies who have adequate birth weight. Thus, severe anaemia during pregnancy has **causal association** with low birth weights.

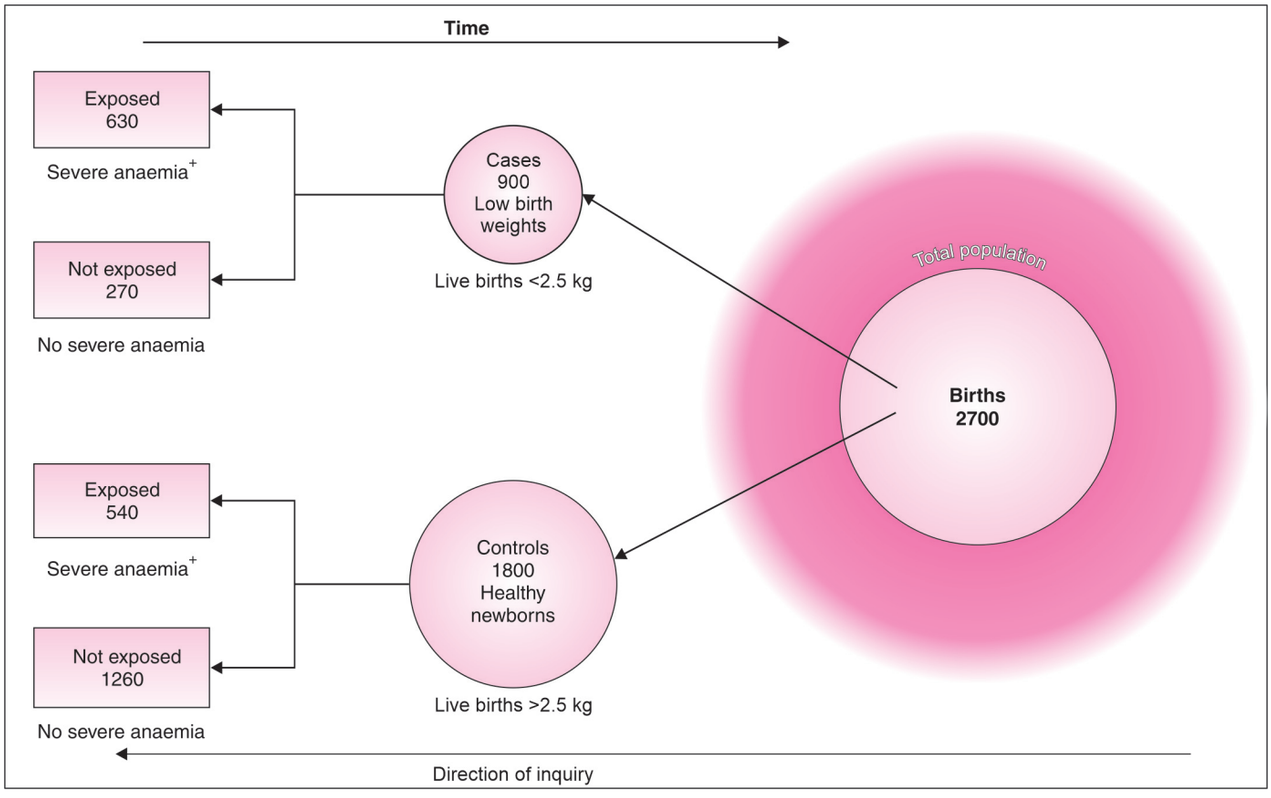


Fig. 7.14: Design of a case control study—severe anaemia of mother and birth weights

Table 7.22: Association between low birth weight and severe anaemia in pregnancy

Exposure			Birth weight		
			<2.5 kg	>2.5 kg	Total
ANAEMIA OF LESS THAN 7g	+	Yes	630	540	1170
	–	No	270	1260	1530
		Total	**900**	**1800**	**2700**

$$\text{Odds ratio} = \frac{630 \times 1260}{270 \times 540} = 5.44$$

d. Cohort Studies

The cohort study measures the incidence and for this reason cohort studies are also called *incidence studies*. In cohort study, the focus is on *healthy population*. The healthy population is divided into two subgroups: One group is that which is exposed to the risk or risk factor is present in that subgroup and the second subgroup is free from risk or exposure. Both these groups, i.e. **exposed** and **non-exposed** should match each others in terms of age, sex, economic status and other attributes but for exposure.

Purpose

Cohort study has two purposes:

- To measure the incidence of disease.
- To find out or determine the cause of disease.

Advantages

Cohort study provides the best evidence about the causation of disease and the most direct measurement of the risk of developing disease.

Disadvantages

- The cohort studies require long time period for follow-up of subjects and many of the subjects may be lost to follow-up.
- The cost involved may be too much.
- If the incidence of disease is low or it is rare very large sample size has to be studied.

Cohort studies are easier to conduct in young children, to study the growth and development and mortality in the first month or first year of life. Similarly, these are easier to conduct in pregnant women to study the outcome of pregnancy and associate the outcome with different variables.

Notable examples of global cohort studies are Framingham heart study, MONICA study on heart disease and Doll and Hill study on smoking and cancer.

Design of Cohort Study *(Fig. 7.15 and Table 7.23)*

During the year 1996 in a rural community development block in 1,00,000 population, 2700 births occurred. Of these 900 were low birth weights and 1800 weighed 2.5 kg or more. These two subgroups of births were followed for one-year period to study the effect of mortality/incidence

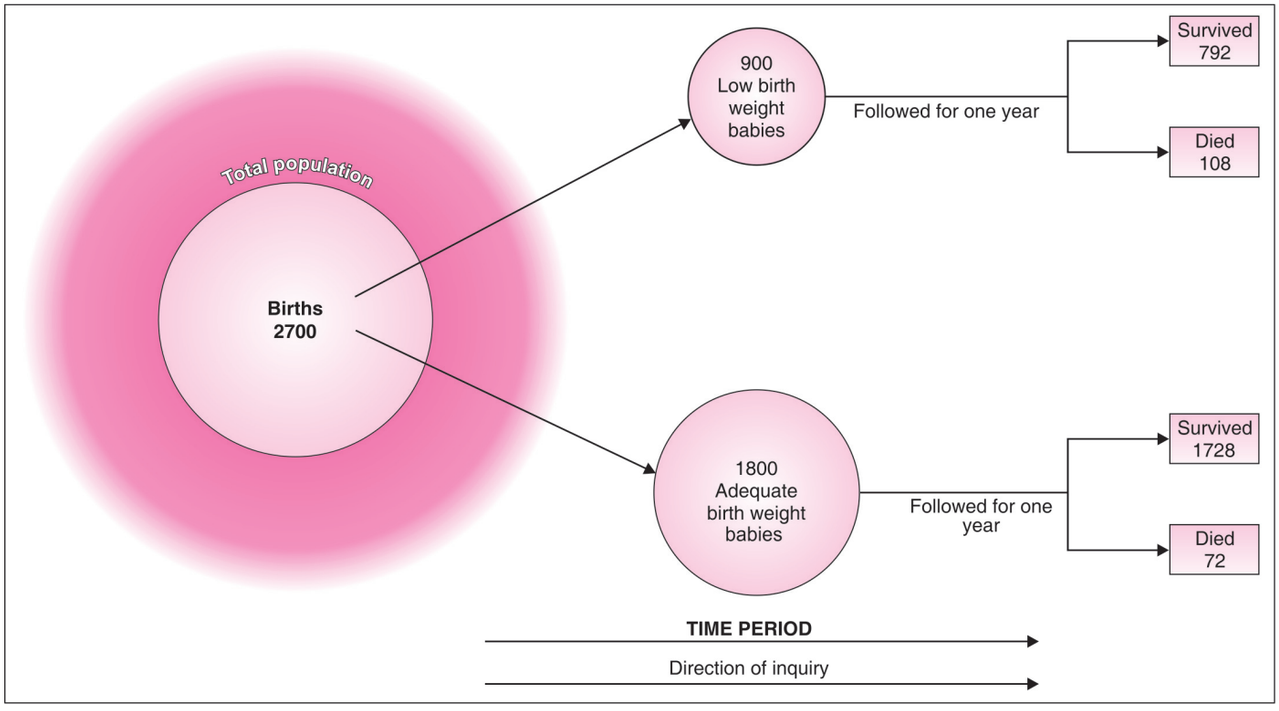


Fig. 7.15: Design of a cohort study

Table 7.23: One year follow-up of cohort of 2700 births in a rural block to study incidence of mortality in LBW

Birth weight (kg)	*Number*	*Survived*	*Died*	*Incidence of infant mortality*
<2.5	900	792	108	120
>2.5	1800	1728	72	40
Total	**2700**	**2520**	**180**	**67**

of mortality in the first year of life. The hypothesis was that incidence of death is much more in babies who are born with low birth weights (Fig. 7.15 and Table 7.23).

Principle of Association/Causal Association

The incidence of infant mortality (IMR) was 120 per thousand live births in low birth weight babies while IMR of 40 was observed in babies who had adequate birth weight. The incidence of IMR was three times higher in low birth weights as compared to normal birth weights after a follow-up period of one year. Thus, risk ratio of infant mortality ($I_E \div I_{NE}$) was measured as 120/40 = 3. Low birth weight was *cause* of high infant mortality.
I_E = Incidence in exposed. I_{NE} = Incidence in non exposed

Attributable Risk

Risk difference or attributable risk = 120–40 = 80.

The incidence of 80/1000 infant deaths was attributable to low birth weight in this study (Table 7.23).

Population Attributable Risk

This is incidence of infant deaths in total population (–) incidence of infant deaths in births with adequate weight divided by incidence of infant deaths in total population.

$$= \frac{67 - 40}{67} = \frac{27}{67} \times 100 = 40\%$$

This means 40% of total infant mortality could be prevented in the population if the risk factor of low birth weight is eliminated in the community.

The incidence of mortality can be obtained for different periods such as during the first 7 days of life, up to 28 days of life and 28 days to less than one year to capture early neonatal, neonatal and post-neonatal component of infant mortality.

Second Model (Table 7.24)

The cohort of young children was followed for one year period to study the incidence of morbidity. Once a week follow-up of young children was ensured at village level by *Anganwadi* workers and mothers themselves. The child weeks of follow-up were calculated as some children were entering and some were leaving and some were dying in the study group at different points of time, hence, person time in terms of weeks followed was used. For example, if a child could be followed up for 52 weeks that child contributed 52 weeks and a child who entered in the study group on the beginning of 51st week contributed only 2 weeks of follow-up. Follow-up period of each child was calculated and added up for all children. Total weeks of follow-up experience of all children were added up and this was used as denominator to calculate episodes of diarrhoea per child per 100-weeks of follow-up. Total weeks of follow-up for infants were 17,903, total episodes of diarrhoea were 2060, and episodes per year were 5.98 per infant in this study. Episodes of 2.63 per sick infant were arrived at in this study.[6] This is also known as **life table method of analysis.**

"Life expectancy of an individual is arrived at by cohort study. All births occurring at a point of time are followed up till such time that all die and the survival of each one at different age is calculated to arrive at life expectancy or if we apply the current age and sex specific mortality rates to a cohort at various ages we can arrive at life expectancy of persons in an area (*see* life table)."

Third Model

This cohort study measured or determined the change of nutritional status of cohort of 570 under six children over a period of one year follow-up with intervention of supplementary and therapeutic nutrition under ICDS.

Out of 187 children who were normal in year 1979, 114(60.97) continued as normal while 39.07% deteriorated. Out of 202 grade I malnutrition 29.22% improved, 55.93% remained in the same grade while 14.36% deteriorated. Similarly, out of 118 grade II malnourished children 55.09% improved and 39.84% maintained the same grade while 5.07% deteriorated. Of 41 grade III children, 65.90% improved their nutritional status, 24.38% maintained and 9.72% deteriorated. Of 16 grade IV children all children, i.e. 100% improved their nutritional status (Table 7.25).

Table 7.24: Incidence of diarrhoeal episodes per year in a rural block April 1984 to March 1985[6]

Age groups (years)	*No. of children experiencing diarrhoea*	*Diarrhoeal episodes*	*Episode per sick child*	*Total weeks of follow-up*	*Episodes per year*
0–1	784	2060	2.63	17903	5.98
1–2	534	1370	2.56	12975	5.49
2–3	238	556	2.33	6892	4.19
0–3	1556	3986	2.56	37770	5.48

Episodes per year = 2060 × 52 weeks ÷ 17903 = 5.98 episodes per year in infants.

Table 7.25: Longitudinal follow-up of under six children to assess the outcome of nutritional status after one year of follow-up in a rural block

Year 1979 Baseline survey		Repeat survey 1980					
Gr.	No.	Normal	Grade I	Grade II	Grade III	Grade IV	Not recorded
Normal	187	114(60.97)	53(28.34)	16(8.56)	2(1.07)	1(0.53)	1(0.53)
Gr. I	202	59(29.22)	113(55.93)	24(11.88)	5(2.48)	0(0)	1(0.49)
Gr. II	118	20(16.95)	45(38.14)	47(39.84)	6(5.07)	0(0)	0(0)
Gr. III	41	2(4.86)	8(19.44)	17(41.60)	10(24.38)	4(9.72)	0(0)
Gr. IV	16	2(12.50)	1(6.25)	8(50.00)	5(31.25)	0(0)	0(0)
Not recorded	6	0(0)	0(0)	6(100)	0(0)	0(0)	0(0)
Total	**570**	**197**	**220**	**118**	**28**	**5**	**2**

(a) Cohort Studies in Malaria[5]

Infant parasite rate (IPR) is calculated as follows:

$$\text{IPR} = \frac{\text{No. of infants found positive for malaria parasite}}{\text{Total number of infants blood smears examined}} \times 100$$

This index gives great deal of information regarding malaria transmission in the area during the epidemiological year. Normally, infants do not have malaria infection at the time of birth, only in very rare cases in holoendemic areas, the transplacental infection may occur in infants.

Sometimes, a longitudinal survey of infant population is carried out. In this study, each infant is registered at the time of birth and followed for a period of one year. By this study, transmission period in an area can be arrived at.

During these longitudinal studies, the point of time when any of the infant in the cohort is found positive, the malaria transmission has deemed to have commenced 21–35 days prior to the date of positivity of the infant. In case, the infant is positive for *P. vivax*, incubation interval is 21 days, while in case of *P. falciparum,* it is 35 days. In the absence of malaria infection in the cohort of infants under study, it may be inferred that there was no or negligible malaria transmission during the epidemiological year. The epidemiologist can conclude that the area is either free of malaria or there was a very negligible malaria transmission. In case, the malaria control operations were being undertaken in the area, it could be concluded that they were able to interrupt the local transmission of malaria during the year of investigation.

(b) *Incidence of Malaria*

The active surveillance and passive surveillance under national malaria control programme generate epidemiological data on malaria incidence.

The surveillance data are continuous/longitudinal at fortnight interval and give the parasite distribution in the community for each fortnight. The annual parasite incidence rate during the year can be easily calculated from the surveillance data. Thus, the annual parasite incidence (API) is *incidence of malaria* in the community assessed on longitudinal basis by cohort study.

$$\text{API} = \frac{\text{No. of blood smears found positive for malaria in one year}}{\text{Total population under surveillance}} \times 1000$$

The surveillance data under malaria is an example of incidence study or cohort study. Further the surveillance data gives accurate estimate of malaria incidence, endemicity, magnitude of malaria transmission and parasites distribution in different segments of the community including the parasite distribution by age, sex, etc. These parameters if collected correctly give a more reliable insight on malaria epidemiology of the area and help in formulation and evaluation of control measures.

Cohort Study in Leprosy (Table 7.26)

This exercise was done in May 2004, for carrying out LEM (leprosy elimination monitoring). Cohort for the MB cases of leprosy registered during the period from 1st May 2001 to 30th April 2002 was analysed to determine total number of cases, total number cured and total number defaulted and total number still on treatment after completion of 12 doses.[7]

Similarly, cohort of new sputum smear positive cases of pulmonary TB is being followed up, to determine cure rate, sputum conversion rate, default and death rate under the TB elimination programme.

EXPERIMENTAL STUDIES

Experimental epidemiology is also known as intervention epidemiology. In this method, the interventions are undertaken which could be treatment, immunization, supplementary nutrition, therapeutic nutrition, specific nutrient like vitamin A, iron and folic acid, salt iodization, insecticidal spray, chlorination of water, etc. Similarly, new drug is tested for its effectiveness. Experimental epidemiology involves experimentation in the groups or community and usually the

Table 7.26: Case holding indicators for MB[7]

Case = A person with clinical signs of leprosy (with or without bacteriological examination), who has yet to complete full course of treatment.
Cured = A patient who has completed a full course of MDT (12 doses for MB).
Defaulter = A patient who has not taken treatment consecutively for more than 12 months.
Left the control area = A patient who has left the area where he/she used to come for MDT treatment and has migrated somewhere else. This patient should be removed from the register (and therefore from the prevalence).

Number of MB cases from 1st May 2001 to 30th April 2002 Registered in area	Number of MB cases cured	Number of MB cases defaulted	Number of MB still on treatment after completion of 12 doses of MDT	Left the control area	Died
Total 18	**12**	**3**	**6**	**1**	**2**

Note: MB patients who had received more than 12 doses should be included in both columns (cured and still on treatment after completion of 12 doses).
Source of data: Leprosy treatment register and/or patient card for the period from 1st May 2001 to 30th April 2002.

effects of an intervention are measured in two groups, namely **experimental group** and **control group.** The interventions are strictly determined by laid down protocol or plan. There are important ethical considerations in the conduct of these studies. If a drug is of proven value this is not denied to persons recruited in the experimental group.

There are three designs of experimental or intervention epidemiology:

1 Randomized controlled trials (RCTs)
2 Field trials
3 Community trials

RANDOMIZED CONTROLLED TRIALS (RCTs)

The randomized controlled trials are also known as randomized clinical trial. RCTs produce best evidence for effect of treatment or an intervention, however evidence of causation is rarely available from RCTs.

Objective

Objective of RCT is to study the effectiveness of a new drug or a regimen in 'patients'.

Steps

1 First step in RCT is to prepare a plan of study or protocol what you wish to test or study.
2 Define study population.
3 Selection of participants by defined criteria as per plan.
4 Randomization of participants.
5 Treatment group and control group.
6 Follow-up of these groups.

Planning RCT

Define clear objectives of RCT, state the inclusion and exclusion criteria of case (case definition is essential to have valid conclusions). Determine the sample size, place, and period of study. The design of the trial must be written in advance whether it would be single blind, double blind or triple blind methods. In single blind method the investigator knows the treatment plan and it is not known to the patient to which group he belongs. In double blind trials, the investigator and the participants both do not know to which group the patient is allocated and the treatment plan. In triple blind trials, the investigator, participants and the person associated with analysis do not know the treatment plan and group allocation. The blinding is useful tool to avoid **bias** in the study. The plan of study must be approved by ethical committee of the institute.

Study Population

The study population varies according to nature of RCT. Most often the patients are chosen from hospital or from the community as per defined criteria as explained below.

In choice of patients for domiciliary and hospital treatment; *open cases of tuberculosis* were chosen as **study population.**

Selection of Participants—Inclusion Criteria

Once we have defined study population, out of open cases of tuberculosis those who fulfilled criteria for inclusion as participants were selected based on some of the criteria like age groups, severity of disease and treatment taken or not, etc. Thus, the participant patients must meet the criteria set by the investigator under the step planning of RCT. Further **informed consent** of the participant is essential for RCT. Exclusion criteria should also be explained such as on treatment cases, severe cases, etc.

Randomization

Subjects in a population are randomly allocated to groups. Once you have selected the study population the next step is to allocate the participants of study into:

1 Treatment groups
2 Control groups.

This should be done without any bias. You can adopt a lottery system, i.e. have predetermined chit or token specifying treatment or control word on it and as the case enters the study, draw a token and categorize the patient to either control or treatment group. Random table numbers can be used for randomization. Randomization is considered to be "sheet anchor" of RCT.

Treatment group and control group (intervention): The treatment group is put on a drug under trial and the control group is given no drug or given a placebo, which resembles with treatment drug in size and colour and looks identical with treatment drug.

If one wishes to determine the efficacy of two different drugs then subgroups can be made for allocation of these subgroups to drug A, B or C, etc. The treatment and intervention needs to be supervised very closely in the hospital.

Follow-up

The final outcome in two groups, i.e. treatment group and control group is observed with the passage of time or such time interval which has been predetermined. The outcome could be *cure* or *improvement* in the condition or *worsening* or **no change** in the condition or patient may die. Cure and all other outcomes are determined as per laid down criteria under the plan of study.

Analysis

The final outcomes are compared between the treatment group and control group or between various subgroups. It could be **meta analysis** of several RCTs done in different parts of the country.

Randomized Controlled Trials in Tuberculosis (Case Study)

Comparison of Home and Sanatorium Treatment[8]

This study was undertaken by tuberculosis chemotherapy centre in Madras, as a controlled comparison of *Home* and *Sanatorium treatment* for one year and subsequently for another four years to study the emergence of relapse cases in these two groups.

Study Population

163 newly diagnosed and previously untreated sputum positive patients of pulmonary tuberculosis from poor section of the community in Madras city.

Randomization

These 163 cases were randomly allocated for treatment at *Sanatorium* or *Home* with the same chemotherapy, i.e. INH 200 mg and PAS 10 g in two divided doses per day. Patients in home series were given weekly supply of drugs to be administered by themselves at home with monthly supervision of their progress at the clinic and were visited at home by a health visitor every fortnight (supervised therapy).

Comparison

The patients in the sanatorium series had bedrest, good accommodation, balanced diet and nursing care. Thus, this was the comparison of treatment of patients in best *sanatorium conditions* with those in usual day-to-day *home conditions* of poor sections of the community.

Results/outcomes

At the end of one year, 86% of patients treated at home converted to sputum negative and remained so (bacteriologically quiescent) as against 92% in sanatorium patients. Improvement in X-ray and closure of cavity were also of the same order in both the groups.

Follow-up

After one year, the sanatorium patients returned to their homes and the patients in both series were closely followed up for another 4 years to study the long-term results. Considering the overall relapse rate of disease in the two groups, it was found that 7% of patients in home series and 10% patients in sanatorium series had bacteriologically relapse over a 4-year period of follow-up.

Conclusion

It was conclusively proved or determined that effect or outcome of treatment of patients at home was as good as treatment in an institution both in respect of immediate recovery and subsequent prevention of relapse and that good food, nursing care and isolation **did not** play any useful role in the treatment of tuberculosis. **Domiciliary** treatment has the added advantage of not causing any dislocation of the family during the period of patients treatment for tuberculosis. Supervised domiciliary treatment paved the way for present day DOTS under revised RNTCP (NTBEP) and thus DOTS was born in India.

TB Attack Rates among Close Family Contacts

This study was planned by the tuberculosis chemotherapy centre to determine the relative risks for contacts of patients treated at *home* and in the *sanatorium*.

256 close family contacts of patients treated in homes and 272 similar contacts of patients treated in sanatorium were intensively followed up by X-ray and bacteriological examination for five years. In each family, there was just one infectious case and the contacts in the two series were similar in all other aspects. Efforts of isolation of the index cases could be best studied by comparing attack rate in the two series in the first year when the index case of the sanatorium series was isolated in the hospital.

In the first year, 4.9% of the contacts in home series developed tuberculosis compared with 7.6% of contacts

of sanatorium patients. Over the whole period of 5 years, 9.8% of contacts of patients treated at home developed tuberculosis as against 14.4% of *contacts* of patients treated in sanatorium. There was no difference of attack rates in the two groups even when the initially tuberculin negatives and initially tuberculin positives were analysed separately.

An interesting observation of the study was that the majority of cases in contacts occurred in children below 5 years of age and were detected within 3 months of diagnosis of the index case and there was suggestive evidence that in most of them the infection occurred before the index case was diagnosed.

Conclusion

There is no special risk to the contacts of patients treated at home with effective chemotherapy, the main risk to them being before the treatment has begun. Hence, *isolation* of patients in hospital/institution or at home is not required. What we require is effective chemotherapy treatment at the earliest.

Sociological Study of Awareness of Symptoms among Persons with Pulmonary Tuberculosis

About 2000 patients having evidence of inactive, probably active and active tuberculosis disease in their X-rays whose sputum results were also available (experimental groups) were age and sex matched with an equal number of persons with normal X-ray (control group) in 34 villages and 4 towns of Tumkur district in Karnataka. These persons were interviewed at random by social investigators for symptoms. Only such symptoms that were associated with pulmonary tuberculosis were taken into consideration. Of these cough for one month or more, fever for one month or more were analysed statistically. 79% of experimental group and 83% of the control group were satisfactorily interviewed.

Results

Cough was found to be the most important single symptom. 69% of sputum positives and 46% of X-ray positives had this symptom against 9% of the normal.

69% of the sputum positive, 52% of the X-ray positives, 29% of inactive and 15% of the controls had at least one of the above symptoms **(cough and fever more than a month).**

Analysis also showed that 95% of the bacteriologically positive cases were aware about their symptoms, 72% experienced cough and were worried about their symptoms and 52% of them actually took action at the existing health facilities under pressure of their symptoms.

Conclusion

Cough of more than a month was most important symptom in bacteriologically positive cases. It is now built in the programme that individuals or patients who have cough for 2 weeks or more with or without other symptoms should have 2 sputum samples examination done for AFB. Usually, at least 3% of new adult outpatients in general OPD have cough for 2 weeks or more. Half or more than half of infectious cases in the community are already seeking services and knocking at the door of health services. Active case detection in high risk population for TB has been started in 2017.

Clinical Trials in Malaria

Drug resistance in *P. falciparum* to chloroquine, as well as proguanil and pyrimethamine is attributable to selection under pressure of drug resistant mutants, which survive by utilizing alternative pathways.

Test Methodology in Drug Resistance Studies

The WHO recommended techniques of *in vivo* (7 to 28 days) are followed for observing the resistance status of *P. falciparum* parasites to chloroquine and other antimalarials, wherever the standard or extended tests are not operationally feasible simplified *in vivo* tests (day 0, day 2 and day 7) are also conducted.

Chloroquine is administered in the initial 3 days after collecting blood smear from day 0 to day 7 and then followed on day 14, day 21 and day 28. Urine test is repeated on day 1 or day 2 to confirm absorption of chloroquine.

Criteria for Selection of an Area

Area with intense malaria transmission showing predominantly *P. falciparum* infection, area with therapeutic failure to drug reported by physician, areas having malaria outbreaks, project areas with tropical aggregation of labour from endemic areas, area reporting high mortality due to malaria, etc. are chosen.

Inclusion Criteria

P. falciparum cases with minimum parasitaemia of 1000 asexual parasites per cu mm blood are selected for study through fever surveys and the fever cases attending the OPDs of PHCs/dispensaries. The screened cases without any evidence of history of consumption of chloroquine (confirmed by urine examination) prior to the test are selected for the study. Selected cases are then administered 25 mg of chloroquine per kg body weight in three divided oral doses of 10 mg, 10 mg, and 5 mg per kg body weight single dose over three consecutive days, respectively.

Criteria for Declaration of Resistant Areas

A chloroquine resistant PHC will be characterized by detection of more than 25% of RII and RIII level cases in a minimal sample of 30 cases (*see* revised criteria).

It is observed that the percentage of sensitive cases markedly declined during the last 18 years from 89.8% in 1978 to 2.5% in 1997. The lowest sensitivity of 0.8% to chloroquine was observed in the year 1994.

Sensitivity Status of other Antimalarials

Large number of studies have been conducted with alternate drugs like amodiaquine, sulfa-pyremethamine, quinine, etc. Studies carried out from 1989 to 1997 in chloroquine as well as amodiaquine use in Northeast areas to determine the comparative efficacy of chloroquine and amodiaquine in treatment of *Pf* malaria indicate that amodiaquine has no advantage over chloroquine in resistant areas. Both the drugs have shown similar response and considering the toxicity associated with amodiaquine it has been withdrawn from the programme as per drug policy in 1995.

In vivo drug resistance studies with sulfapyrimethamine and quinine were conducted on 1127 and 209 cases respectively. Sulfapyrimethamine drug combinations were introduced as a second line of treatment in chloroquine resistant areas as per the NMEP drug policy. Study results have shown resistance to this drug combination in low proportion in the North Eastern states, West Bengal and Kolar district of Karnataka and in Bhopal city of Madhya Pradesh and Tripura.

Significance

The most important factor that determines the distribution of resistant strains is the prolonged drug pressure in the community with sub-therapeutic dosage of antimalarials. Efficacy of drug trials studies in malaria is *important to evolve national policy on drugs in malaria*.

Leprosy

A randomized controlled trial in leprosy has made revolution in treatment and has reduced the duration of treatment with multidrug therapy (MDT).

Outcome of multicentric study in India on efficacy of different treatment regimens have been accepted by WHO Leprosy Elimination Advisory Group (LEAG) in 1997 and 7th WHO expert committee on chemotherapy. The LEAG has endorsed the technical recommendations of the 7th expert committee on chemotherapy of leprosy and has urged all the national Governments to implement the same. Now the duration of treatment of MB has been reduced to 12 months and for PB cases for 6 months.

FIELD TRIALS

Field trials in contrast to clinical trials focus on healthy populations who are exposed to the risk of development of disease.

Example: Infants and young children who are at risk of developing measles in the community.

Trial of vaccine is conducted on healthy children or healthy population in the field. According to protocol, the study population is defined and participants are chosen and assigned to experimental group and control group and intervention is done. One group is immunized and other is non-immunized. These two groups are followed for a defined period (say one year or longer) and the outcome or incidence of disease occurrence in both groups is recorded and the results are compared in two groups. In field conditions such a situation already exists, some children are immunized and some do not accept the immunization and are left as unimmunized. This opportunity provides a chance to conduct field trials to determine the *efficacy of a vaccine*.

Example: The efficacy of measles vaccine is determined by field trials. Under ideal conditions, this vaccine has high proven efficacy (approx. 90%) and should not be denied to infants. Immunization services with a measles vaccine efficacy of 90% are protecting children as effectively as possible against measles. A vaccine efficacy of less than 80% means there is problem with the vaccine. This could be due to problem with the cold chain, the injection technique or the age at which the health worker is immunizing the children, and you should take action to correct it.

To calculate vaccine efficacy, we need to obtain following information from the health records.

- The size of study population—which are children 12–23 months of age since these children were under one year of age in the previous year.
- The coverage of measles vaccine in children.
- The number of cases of measles in immunized children, 12–23 months of age.
- The number of cases of measles in unimmunized children 12–23 months of age.

Size of Population

If a health centre has 30,000 population and the birth rate of the area is 30/1000, the size of study population (12–23 months children) can be calculated by 30,000 × .03 = 900.

1. Therefore, study population of 12–23 = 900
2. Measles immunization coverage in children 12–23 months of age = 40%
3. No. of measles cases in immunized children 12–23 months of age = 40
4. No. of measles cases in unimmunized children 12–23 months of age = 486
5. No. of immunized children in study population

$$= \frac{900 \times 40}{100} = 360$$

6. No. of unimmunized in study population = 540

Let us put these data in tabular form (Table 7.27).

Interpretation

The measles vaccine efficacy of 88% in field trials indicates or determines that high efficacy is being achieved

Table 7.27: Efficacy of measles vaccine (field trials)[9]

Disease		No. of children (12–23)		
		Vaccinated	Non-vaccinated	Total
OCCURRENCE OF MEASLES DISEASE	Yes	40	486	526
	No	320	54	374
	Total	**360**	**540**	**900**

$$\text{Attack rate of measles in immunized children} = \frac{40}{360} = \frac{1}{9}$$

$$\text{Attack rate of measles in unimmunized children} = \frac{486}{540} = \frac{9}{10}$$

$$\text{Efficacy of measles vaccine} = \frac{\text{Attack rate in unimmunized (–) Attack rate in immunized}}{\text{Attack rate in unimmunized}} \times 100$$

$$= \frac{\frac{9}{10} - \frac{1}{9}}{\frac{9}{10}} \times 100 = 88\%$$

in field conditions. It means it confers protection to nearly 88% of immunized children and occurrence of disease—one in 9 children in immunized against 9 out of 10 in unimmunized further confirms its efficacy.

BCG Vaccine Trials

A field trial of BCG vaccine has reported the efficacy of BCG vaccine ranging from 50 to 60% all the world over. Thus, efficacy of BCG is variable. The reasons for this variation are not clear, but the conclusion is obvious—BCG vaccine will not control TB. It still has vital role in **preventing serious disseminated disease** in children and that is why it is incorporated in the universal programme of immunization in India and most developing countries.

COMMUNITY TRIALS

In these trials, the treatment groups are communities rather than individuals.

The best example of community trial is supply of iodized salt to community and reduction of prevalence of the problem of goitre in the community. The goitre prevalence rates were very high in Himanchal Pradesh in 1953 as revealed through baseline survey of goitre in the community. A successful trial of providing iodized salt in phased manner indicated marked reduction of problem of prevalence of goitre in experimental population. The control groups in this study were communities in Himachal Pradesh not supplied with iodized salt or covered with iodized salt in phased manner subsequently (Table 7.28).

Some of the areas in Himachal Pradesh started receiving iodized salt as early as 1957 (Kangra Valley) after initial surveys in 1956, however, the national programme on control of goitre commenced in 1962. The prevalence of goitre was 55% in 1956 in Kangra Valley, which declined to low level of 32% in 1968 after the supply of iodized salt in Kangra Valley. Following this experiment, national programme on control of goitre was launched in 1962 and subsequently renamed as National Iodine Deficiency Disorders Control Programme (NIDDCP). The pilot study (1994) reported TGR of 7% in 4 selected blocks of district Kangra which further speaks of success of intervention.[10] A country wide study carried out by NIN and DGHS in 40 districts to assess the impact of iodization revealed that overall prevalence of total goiter rate declined from 14–69% during 1984–94 to 2–40% in 2003. TGR was ≥ 5% in 37 out of 40 districts.

Table 7.28: Community trials of iodized salt

Area	Prevalence of goitre 1956	Intervention 1962	Prevalence of goitre	
			1968	1994
Kangra	55%	Iodized salt	32.1%	7%
40 Districts of India	14–69% (1984–94)	Do	2–40% (2003)	

Competency addressed: The student should be able to:
CM 7.8: Describe the principles of association, causation in epidemiological studies.

PRINCIPLES OF CAUSATION AND ASSOCIATIONS IN EPIDEMIOLOGICAL STUDIES

One of the major use of epidemiology is to discover or determine the causes of disease and help in prevention and control of disease in population and its elimination.

Disease occurs because of some external stimulus. Before the disease occurs, there is interplay of external stimuli/stimulus between "environments", disease producing "organism/factors" and the "host", which we call as *epidemiological* triad (Fig. 7.16).

Cause is something, which precedes the occurrence of disease or effect or unfavourable outcome. Logically **cause must** precede a **disease**.

Example

Road accident ⟶ Fatal head injury to host ⟶ Death of host

Road accident caused fatal head injury to host and the host died. Here the final outcome or unfavourable outcome or **effect** was death. Fatal injury precedes death. Therefore, **cause** of death is road accident and

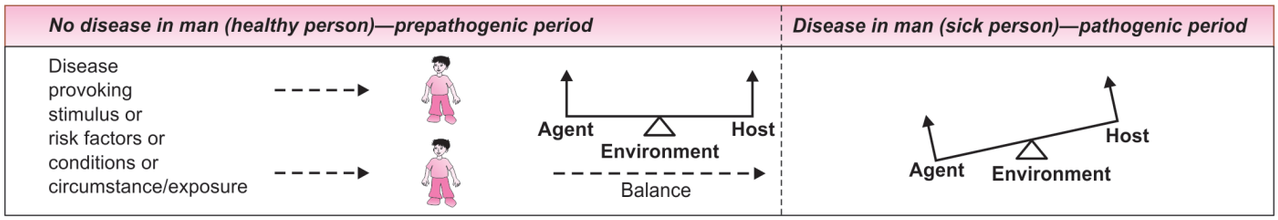


Fig. 7.16: Interplay of external stimuli between agent, host and environments (natural history of disease)

fatal injury. Here the underlying cause is injury, which initiated the train of morbid events leading directly to death.

Definition of Cause

A cause of disease is defined as an event, circumstance, condition, risk factor, exposure, characteristic or a combination of these factors, which result in producing the disease.

Necessary Cause

Vibrio cholerae is a cause of cholera disease. The causation is somewhat better understood in communicable diseases, e.g. *Vibrio cholerae* is a cause of cholera disease. The cholera cannot develop or occur in the absence of *Vibrio cholerae*. In other words, the *Vibrio cholerae* is *essential* for cholera to occur. This is termed as "*necessary cause*" for occurrence of cholera.

In outbreak or epidemic of cholera, not all people who drink contaminated water suffer, some suffer cholera, while many escape despite ingesting *Vibrio cholera*e through contaminated water. It proves that *Vibrio cholerae* is not a *sufficient cause* of cholera, though it is necessary cause. *Sufficient causes* other than necessary cause must exist together for occurrence of cholera.

The sufficient causes for cholera are insanitary conditions, open defecation, water contamination with sewage, adequate dose of *Vibrio cholerae*, survival of organism, host factors (resistance or immunity, nutritional status, and personal hygiene, etc.).

Sufficient Cause

"Sufficient cause" or sufficient causes are factors and conditions, which are other than the etiological cause of disease. "Sufficient causes" include factors in the environ**ments**, and factors and conditions in the **host**, which produce a disease provoking stimulus/stimuli for initiating the disease process in the host (Fig. 7.16). Sufficient cause often comprises several components.

Approach

Science of epidemiology helps determining the causes. We may begin with a *disease* problem and then search for its causes or we may begin with potential cause, e.g. air pollution and search for its effects on people or follow *healthy people* and study the effect of an *exposure* on them. Most of the clues and sufficient causes of a disease come through descriptive studies (observational epidemiology). Snow described occurrence of cholera deaths due to contaminated water much earlier (in 1853) than the discovery of disease producing organism in 1883 (*Vibrio cholerae*). Control measures were initiated much before the discovery of *Vibrio cholerae*, on the strength of descriptive epidemiology.

Single and Multiple Causes

In communicable diseases, usually the etiological organisms are responsible for occurrence of diseases in combination with sufficient causes. These infectious organisms can be isolated and proved to be cause of a disease. In the later part of 19th century, most of the disease-producing organisms were discovered and interest concentrated on microorganisms. Koch's laid down postulates or rules for occurrence of disease due to living organism:

a. The organism must be present in every case of disease.
b. One should be able to isolate the organism on pure culture.
c. The isolated organism when inoculated should be able to produce specific disease in susceptible animal.
d. The organism must then be recovered from the animal and identified.

Koch's postulates are not wholly true in all circumstances. We may not be able to isolate *Mycobacterium tuberculosis* from all those persons who have the disease, but certainly, the *M. tuberculosis* is necessary cause of tuberculosis.

In communicable diseases, the aetiology of disease is well established but in many of the non-communicable diseases, there are multiple causes/factors.

Competency addressed: The student should be able to:
CM 1.3: Describe the characteristics of agent, host and environmental factors in health and disease and **multifactorial etiology** of disease

Multifactorial Diseases

Non-communicable diseases like coronary heart disease, diabetes and cancer have multiple risk factors for their occurrence and causation. Web of causation in non-communicable diseases is much more complex as no single factor can be pinpointed or incriminated as an aetiological factor.

Coronary heart disease risk factors include high level of saturated fats in diet, physical inactivity, raised serum cholesterol, level of unfavourable lipid concentration, hypertension, smoking and obesity explain at least 75% of new cases of cardiovascular disease in the community. Science of epidemiology through studies like Framingham study and MONICA study, the largest global study ever undertaken on cardiovascular diseases, have proved the role of multiple risk factors as described above, by undertaking longitudinal (cohort) study lasting for several years. Sufficient evidence has accumulated on coronary heart disease prevention which centres around **primordial prevention**, i.e. adoption of healthy lifestyles by people and adoption of population-based strategies to avoid the emergence of risk factors in population such as controlling tobacco, controlling fats and promoting healthy eating and physical activity.

HOW TO ESTABLISH CAUSE OF DISEASE?

Cause and **effect** relationship can be established by following epidemiological principles tested over time.

Temporal Relationship

Temporal relationship or time series studies, the cause must precede the effect. If the cause is an exposure or toxic substance in a factory (say lead), the level of exposure must reach to a certain level before it can produce toxic effects on a person; hence, the persons exposed to lead should be observed at various points in time to measure the effect of exposure (lead).

The time to measure the effect could be every 6 months. The exposure to lead can be observed at 6, 12, 18 and 24 months to measure the effect. Repeated measurements of lead exposure at more than one point of time at different locations may provide useful and stronger evidence than only one measurement at one point in time. Cross-sectional studies and case control studies, in which the cause and effect are measured at the same point of time, are not suitable to establish the cause and effect relationship. Thus, **time series studies** and temporal relationship between **cause** and **effect** can provide better evidence to establish cause of an effect.

Strength of Association

Astrong association between possible cause and effect can be measured by risk ratio. **Relative risk** measures the strength of association between **cause** and **effect.** Relative risk of greater than 2 can be considered strong association or causal. If the relative risk is manyfolds say 4 times or 10 times, it is much stronger evidence that the exposure is cause to effect. The size of risk ratio which measures the incidence in exposed and the incidence in non-exposed (I_E/I_{NE}) helps to establish cause to effect relationship. Odds ratio is similar to relative Risk.

Dose–Response Relationship

If a dose–response relationship can be demonstrated, it strengthens the argument for *cause* and *effect*.

Doll and Hill established in 1950s the relationship between cigarette smoking and lung cancer. Relationship between average number of cigarettes smoked per day and annual lung cancer death rates per 1000, measures dose–response. With the increase in number of cigarettes per day the mortality effects are increased. This way it could be established that heavy smokers (cause) experienced high rate of cancer lung (effect). Many studies have demonstrated dose–response relationship of this kind. Thus, it was concluded that smoking had causal relationship with lung cancer.

Reversible Association

If the exposure or cause is removed, it results in decreased risk of disease, i.e. the association between smoking and lung cancer is reversible if smoking is stopped. It was proved by Doll and Hill that if smoking was stopped the risk of mortality due to lung cancer decreased substantially. These observations establish the *cause* to *effect* relationship.

Consistency

If the results of several studies done in different parts of the country come out with similar results it can be concluded that the evidence of causal relationship exists.

Meta-analysis technique can be adopted and results of various randomized controlled trials done over different parts of the country can be pooled to generate evidence. If the results are consistent or similar in different parts it probably establishes that cause and effect have strong association. Results of BCG trials to establish its efficacy, varied from 0 to 80% over different parts of the World, thus it was concluded that BCG does not reduce the incidence and prevalence of lung tuberculosis but certainly it prevents serious forms of tuberculosis in children.

Plausibility

It means that cause to effect association should be consistent with knowledge. Knowledge changes with the passage of time and advancement. Effects observed due to a cause should take into the consideration the results of experiments in laboratories done on animals and all other scientific evidences.

Study Design

The study design to establish cause to effect relationship is most important. The randomized controlled trials (RCT) produce best evidence for effect of treatment or an intervention, however, evidence of causation is rarely

available from this type of study. Most often, the evidence comes from observational studies; almost all the evidence of most of the waterborne diseases came from observational or descriptive epidemiology. **Cohort studies** provide **strong evidence** for **cause to effect** relationship and similarly **case control studies** when pursued over different points in time produce moderate evidence of cause to effect relationship. However, **cross-sectional** studies which measure the cause and effect at the same point in time provide weak evidence of cause to effect relationship and similarly **ecological studies** provide least satisfactory evidence for *cause* to *effect*.

Weighing the Evidence

The available evidence on cause and effect must be weighed to make valuable judgment. After examining all the available evidences, the judgment of cause can be made but sometimes it may be difficult.

Competency addressed: The student should be able to:
CM 7.8: Describe biases in epidemiological studies.

BIASES IN EPIDEMIOLOGICAL STUDIES

The focus of epidemiology is to measure diseases/events in the population. The measures must be accurate. The most epidemiological studies rely on part or sample of population, to arrive at true population value, sample value should reflect true value of population, which might not be so. Errors in epidemiological studies affect the sample value; hence, these errors should be minimized by observing the principles or rules of the study.

Common errors which can occur in the study are:

- Random errors (non-sampling errors)
- Sampling errors

Random Errors

These include individual biological variations, and measurement errors.

Biological Variations

The individual biological variations are well known since we study the part of population and that part of population may have different biological characteristics or variables and may not be true representative of total population. The biological variations are related to age, sex, genetic make up and heredity, race and ethnicity. Hence, study population must match with control group.

Measurement Bias

The measurement of a disease may be inaccurate or may not be valid or in other words the measurement do not measure correctly what they intend to measure. Defective collection of information, is called response error. There could be defective measurement or defective instrument (Proforma, Questionnaire) or defective diagnostic criteria. Laboratory results may differ from one lab to another. Therefore, standardization of technique of measurement or instrument is essential to avoid measurement bias. The instruments like blood pressure apparatus, weighing machine and laboratory test must be standardized.

Internal quality control by the testing laboratory itself is desirable and external quality control helps to establish reliability and validity of a test. HIV positive samples detected by one laboratory are cross checked at reference laboratory to enhance the quality control. Training of laboratory personnel helps avoid measurement errors apart from calibration of instruments.

Sampling Errors (Process of Selection of a Sample)

These are due to wrong selection of participants for study population, which may not represent the characteristics of the population. The best way to reduce sampling errors is to increase the size of sample in the study and adopt ***Principle of randomization***. Determination of sample size for health studies has been published by WHO (Lwanga and Lemeshow, 1991).

Selection Bias

The sample selected may be a biased sample and it may not be representative of true characteristics of population. Selection bias occurs when there are systematic differences between the characteristics of people selected for a study and characteristics of those who are not.

If the non-respondents are replaced by other individuals this results in selection bias. Selection biases are common in randomized controlled trials (RCTs). In a school health survey for prevalence of disease the sick children may be absent or stay at home on the day of survey or if one is studying the factory workers the sick might not have come at work place, unless follow-up visits are assured the results may be biased. In HIV sentinel surveillance, selection bias has been removed by including all consecutive new cases antenatals in the sample, visiting clinic for first time.

Participation Bias

If HIV testing is not unlinked/anonymous or if testing facility is located far way from clinic site then individual may not participate in study and this way participation bias results.

Confounding Bias

The confounder means a factor or character, which is equally important for causation of disease than the only one chosen factor to establish causal association. If one is studying the association of diet with occurrence of cardio-vascular disease and the smoking is not being accounted for, the interpretation is biased one.

Common confounding factors are—age, social class and habit in epidemiological studies. Confounders can be removed by adopting the procedure of randomization, matching controls with experimental subjects and adhering to criteria of selection of cases and controls and by giving due weightage to confounding factors at the time of analysis.

Ethical Issues

The ethical issues in epidemiological studies are important and cardinal. The guidelines contained in the declaration of Helsinki and ethics and epidemiology, and international guidelines must be observed. The institutions where research is being pursued must have an ethical committee to regulate the ethical considerations. Before the studies are undertaken, the study plan must be approved by the ethical committee.

Competency addressed: The student should be able to:
CM 7.9: Describe and demonstrate the application of computers in epidemiology.

Application of Computers in Epidemiology/Health Sciences

Computer technology have made it much easier to process data, store data and its retrieval. This technology can produce tabulations, graphs and generate routine reports. On line transmission of routine reports generated by health facilities are now being transmitted through this technology. Data entry operators have been employed at the level of PHC, CHC, district and state level to transmit reports quickly in the system. Main uses of computers in health sciences are:

i Easy access to, and full exploitation of statistical tools.
ii Exploring relationship of variables in data sets.
iii Access to national/international literature and instant selective retrieval.
iv Quick and more effective communication facilities using technologies such as electronic mail (e-mail).
v Record archiving.
vi Use of diagnostic tools in selecting appropriate treatment and in assessing prognosis.

Varieties of software packages are available such as Epi–Info–Epidemiological information processing system. Among the commonly used packages are microsoft, excel, SPSS, SAS, minitab, systat, NCSS, etc. For special purpose we have enquiry adviser, statxact, solas, sigmastat, and epi info.

Computers' Limitations

Computers can not make decisions for you or think for you. Computers are no substitute for looking, thinking, discussing and taking action. Computers cannot contact reporting units or physicians for missing information, Interpret laboratory test, make judgment about epidemiologic linkage, duplicate records, data entry errors and declare a state of epidemic.

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EPIDEMIOLOGICAL BASIS OF NATIONAL HEALTH PROGRAMMES (NHP) IN INDIA AND LEARNING OF EPIDEMIOLOGY

EPIDEMIOLOGY PROVIDES SUFFICIENT EVIDENCE FOR EFFECTIVE CONTROL MEASURES

Various national health programmes for specific communicable and non-communicable diseases and other problems have been launched in successive Five-Year Plans. The epidemiological basis/evidences for these programmes were as under:

i Wide spread geographical distribution of diseases.
ii High prevalence/incidence (high disease burden).
iii High mortality (premature deaths) and disabilities.
iv Epidemics, outbreaks and pandemic potential of disease.
v When economically active population gets affected.
vi Rapid population growth, demographic transition and ageing.
vii Widespread undernutrition and emerging over-nutrition—obesity.
viii Changing lifestyles: Tobacco use, physical inactivity.
ix Deteriorating environments—leading to slums, vector breeding—poor waste management (garbage, human and animal excreta) indoor and outdoor air pollution.

Science of epidemiology helps in:

1 Identification of causes/risk factors of illness, monitoring health status, disease outbreaks and measuring effectiveness of interventions.

2 Planning, monitoring and evaluation of programmes and guide public policy and programme design.

Everyone of these national programmes require on one hand a robust public health system as their core delivery strategy, and on the other hand they can be considered as opportunities to strengthen healthcare systems and designed keeping this goal in mind. All services available under national programmes are free for all and universally accessed with fairly good rates of coverage.[1]

Common Objectives of NHP

- To prevent and control of outbreaks/epidemic
- To reduce the incidence and prevalence of disease
- To prevent premature deaths and reduce mortality to acceptable low levels
- To prevent disabilities
- To eradicate/eliminate the disease is the ultimate objective
- To achieve sustainable development goals in health
- To improve the nutritional status of vulnerables
- To promote healthy behaviours and lifestyles by BCC
- To improve the quality of life
- To stabilize population
- To improve environmental sanitation (promote hygiene, sanitary latrines, safe water and safe disposal of excreta)
- To strengthen the public health systems
- To establish surveillance system
- To promote research
- To achieve inter-sectoral coordination/convergence
- To involve private sector and NGOs
- To enhance community participation

Core Strategies/Interventions Adopted for NHP to Achieve the Objectives

1 **Education:** Behaviour Change Communication (BCC) and Development of Healthy Lifestyles. Prevention of emergence of risk factors in population; in addition to personal hygiene, periodic health check up and pre-placement examination.

2 **Improve nutrition:** Promote exclusive breast-feeding, complementary feeding, adequate feeding and supplementation of IFA and Vit A. Universal salt iodation and control infections, ensure food security—healthy eating and mass deworming.

3 Universal immunization

4 Early diagnosis and complete treatment as per standard treatment protocols.

5 Effective epidemiological surveillance and screening programmes (Integrated Disease Surveillance Programme) for early detection of outbreaks/epidemics and their control and prevention.

6 Integrated Management of Newborn and Childhood Illnesses (IMNCI).

7 **Treating and improving environments:** Safe drinking water, safe excreta—disposal, source reduction for breeding (waste water and solid waste management). Integrated vector control and reduction of air pollution.

8 Maternal and Child Health Services (RMNCH) + A safe motherhood and child survival.

9 Population stabilization—contraceptive promotion

10 Curb use of illicit drugs—drug deaddiction supply reduction and demand reduction strategies.

11 **Health legislations** and policies—to control tobacco, alcohol, drugs, food safety, regulate salt content of manufactured foods, enhance production and consumption of fruits and vegetables, promote physical activities. Public Health Act for control of epidemics.

12 Strengthening public healthcare delivery system (manpower, finance, infrastructure and essential medicines/drugs). Engage private sector and NGOs.

13 Liquidation of reservoir of infection/disease (in zoonotic diseases), such as rats, pigs and birds or reduction of population of stray dogs by animal birth control (ABC).

14 Epidemic/disaster preparedness and management.

15 **Prevention of injuries and accidents (intentional and unintentional):** Develop counselling services in school/college for life skill training, stress management and suicide prevention.

16 Observe universal precautions

17 Observe international health regulations.

These interventions focus on community and are population-based strategies, which treat underlying causes/determinants/risk reduction of disease or problem.

Message: Major aspects of epidemiology such as extent of health/disease problem, disease burden, incidence and prevalence, time trends, its geographical distribution, population affected most, case fatality, surveillance and case detection methods and evidence based interventions/strategies, programme management (planning, organization, implementation, monitoring and evaluation of programme) can be learned in a systematic manner by learning

National Health Programmes. In a way all the national health programmes reinforce and enrich the learning of subject of applied epidemiology and their management aspects.

Knowledge of applied epidemiology helps to plan, organize, implement, monitoring and evaluation of all national health programmes.

Various methods of epidemiology—descriptive, analytical and experimental epidemiology can be best learned through the National Health Programmes.

List of 20 notifiable communicable diseases reported every month by all health/medical institutions to CBHI: Acute diarrhoeal diseases including gastroenteritis, diphtheria, acute poliomyelitis—new cases, tetanus other than neonatal, neonatal tetanus, whooping cough, measles, pneumonia, enteric fever, hepatitis A, viral hepatitis B, viral hepatitis CDE, meningococcal meningitis, rabies, AIDS, syphilis, gonococcal infection, other STDs, and pulmonary tuberculosis are notifiable diseases.

List of National Health Programmes

A. National Health Programmes for CCDs

- NVBDCP: Malaria, dengue, chikungunya, Japanese encephalitis, filaria, kala-azar and KFD.
- Revised National Tuberculosis Control Programme (RNTCP) (National TB Elimination Programme).
- Leprosy: National Leprosy Eradication Programme.
- National Aids Control Programme and National Programme on prevention of Parent to Child Transmission.
- RTI/STI—National Guidelines.
- Polio eradication.
- Yaws eradication.
- National Programme for Prevention and Control of Deafness.
- National rabies Control Programme.
- National Programme for Prevention and Control of Antimicrobial Resistance.
- Programme for Prevention and Control of Leptospirosis.
- National Viral Hepatitis Control Programme.
- National Deworming Drives (days).
- Integrated disease surveillance mission. Integrated Disease Surveillance Programme.

B. Water and Sanitation

- National Rural and urban Drinking Water Supply and Sanitation Programme.
- National Programme for Prevention and Control of Fluorosis.
- National Guinea Worm Eradication Programme.
- National Diarrhoeal Disease Control Programme.
- *Swachh Bharat Abhiyan* (total sanitation campaign).

C. MCH and Family Planning

- National Family Planning Programme.
- Reproductive, Maternal, Newborn, Child and Adolescent Health (RMNCH + A).
- *Janani Suraksha Yojna* (JSY)
- Integrated Management of Neonatal and Childhood Illness and Integrated Action Plan for Pneumonia and Diarrhoea in 4 states.
- India's Newborn Action Plan.
- *Navjat Shishu Suraksha Karyakram*.
- *Janani Shishu Suraksha Karyakram*.
- Universal Immunization Programme.
- Integrated Child Development Services Scheme (ICDS)—Mission.
- *Rashtriya Bal Swasthya Karyakram* (RBSK).
- National Adolescent Health Programme (RKSK) and
- School Health Programme.
- *Pradhan Mantri Matru Vandna Yojana*.

D. Nutrition

- National IDD Control Programme.
- National Iron + Initiative. Anaemia *Mukat Bharat*.
- National Nutritional Anaemia Control Programme.
- National Programme for Control of Blindness (Vit A).
- Mid-day-meal Programme in Schools.
- Applied Nutrition Programme and Supplementary Nutrition Programmes.
- National Nutrition Mission (*Poshan Abhiyan*).

E. Non-communicable Diseases (NCDs)

- National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Strokes, Chronic obstructive pulmonary and chronic kidney disease (PM—National Dialysis Programme).
- National Tobacco Control Programme.
- National Oral Health Programme.
- National Programme for Care of Elderly.
- National Mental Health Programme.
- National Trauma Control Programme.
- National Programme for Prevention and Management of Burn Injuries.

- National Programme for Prevention and Control of Blindness and visual impairment.
- Drug Deaddiction Programme.
- National Organ Transplant Programme.
- National Cancer Registry Programme.

F. Others

- National Free drugs and diagnostic initiative.
- National Policy on ARI Control.
- National Health Mission—Universal Health Coverage.
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CHAPTER

8

Epidemiology of Communicable and Non-communicable Diseases and Related Disease Specific National Health Programmes

In community medicine the concern is 'Community', to control, eliminate, eradicate and reduce risks of public health problems in community

Competency addressed: The student should be able to:
CM 8.5: Describe and discuss the principles of planning, implementing and evaluating control measures for disease at community level bearing in mind the public health importance of the disease.

PRINCIPLES OF PLANNING, IMPLEMENTATION AND EVALUATING CONTROL MEASURES OF DISEASE AT COMMUNITY LEVEL

Planning: Health Planning is the process of defining community health problems, identifying needs and resources, establishing priority problems, goals and objectives, designing strategies and setting out the administrative actions needed to reach these goals and objectives.

KEY PRINCIPLES OF PLANNING

1. Assess Burden of Communicable, Non-communicable and other Health Problems

Always involve community in the planning process. Burden of disease is assessed in terms of incidence, prevalence mortality, disability and loss of DALYs. This information is available through service statistics of health facilities, household surveys and facility surveys, national family health survey, global disease surveys, disease surveillance programmes, disease registries, SRS data besides NSSO data, and above all data of community consultations.

Example: Data based burden of CCDs and NCDs.

i India lost 33% of total DALYs from communicable, maternal, neonatal and nutritional diseases, 55% from non-communicable diseases and 12% from injuries in 2016 (ICMR, PHFI and IHME 2017).
ii The proportion of all deaths in India due to communicable, maternal, neonatal and nutritional disorders reduced from 53.6% in 1990 to 27.5% in 2016, those due to non-communicable diseases increased from 38 to 62% and those due to injuries changed from 8.5 to 10.7%.
iii Tobacco users in India as per GATS-2—nearly 28.6% of adults use tobacco.
iv Prevalence of any mental disorder in adults—10.6% in 2015–16.
v Substance use disorders—harmful alcohol users 5.2%, Cannabis 2.8%, opioids 2.06% and sedatives 1.08% in 2018.
vi Prevalence of anaemia in pregnant women—52% in (2019–21) (NFHS-5).
vii Prevalence of malnutrition in young children—32% in 2019–21.
viii Incidence of TB in India—2.59 million per annum in 2020.
ix Burden of HIV—2.40 million people living with HIV/AIDS in 2021.
x Infant mortality rate—28 per 1000 live births in 2020.
xi Maternal mortality ratio—97 per lakh live births in 2018–20.
xii Contraceptive prevalence rate—56.5% and TFR 2.

In addition to disease burden we must also know WHO, WHERE and WHEN?

Persons: Who are most affected by disease—age and sex, groups, at risk population, economically active age groups, etc.

Places: Geographical distribution of disease and factors and conditions favourable for occurrence and spread of disease.

Time: Trends of disease over long time, seasonal variations as also epidemic potential of a disease.

Major courses of diseases/deaths: These are—unhealthy life styles, environmental factors (unsafe water, insanitation, air pollution, soil pollution, vectors of diseases), nutritional deficiency/excess, injuries, poverty, and illiteracy.

2. Establish Priorities by Assigning Weights/Score

In consultation with community—*panchayats* and urban local bodies and NGOs. Priorities are based on incidence/prevalence level, severity of disease-high mortality or disability, effective control measures, acceptability and cost.

Priorities are as under

a Maternal and child health, family planning and immunization.
   i Malnutrition in young children, adolescents and pregnant women as its prevalence is high.
   ii Diarrhoea and pneumonia in children which are responsible for 6.4% and 15% of deaths in under 5 children respectively (severe diseases).

b Non-communicable disease and occupational diseases—are highly prevalent and leading cause of deaths

c Communicable diseases—epidemic prone diseases, and endemic diseases (TB, leprosy, filaria, malaria, STI, Kala azar, etc).

3. Situational Analysis—Where are we now?

This entails conducting facility survey, household surveys (population size to be covered), collecting data from secondary sources, compiled service statistics and any published study such as national family health surveys, etc. These data help provide a snapshot of where the district/state/area stands with respect to key programme indicators (baseline data). Apart this exercise helps mapping of available resources in terms of trained manpower, budget, material and supplies, drugs and laboratory support, transport for mobility and physical facilities to carry out activities.

4. Goals and Objectives—Where do we wish to Go?

i To reduce burden of disease in terms of incidence, prevalence, deaths and disability and their risk factors.

ii Elimination and eradication of disease is the ultimate goal.

Examples of Specific Objectives

- Anemia reduction targets: To reduce prevalence of anemia by 3% point per annum among children, adolescents and women by 2022 from base year 2016.
- To reduce stunting, wasting and low birth weight by 2% per annum.
- 25% reduction of overall mortality from non-communicable diseases (referred to as 25 × 25) by 2025.
- To reduce neonatal, infant, child and maternal mortality to 16, 28, 23 and 100, respectively by 2025.
- 95% reduction of new HIV infections (incidence) by 2030 as compared to base year 2010.
- 80% reduction of TB incidence—from 211 per lakh in 2015 to 43 per lakh by 2025.
- 90% reduction of TB mortality from 32 per lakh to 3 per lakh by 2025.
- To reduce TB prevalence from 320 to 65 per lakh population (80% reduction).
- To eliminate leprosy in the country by 2020, i.e less than one case per 10000 population in all the districts of India.
- Eliminate malaria from India by 2030, i.e. zero.

  Indigenous case of malaria in all the districts.

5. How will we get there? Control Measures/Strategies/Interventions for CCDs and NCDs and Maternal, Neonatal, Child and Adolescent Health

Reduction of Under 5 Morbidity and Mortality and Maternal Mortality

National Family Welfare Programme, Universal Immunization, RMNCH+A Programme, and India Newborn Action Plan are committed to reduce neonate, infant, child and maternal mortality and high fertility in high focus states.

Reduction of Malnutrition

Several national nutritional intervention programmes are in place—ICDS, mid-day meal programme for schoolchildren, National Food Security Act, intensified national iron plus initiative, Anaemia *Mukt Bharat* and National Nutrition Mission (*Poshan Abhiyan*) to mitigate malnutrition among vulnerables including food safety and standards Act (FSSA).

Safe Water and Sanitation

To reduce the incidence of water and vector-borne diseases, worm infestation and improve personal hygiene through *Swachh Bharat Abhiyan*—safe water and improved sanitation for all. *Jal Shakti Ministry* has been formed to ensure piped water supply for all and toilets for all households by 2024.

Improving Air Quality—National Clean Air Prog.

Under PM *Ujwala Yojna*—subsidized clean fuel (LPG) to poor households. Nearly 70–80% of households use unprocessed biomass fuel. Outdoor air pollution control measures through legislations and education are under way.

Adoption of Healthy Lifestyles by Population and Behaviour Change Communication

Promote healthy lifestyles—healthy diets, physical activity, 5 g of salt per day, avoiding tobacco and harmful

use of alcohol. Primordial and primary prevention measures to prevent emergence of risk factors in community. Population-based screening programme and management of common NCDs and cancers and reduction of salt contents of processed foods, hepatitis B and HPV vaccination to prevent cancers and control NCDs.

National Disease Control/Elimination Programmes

Elimination of TB—national strategic plan for TB elimination and HIV/AIDS, malaria, filaria, kala-azar, leprosy elimination are in place, besides national programmes for NCDs, blindness, mental health, deafness, IDD and oral health.

Road Traffic Injuries and Intentional Injuries

Prevention of RTA and trauma management besides **mental** health programme are in place.

Addressing Determinants of Health

Nutrition, water and sanitation, literacy, housing, roads and transport, are social determinants or causes for the causes, need intersectoral coordination.

6. What Resources are Required?

i Adequate human resources for health as per IPHS, 2022 adequate health budget—2.5% of GDP, and physical infrastructure as per National Health Policy, 2017 and IPHS 2022 to carry out activities.

ii Generate information on morbidity and causes of death—through service statistics, SRS—verbal autopsy, civil registration system, medical certificate of cause of death and disease registries and special surveys/studies.

iii Improve integrated disease surveillance system/ epidemiological surveillance programmes to deal with outbreaks and pandemics.

7. Implementation of Strategies

A plan is as good as its implementation. These interventions/strategies have to be implemented through existing healthcare delivery systems—by public health/ government and private providers apart from non-governmental health and voluntary agencies. National strategy for comprehensive primary healthcare has been evolved and being implemented in phased manner in the country. Mid-level health providers (MLHP) are being posted at subcentres level (HWCs) under *Ayushman Bharat* (PMJAY) programme.

Workplan of Activities/Action Plan

The broad strategies are converted into implementable activities. Time of initiation of activity, the tentative duration of implementation and completion of each activity are specified and more importantly persons/ agency responsible are explicitly stated. Scheduling of activities in a systematic way and costing of each activity is included in the work plan. When all activities are worked out and timeline defined with responsibility, it will give an overview of activities against which monitoring can be undertaken.

Work Reporting

The work plans are implemented at village, subcentre, PHC, CHC and district level. Work performance and essential service indicators are continuously collected, recorded and reported on standard format by health workers and ASHAs every month (monthly progress report). Health supervisors and medical officer I/C oversee the monthly progress reports and review these reports at monthly review meeting with the workers and plan activities for the next month.

8. Monitoring and Evaluation—How do we know we are on the Right Track?

After finalization of workplans and initiating the activities there is an imperative need to continuously monitor the inputs and progress of activities and their performance periodically (once a month). The performance indicators for CCDs and NCDs have been worked out under national health programmes.

There is built-in mechanism of monitoring and evaluation for all the national health strategies/programmes. Monitoring and evaluation indicators of health services and management broadly include:

- Input indicators
- Process indicators

} Monitoring

- Outputs indicators
- Effects indicators
- Impact indicators

} Evaluation

Besides indicators, performance standards for each indicator have been evolved to measure gaps between actual and standard performance. Thereafter, root causes of performance gaps are being determined to improve the performance by eliminating the root causes.

Monitoring is a continuous process and a management tool to track the progress of programme activities. Community can also monitor the programme to provide rich feedback for improving the programme and its planning. Encourage community monitoring.

Evaluation is the end stage of planning. Evaluation is primarily concerned with degree of achievement of programme objectives, 'at what cost'—should the programme be continued as such or objectives be modified or programme to be done away. Performance evaluation mechanism mostly relies on **baseline** household survey community needs assessment and facility survey data and concurrent, mid term and end line surveys. Information for monitoring and evaluation is generated through routine

monthly/quarterly/annual reports, by fields observations and by special studies/surveys periodically and community monitoring and evaluation mechanisms.

Competencies addressed: The student should be able to:

CM 8.1: Describe and discuss the epidemiology and control measures including the use of essential laboratory tests at the primary care level of communicable diseases (CCDs).

CM 8.3: Enumerate and describe disease-specific national health programs including their prevention and treatment of a case of CCD.

How to achieve? Observing immunization session, mass deworming, diarrhoea fortnight, outreaks measures, and surveillance under IDSP, TB case finding and treatment.

HIV/AIDS PANDEMIC

Acquired immunodeficiency syndrome (AIDS) was a leading cause of death in adults in the world.

NATURAL HISTORY OF HIV/AIDS—WINDOW PERIOD

The natural history of disease begins as soon as the Human Immunodeficiency Virus (HIV) (antigen) enters the body of susceptible host through any of the modes of transmission. The virus multiples within T-lymphocytes helper cells or CD4 cells. It destroys body immunity or immunological response to invading pathogen. The host's defence mechanism comes to play and antibodies against antigen develop. The detection of antibodies against HIV in human blood is termed **HIV positivity** and a person is called HIV positive (seropositive or reactive).

Following exposure to HIV there is period of **6–12 weeks** between initial infection with HIV and the time when the antibodies can be detected in the blood. This period is known as **window period.** A blood test performed during **window period** yields negative test result for antibodies but such a person can transmit HIV infection to other persons. Antibody test during window period does not reveal true status. These persons may require further testing after 12 weeks. Once infected the person remains infective throughout his life.

Thus, the **infectivity** of virus is **lifelong**, though it may vary with time, being high:

- In the initial stages of infection
- In the stages when clinical manifestations appear.

Progression of HIV infection to AIDS is variable. 20% of those infected will develop AIDS in 5 years, and 50% in 10 years and decreasing proportion after 10 years. Thus, a healthy looking person can have HIV/AIDS. The hallmark of HIV infection is progressive loss of specific type of immune cell called T-helper or CD4 cells (loss of immunity). When CD4 count falls below 200, the person is said to develop AIDS. It is estimated that for every full blown case of AIDS, there are 3–5 persons with ARC (AIDS related conditions) and 50–100 infected with the virus but who are asymptomatic. AIDS is, therefore, often termed 'the hidden epidemic' (Fig. 8.1).

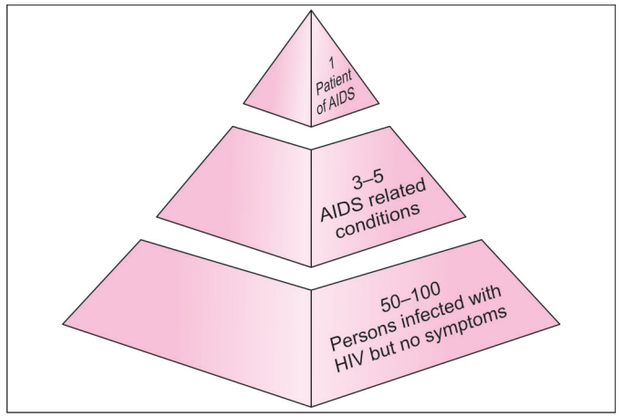


Fig. 8.1: Hidden epidemic (iceberg phenomenon)

EPIDEMIOLOGY OF HIV/AIDS EPIDEMIC

HIV virus persists within cells for years. HIV is of two types: HIV1 and HIV2. It is a fragile virus gets killed by sunlight, heat and hypochlorite.

Causative agent: HIV which causes AIDS is lentivirus with unique enzyme-reverse transcriptase.

Global distribution: HIV and AIDS is a global problem. It is a pandemic and **modern epidemic**. It requires a global response. At the end of 2021 people living with HIV were estimated around 38.4 million in the world more than ever before due to **life-prolonging effect** of anti-retroviral therapy. **Global** incidence—about 1.5 million became newly infected with HIV in 2021. Nearly 0.65 million AIDS deaths occur every year, while no country is free from HIV/AIDS, it is not uniformly distributed in the world. The worst affected region is Sub-Saharan Africa which is home to **25.6** million of **HIV** adults and children.[1] Next comes Asia and Pacific which accounts for over 6.0 million cases and India's share in this region is 2.40 million, thus India is next big **epicentre** after Africa (Table 8.1).

Table 8.1: Global distribution of HIV/AIDS

Adults and children living with HIV, 2021	
Regions	*HIV case load (million)*
Eastern and Southern Africa	20.6
Western and Central Africa	5.0
Asia and the Pacific	6.0
Latin America	2.2
Caribbean	0.33
Eastern Europe and Central Asia	1.80
Western and Central Europe and North America	2.3
Middle East and North Africa	0.18
Global burden	**38.4**

Source: UNAIDS epidemiological estimates 2022

PREVALENCE AND BURDEN OF HIV EPIDEMIC IN INDIA—CURRENT STATUS OF EPIDEMIC

HIV in India continues to have multiple epidemics.

HIV burden in India—estimates of 2021 replace all the previous estimates: Latest estimates indicate that 2.40 million people were living with HIV/AIDS by the end of 2021, of these 44% were women.

Overall prevalence: Adult HIV prevalence in India was 0.21% in 2021 down from peak level of 0.55% in the base year 2000 thus a 62% decline of prevalence.

HIV prevalence (%) among antenatals and core high-risk groups at national level in 2017 and 2019 is depicted in Fig. 8.2 and Table 8.2.

HIV trend in India Tables 8.2 and 8.3. Declining trend of HIV prevalence in general population, antenatals and high risk groups was obvious, except in injecting drug users (IDU) who show stable to rising trend—a sign of concern. Thus India continues to portray concentrated HIV epidemic in core high risk groups.[2,3] This critical information helps to further plan, implement monitor and evaluate HIV control programme to achieve UNs goal of 95–95–95 (sustainable development goals by 2030).

Annual Incidence (Annual New HIV Infections)

HIV incidence (new cases per year) has declined from 1 lakh in 2010 to 62970 in 2021 (Fig. 8.3). Thus, a decline of 46.3% since 2010, is a sign of impact of the programme interventions and a sign of reversal of epidemic. Response need to be accelerated to achieve 95% reduction by 2030. However, all of the decline is due to decrease in HIV prevalence among men (NFHS4). Nationally HIV incidence per 1000 uninfected population was 0.05 in 2021.

Table 8.2: Trends of HIV in India in different population groups (Typology)

Population groups	*2003*	*2004*	*2005*	*2006*	*2007*	*2008–09*	*2010–11*	*2014–15*	*2016–17*	*2020*
Antenatals	0.80	0.95	0.90	0.60	0.49	0.49	0.42	0.35	0.28	0.24
FSW	10.33	9.43	8.44	4.90	5.06	4.94	2.67	2.2	1.56	5.8
IDU	13.15	11.16	10.16	6.92	7.23	9.19	7.17	9.9	6.26	7.4
MSM	8.47	7.47	8.74	6.41	7.41	7.30	4.43	4.3	2.69	3.6
Truckers	–	–	–	2.37	2.87	1.57	2.59	–	0.86	–
Migrants (SMM)	–	–	–	1.60	3.61	2.17	0.99	–	0.51	–
Transgenders	–	–	–	–	–	–	8.82	7.2	3.14	6.5

Prevalence figures in percentages source, NACO—India. Prevalence in 2020 for HRG based on self reported under IBBS

Table 8.3: Trends of adult HIV prevalence in India (2001 to 2021)

Year	*Prevalence rate (%)*	*HIV burden in million*
2000–01	0.55	5.5
2001–03	0.38	2.51
2006	0.36	1.47
2007	0.34	2.22
2008	0.32	2.19
2009	0.31	2.17
2010	0.32	2.15
2011	0.29	2.14
2012	0.28	2.12
2013 and 14	0.27	2.11
2015	0.26	2.11
2017	0.22	2.14
2019	0.22	2.34
2020	0.22	2.31
2021	0.21	2.40

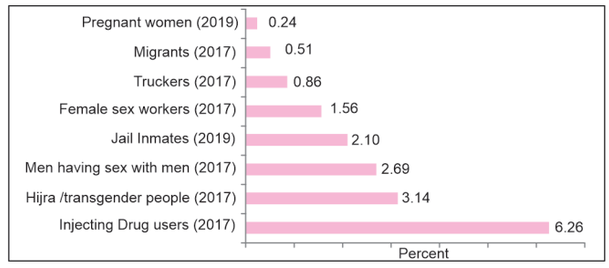


Fig. 8.2: HIV prevalence (%) in different population groups in India

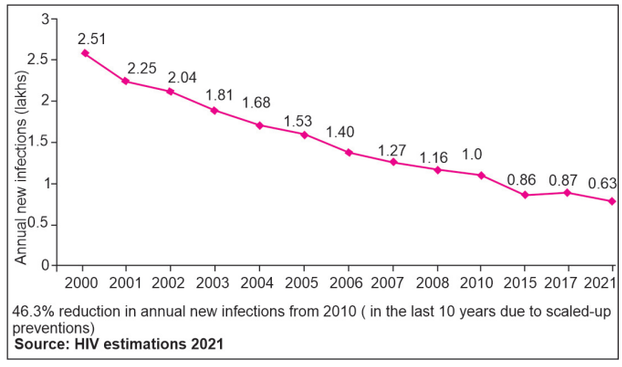


Fig. 8.3: Evidence of programme impact

HIV Across Lifecycle

Of all HIV infections 3.5% were in children, 44.3% in women between 15–49 years age group and remaining 52.2% were in men above the age 15 years.

Distribution by sex: Adult HIV prevalence in men was 0.22% against 0.19% in females.

Rural–urban: HIV prevalence was twice as high in urban areas as in rural areas (0.38% versus 0.17% NFHS4).[4]

Place Distribution—States and Regions-wise Distribution (2021 HSS)

HIV infection is not informally distributed in India among the states and UTs. Mizoram has shown highest estimated prevalence of 2.70% followed by Nagaland at 1.36%, Manipur 1.05%, Telangana 0.47%, Andhra Pradesh 0.67% and Karnataka 0.47%, against the national prevalence of 0.21%.

Integrated bio-behavioral surveillance (IBBS) data provides critical information for the first time on representative HIV prevalence data among core high risk groups from many more states and regions across the country. Prevalence rates of more than 5% in FSWs were observed in Maharashtra, Andhra and group of states-Manipur, Mizoram and Nagaland.[5] Similarly HIV prevalence among IDUs in group of states-Bihar, UP, and Uttarakhand was 27.2%.

Annual AIDS related deaths: 41970 AIDS related deaths were estimated in 2021, a decline of 76.5% annual deaths since 2010 estimated deaths of 151300.

Bridge Population in HIV Transmission

Individuals who have sexual partners in the 'core high risk groups' and other partners are called 'bridge population', because they form a transmission bridge from high risk groups to general population. In the context of HIV pandemic the concept of 'bridging' refers to group of people who connect **high-risk** and low-risk population. Single male migrants, long distance truckers, who also have sex with commercial sex workers and also with their monogamous wives are examples of **bridge** population (Fig. 8.4).

Mapping of bridge population and HRGs was done in 2009 and it estimated 9.2 million of bridge population of trucker, and migrants in India besides 1.47 million of female sex workers, men having sex with men and injecting drug users. Larger the bridge population, more is the transmission.

Mode of Transmission (Fig. 8.5)

Following are the modes of transmission

1 Unprotected sexual intercourse—88%.
2 Parenteral—injecting drug use (IDU)—1.7%.
3 Unsafe blood and blood products transfusion—1%.

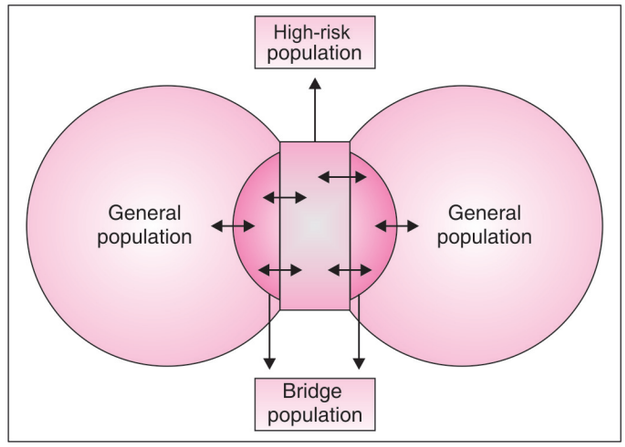


Fig. 8.4: Dynamics of HIV transmission

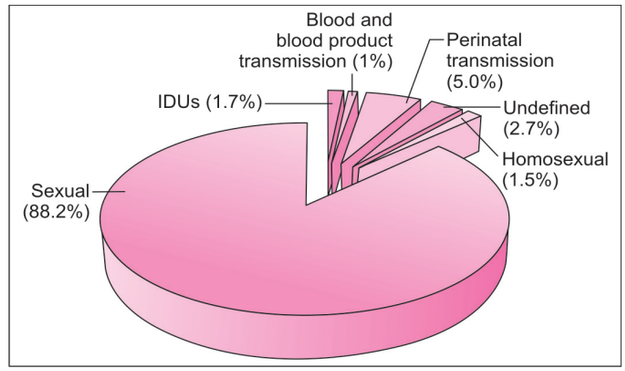


Fig. 8.5: Modes of transmission of HIV in India

4 Vertical transmission—parent/mother to child transmission or transplacental transmission/perinatal—5%.
5 By organ transplant.

Unprotected Sexual Intercourse

The primary driver of HIV epidemic transmission in India is through unprotected heterosexual intercourse. The unprotected sexual intercourse, whether men having sex with men, or women with men is the most common way of transmission of HIV in 85–90% of new infections. Number of sexual partners and number of unprotected sex acts with infected partners determine the occurrence of HIV infection. All unprotected acts of sexual penetration—anal, vaginal and oral carry risk of HIV transmission because they bring sexual secretions directly into contact with exposed mucus membranes. Injury to the mucus membranes of rectum, vagina and oral cavity may help the virus to enter into bloodstream. 'Receptive' partners are at greater risk than 'insertive' partners. However, HIV can also be transmitted through unbroken mucus membrane.

Parenteral Transmission

Sharing of needles and syringes, use of unsterile needles and syringes, transfusion of HIV infected blood,

transplantation of infected organs and tissues can transmit HIV infection. These are most efficient ways of transmission of HIV. Screening of blood before transfusion in all blood banks is mandatory requirement.

Conclusion: In HIV infected person the virus is present in **body secretions**, such as vaginal, semen, rectal, breast milk, and **body fluids** (blood and other body fluids).

Parent/Mother to Child Transmission (MTCT)

HIV infected pregnant women can transmit HIV to her **foetus** or newborn infant, before, during and after birth through placenta, vaginal and cervical secretions, amniotic fluids and breast milk. A pregnant women with HIV infection has approximately 15–45% chance of passing the virus to her **foetus** or newborn baby. However, the risk drops to just 1% if ARV medicines are given to both mother and children. Nearly 20612 pregnant women living with HIV need ART per annum.

The MTCT rate in 2020 was estimated at 27.4% down from 40.2% in 2010 against the target of 5%.

Reservoir of HIV

People harbouring HIV in their body serve as reservoir of infection. In India, 2.40 million people are living with HIV, serve as reservoir for transmission of HIV.

Sources of Infection

Body fluids like blood, semen, vaginal fluids which contain HIV are major sources. Contaminated breast milk may be source of infection from mother to child transmission. Saliva and tears are not considered to be important sources of transmission.

Host Factors—Risk Behaviours (Table 8.4)

These include sexual behaviours of adolescent and youths, premarital unsafe sex, drug abuse, presence of STD in sexual partner and sex with CSWs are risk behaviours in HIV transmission. In addition, literacy level and access to correct information on HIV/AIDS are important determinates. Urbanization and migration of young men to urban areas for livelihood drives the HIV epidemic to rural population.

Commercial Sex Workers (CSWs)

Prostitution is illegal in India. However, commercial sex work is a prolific business in all parts of the country particularly in metros, highways, urban 'red light area', call girls operating in posh areas, urban slums, who exchange sex for money.

About 50% of CSWs have one or the other sexually transmitted diseases (STDs) and 1.6% have HIV infections which are potent risk factors for HIV transmission to bridge population. Sonagachi, the oldest and largest 'red light area' of Kolkata, the CSWs themselves organized condom promotion and sought early treatment for STDs with encouraging results.

Sexually Transmitted Infections (STIs) and HIV

STIs and HIV have strong nexus. Risk of transmission of HIV increases fivefolds to ten times in the presence of genital discharge and genital ulcer syndrome. Early diagnosis and complete treatment of STIs reduces the risk of transmission of HIV infection by more than 40%.

Discrimination and Stigma

High level of discrimination and stigma prevails and as a result many of the HIV positive hide their status. Family deserts them, employer throws them out of job and hospital accepts them reluctantly, people have negative attitudes towards HIV positives.

Economic Impact of HIV

Economic losses due to HIV/AIDS are tremendous to individual, family and community and the nation.

TB and HIV

HIV infection is most important risk factor for progression of latent TB infection to active TB disease. Lifetime risk of TB disease is 6 times more in HIV positive persons. Tuberculosis is the most common opportunistic infection in HIV. An HIV infected person becomes a full fledged case of AIDS in the presence of TB disease. HIV and TB is deadly combination as drug resistance against TB increases mortality rate manifolds.

Expectation of Life

HIV/AIDS is a major global health emergency. It is leading adult killer in world. It has reduced life expectancy. Case fatality is 100%. ART prolongs life of PLHIV.

Coverage of Adults with Antiretroviral Therapy (ART)

Global coverage level of ART was about 87% at the end of 2021. In India, 83% of adults with HIV infection have been covered by ART by March 2021. Target by 2030 is to reach a coverage level of 95%.

Revised Guidelines of WHO on ART: Test and Treat all HIV Positives

The new strategy by WHO calls for early treatment of all HIV infected persons to stop HIV transmission to partners. This means treating people whose immune system is not depleted to the level that usually requires therapy. The increase in access to ART is poised to decrease the incidence of HIV (new infections) further downwards, besides survival rates (prolonging life) in HIV positives and improving quality of life.

National Surveillance Systems in HIV, Viral Hepatitis B and C in 2023: "Integrated and enhanced Surveillance and Epidemiology"

There are two kinds of surveillance systems in HIV.[6]

a **Biological surveillance**—biological specimen collection (blood sample) for HIV sentinel surveillance (HSS) and surveillance of syphilis, hepatitis B and C.

b **Behavioural surveillance** survey (BSS) includes collection of information on knowledge and risk perception on HIV/AIDS, sexual behaviours and exposure to HIV/AIDS and NVHCP services.

Combining biological and behavioural surveillance or **integrated biological** and **behavioural surveillance** (IBBS): This strategy links risk behaviours with HIV and hepatitis B and C to better understand the vulnerabilities and tracking behaviours leading to HIV infections, syphilis, hepatitis B and C.

Biennial HIV Sentinel Surveillance (HSS) Plus in India

Definition: HSS is **collection** of **information** on HIV, syphilis hepatitis B and C prevalence and distribution at regular interval **for action** among different populations and geographical areas. National viral hepatitis surveillance has been integrated with HSS resulting in HSS plus.

Objectives of HSS Plus—2023

- To monitor trends of HIV epidemic in the country
- To monitor prevalence of HIV in different population subgroups (antenatals, FSW, MSM, IDU, migrants and prisoners) and different geographical areas
- To estimate burden of HIV, hepatitis B, C, and syphilis
- To evaluate impact of HIV interventions
- To identify emerging pockets of HIV epidemic.

CRITICAL POPULATIONS FOR HSS PLUS 2023

1. Low Risk Groups—Antenatals (15–49 years)—891 Sites

Pregnant women represent the sexually active segment of general population, hence taken as proxy for monitoring of HIV among general population. Pre-determined sample size of 400 antenatals between 15 and 49 years age groups from ANC sentinel sites are selected by **consecutive sampling methodology** over a period of 3 months at each site.

Testing Strategy

From 2017 onward linked anonymous confidential testing methodology has been adopted. This strategy will facilitate meeting India's goal towards elimination of mother to child transmission of syphilis and HIV by universal screening/testing all pregnant women for HIV syphilis hepatitis B and C. After informed consent a portion of blood collected for routine clinical diagnosis is separated for HSS plus purpose after removing all the personal identifiers like name, address and mobile number. However, surveillance code is linked with ANC registration/OPD code in a separate register (HSS register) which is kept confidentially at ANC HSS site. Purpose is to universally link all antenatals to PPTCT programme at ICTC and hepatitis B and C positives to NVHCP.

2. High Risk Groups (HRGs)—600 Sites

HRG: Population with high risk behaviour for contracting and transmission of HIV include: FSW, MSM, IDU, single male migrants, long distance truckers, prisoners and transgenders.

- **Purpose:** The main purpose of HSS in high risk groups behaviours is to reduce incidence of HIV and detect emerging epidemics. HIV infections are more likely to emerge first of all among HRGs who constitute most critical populations to target for surveillance and preventive activities.
- **Pre-determined:** Sample size in HRGs is 250 eligible high risk individuals for each site by consecutive or by random sampling method who are 18 years and above. Sample size for prison inmates in 400 there are 53 prison sites.

If the quota is met before 12 weeks elapse, the sampling should stop, if the sample is not met during 12 weeks period, that is not problem the sampling should stop. In HRGs informed consent/assent is also obtained. In HRGs dried blood spot (DBS) method is used using special Whatman 903 protein saver card. The DBS sample are sent to designated laboratory, where serum is eluted from DBS for testing.

Test protocol: Two test protocol is adopted in HIV: First test of high sensitivity and second test of high specificity if first test is reactive. One test protocol for hepatitis B and C is adopted and two test protocol for syphilis (TPHA and RPR).

National Integrated Bio-behavioural Surveillance (IBBS) Model

The behavioural surveillance surveys have been replaced with IBBS model in 2013–15 and integrated with HSS plus.

What is IBBS? It is a collection of biological and behavioural **information for** HIV from HRGs for **action**.

In 2014–15 IBBS was implemented to provide HIV/AIDS related knowledge, attitudes, practices as well as status of HIV and related health conditions among HRGs. although IBBS provided comprehensive set of bio-behavioural indicators, it was complex and resource intensive. In 2020 IBBS was replaced with BSS lite (simplified version).

Specific Objectives

- To analyse and understand HIV related behaviours (Table 8.4) and HIV prevalence among key risk groups in different regions by linking sexual and substance use behaviours with biological findings.

Table 8.4: National integrated biological and behavioural surveillance (IBBS) in high-risk groups (HRGs) 2015 and 2020 select indicators

		Years						
		2020	2015	2020	2015	2020	2015	2020
Indicators	HRGs sample size	5018	20707	4991	23081	4207	19902	2353
(Key risk behaviours)		FSWs (%)		MSMs (%)		IDUs (%)		Hijra/TG
• Heard of HIV/AIDS		95.8	95	97.5	95	97.6	96	98.6
• *Comprehensive knowledge of HIV transmission		34.9	42.5	43.1	45.5	35.9	42.6	45.3
• Had misconception about route of transmission		–	26.8	–	20.9	–	26.1	–
• Tested for HIV in last 12 months		84.6	99	81.9	99	78.9	92	86.6
• **(Self reported) HIV prevalence level**		**5.8**	**2.2**	**3.6**	**4.3**	**7.4**	**9.9**	6.5
• Medium age of first sexual act		13.7	18 years		16 years	18.6	19 years	
• Median age of initiation of commercial sex work		22	22 years	17	17 years	21	20 years initiation of drugs	14
• Sex with commercial male partner 2 weeks priar to survey		86	79	55	46	28	–	76
• Sex with regular male partner		70	82	64	54	70	–	56
– Exposure to programme services in last 3 months		95.9	90	91.6	78	92.8	81	93.2

*Comprehensive knowledge means knowing that consistent use of condoms every time they have sex and having just one uninfected faithful sex partner can reduce the chances of getting HIV/AIDS, knowing that a healthy looking person can have HIV/AIDS, and rejecting two common misconceptions about transmission or prevention of HIV/AIDS.

- To measure and estimate change in HIV related behaviours and HIV prevalence among key HRGs between baseline and endline for NACP IV.
- Generate district level estimates for PL HIV which was a major information gap under NACP III for effective targeting and planning.[5]
- Behaviour surveillance survey-LITE (BSS lite) was conducted in 2019–20. Results are presented in Table 8.4.

NATIONAL AIDS CONTROL PROGRAMME

Competency addressed: The student should be able to:

CM 8.3: Enumerate and describe disease specific national health programs including their prevention and treatment of a case of communicable disease.

In 1992 National AIDS and STD control programme (NACP) was launched to control HIV/AIDS. National Aids Control Organization (NACO) is the nodal organization for NACP. It is being implemented through State/UT AIDS Control Societies (SACS) and closely monitored by district AIDS prevention and control unit (DAPCU) in 188 priority districts (based on HIV sentinel surveillance data of 2004–06). NACO has implemented four phases of **National AIDS and STD Control Programme** (NACP) from 1992–2021 including extended Phase IV 2017–21. Currently NACP Phase V is in progress from 2021 to 2026 under 100% central sector scheme. Primary goal is to accelerate the process of reversal of epidemic of HIV in India.

National Strategic Plan and 'Mission' Sampark 2017–24 for HIV/AIDS (NACP)[7]

India is committed to achieve sustainable development goals (SDG) of United Nations, i.e. 'Ending the epidemic of HIV/AID by 2030' and reversing the spread of HIV/AIDS.

Under 'Test and Treat' policy of 2017 '*Mission Sampark*' was launched to search all those 'who are aware of their HIV positive status' but are not on ART. Intensified *Mission Sampark* is latest effort to expand test and treat policy to achieve 95–95–95 targets.

Vision: AIDS free India

UNs Global Targets 95–95–95 Fast track targets by 2030

- 95% of all people living with HIV will know their HIV status
- 95% of all people diagnosed with HIV infection will receive sustained ART and
- 95% of all people receiving ART will have durable viral suppression, to the extent that it cannot replicate.

'End AIDS Epidemic by 2030': Definition: 95% reduction of new HIV infections (incidence) and AIDS related mortality compared to 2010 baseline.

Goal: Zero new infection, zero discrimination and zero AIDS related deaths and zero transmission from mother to child. **Impact indicators achieved so** far are **indicated** in Table 8.5.

Table 8.5: Impact indicators of HIV during 2020–21 India's score card[8,9]

Indicators	*National achievement in 2021*	*Target by 2030*
1. People living with HIV/AIDS (PLHIV) in 2021	2.4 million	–
2. People living with HIV (PLHIV) who know their HIV status	78%	95%
3. PL HIV who kow their HIV positive status and are on antiviral therapy	83%	95%
4. PL HIV on antiviral therapy and virally suppressed	85%	95%
5. Decline in annual AIDS related deaths in 2021	76.5%	95%
6. Decline in annual new HIV infections in 2021	46.3%	95%
7. HIV positive mothers on antiretroviral theraphy	56%	95%
8. ART initiation rate	94%	95%

Comprehensive Strategy of NACP and Policy Shift

- **Prevention**
- **Test and Treat all HIV Positive**—a policy shift
- **Laboratory Services**
- **Stigma and Discrimination** (implementation of HIV/AIDS prevention and control Act-2017).

Intervention/Services/Levels of Prevention

A. Preventive Services in Population

1. Communication of existing knowledge on HIV/AIDS[9]

The only cure for HIV is prevention since HIV/AIDS is incurable and fatal in the long run.

Information, education and communication for **general population** (adolescents and young people and women) and **high risk groups** with focus on behaviour change and demand generation is the major intervention.

Coverage: Ensure high coverage of general population and high risk groups close to 95%.

How? NACP is reaching general population and high risk population through mass media, mid-media (folk media), through Adolescent education programmes (AEP) in schools, to build 'life skills' of adolescents to cope with negative peer pressure and develop positive behaviour, **red ribbon** clubs in schools and colleges as also through interpersonal communication and ICTCs. Over 67% budget is being spent on prevention programmes. Attempt is made that 99.78% of adult persons who are HIV negative they stay healthy and do not acquire HIV infection. Secondly, HRGs and bridge population should adopt healthy behaviours (behaviours change communication) for risk reduction and to reduce incidence of HIV. Comprehensive knowledge on HIV/AIDS among adult females was low at 21.6 against 30.7% in adult males. (NFHS-5). IBBS reported figure being 35 to 45% in high risk groups.

Demand generation: People should utilize preventive and promotive services under the programme.

2. Targeted community led interventions (TIs)

TIs are implemented as NGO/CBO peer led outreach model to provide package of services. People from high-risk communities—peer educators are engaged to deliver package of services to HRGs.

The entire programme of TI is built on the peer-led in partnership with NGOs/CBOs. People from high risk communities—peer eductors and outreach workers identify the high risk groups and provide services and information through regular inter-personal communication sessions.

For core high risk groups (HRG) and bridge population, high level of coverage over 95% have to be ensured to achieve the desired impact (reduction of incidence).

Preventive services under targeted interventions

a Screening or **early detection** of STIs by regular medical check-ups of HRGs every **3 months** and complete treatment by syndromic management beside partner notification and treatment.
b **Testing** of HRGs for HIV, hepatitis B, C, TB and syphilis every 6 months and linking HIV positives with care, support, and treatment to improve survival and quality of life of PLHIV.
c Linkage with ICTC for counselling and testing for HIV, Hepatitis B and C and syphilis.
d Free condom and lubricant distribution.
e Needle and syringe exchange programme, abscess prevention and management and social marketing of condoms.
f Opioid substitution therapy for IDUs. Linkages with detoxification and rehabilitation services.
g Behaviours change communication.

How: These preventive services are provided by non-governmental organizations at **clinic** or **drop in centres** and at doorsteps of HRGs by peer educators.

Revamped and revised elements of TI

i Differentiated approach—segmenting key population
ii Strengthen outreach activity

iii Community based screening by TI to cover hard to reach HRGs
iv Bio-medical waste management
v Peer navigation
vi Index testing
vii mapping and population size estimation
viii secondary distribution of needles and syringes
ix Satellite OST centres and community score card.

3. HIV counselling and testing services (HCTS)

The HCTS includes following components.

I Integrated counselling and testing centres—ICTC/HCTS.
II Prevention of parent to child transmission of HIV (PPTCT)
III HIV/TB collaborative activities

Integrated counselling and testing centres (ICTCs)

Voluntary HIV testing and counselling services for HIV infection: The first critical step of 95–95–95 target in detecting and linking people with HIV to access treatment and care. ICTC provides an opportunity to reinforce HIV prevention. The national programme is offering ICTC services since 1997. There are different types of ICTCs/ HCTS facilities in India which include:

Standalone (SA–ICTC), mobile ICTC, facility integrated counselling and testing centres (F–ICTC), public private partnership ICTC (PPP/ICTC) and community-based screening approach for HIV detection. Over 34500 ICTCs in the country have been set-up to cover general population, pregnant women and HRGs. ICTCs are managed by trained and dedicated male and female counsellors. Any one can access ICTC services, full confidentiality is maintained.

To achieve the new 95–95–95 global HIV targets, the first being diagnosis of 95% of people living with HIV. At present 78% of PL HIV know their status. To speed up the HIV diagnostic testing services, new WHO guidelines may be followed under NACP. The NACO will accelerate or scale up the HIV testing services to achieve first 95 to cover high risk and vulnerable population and to reach the unreached. The new consolidated WHO guidelines lay stress on lay worker screening including self-testing and community-based testing by health workers besides mobile testing labs, index testing and partner notification.

Prevention of parent to child transmission of HIV and syphilis (PPTCT)

Objectives:

i Elimination of parent to child transmission of syphilis and HIV by 2020.
ii Universal screening/testing of all pregnant women (100%) for HIV and syphilis hepatitis B, C, and providing counselling, testing services to pregnant women.

How? Network of 34500 ICTCs in the country offer PPTCT services, i.e. testing every pregnant woman (universal coverage) to detect HIV and syphilis positive pregnant women and eliminate transmission of HIV and syphilis from mother to child. At present programme covers 56% of positive pregnant women. If HIV positive pregnant women are untreated they would have 15–45% chance of transmitting the virus to their babies during pregnancy, labour, delivery or breastfeeding. However, risk drops to 1% if ARV medicines are given to mothers and children.

Services: Counselling and treatment, lifelong ART, using triple drugs regimen for all pregnant and breast-feeding women infected with HIV irrespective of CD4 count. Nevirapine prophylaxis to exposed babies for a minimum period of 6 weeks is a routine regimen.

HIV/TB collaborative activities

TB disease is the commonest opportunistic infection among HIV infected individuals and a major cause of mortality. Nationally about 4% TB patients registered under RNTCP have HIV infection. TB associated HIV epidemic is posing a great challenge. The national HIV/ TB response includes three 'I's, i.e. ICF, isoniazid preventive therapy and infection control in high burden ART centres.

a.Intensified TB case finding (ICF) at HIV care setting: Under ICF, all ICTC clients are screened by ICTC counsellors for presence of TB signs and symptoms (presumptive TB cases) and clients who have symptoms and signs of TB are referred to RNTCP diagnostic and treatment facility. Using cartridge-based nucleic acid amplification test (CBNAAT) for early diagnosis of TB and Rif. R for people living with HIV is being done at district level. Daily treatment anti-TB regimen in fixed drug combination is being used and innovative drug intake tracking mechanism using missed call at a toll free number on the strip is being used under the programme.

b. Isoniazid (INH) preventive therapy: INH preventive therapy is the key intervention for prevention of 'TB among people living with HIV recommended by WHO.' Isoniazid protects against both, progression of latent TB infection to active disease (reactivation) as well as re-infection when exposed to active TB case.

c. Infection control: To prevent transmission of TB at healthcare setting, airborne infection control measures are being undertaken.

d. Migrant interventions

i At source—at village through source migrant interventions.
ii At destination—where migrant come for work and livelihood.
iii At transit place—the places from where they board train or bus

Services: Information on HIV/AIDS and commodities distribution.

e. Link worker scheme for rural areas (LWS): High risk groups and vulnerable population of rural areas of

144 high priority districts (HIV prevalence more than or equal to 1%) are being covered by highly motivated and trained community members—20 cluster link workers in each district. Each cluster consists of five villages. These workers along with ASHAs and *Anganwadi* worker establish contacts with HRGs (FSW, MSM, IDU) and link them to services agencies in the area apart from providing information on HIV and distribution of commodities. In the long run the NACP is to be integrated with NHM to enhance coverage in rural areas.

f. Sexually transmitted infections (STIs) and reproductive tract infections (RTIs) prevention and control: Presence of RTIs and STIs enhances the chances of acquiring and transmitting HIV infection by 4 to 8 times, hence control and prevention of STI/RTI is a key preventive strategy for HIV. Early diagnosis and complete treatment of STI/RTI reduces the transmission rate of HIV infection by more than 40%. Under NACP syndromic case management of STI/RTI with minimal lab tests is the cornerstone of the programme. Currently there are 1822 designated STI/RTI clinics (DSRCs) (*Suraksha* clinics) across the country at least one per district.

Since major proportion of patient over 70% with STI/RTI seek services from vast network of private healthcare systems, NACO has initiated partnership with private sector and organized public health sector.

g. Condom promotion programme: Nearly 88% of HIV infections are transmitted by unsafe sex. NACO is promoting consistent and correct use of condoms to prevent STI/HIV infections. Free supply of condoms is ensured under the programme besides social marketing programme of condoms to increase outlets.

h. Safe blood transfusion services: NACP is promoting voluntary blood donation. Modern blood bank services have been established. To reduce blood borne transmission of HIV, mandatory screening or 100% testing of every unit of blood for HIV, hepatitis B and C, malaria and syphilis is being ensured to prevent transfusion transmissible infections (TTI).

i. New Initiative in Care Support and Treatment (CST) 'Test and treat all policy': Moving away from CD4 cut off 500 to treat all HIV positives as soon as they are detected is major way to reduce new HIV infections, reduce progression to AIDS and prevent TB among PLHIV. The policy was rolled out in 2017. With the adoption of 'test and treat' policy all people living with HIV are eligible for ART initiation, irrespective of their CD4 counts or WHO Staging to avoid multiple visits.

j. Viral load testing: NACP provides quality testing services for HIV free of cost, and monitors safe blood. Among people assessing treatment 85% were virally suppressed in India in 2020.

k. Care support and treatment (CST) component of National AIDS Control Programme: The overall goal of CST is to improve the survival and quality of life of the PLHIV (people living with HIV).

- **Free and universal access to lifelong standardized** ART, Highly active anti-retroviral therapy (HART) through ART centres, paediatric centres of excellence, facility integrated (HART) centres, link ART centres, link ART plus centres and care and support centres established by NACO. These centres provide free of cost ART. Care and support centres ensure free access to ART for first line and second line ART and even third line ART. Treatment is lifelong.
- These centres also provide free lab diagnostics-CD4 and viral load testing, psychological support, prevention, diagnosis and treatment of opportunistic infections like TB, and home-based care free of stigma and discrimination.

Viral load testing facilities are very limited in the country; now free of cost viral load testing at least once a year for PLHIV has been initiated in March 2018. Viral load test is used to measure the effectiveness of ART programme.

Goal is to achieve 95% coverage of ART in PLHIV who know their HIV status to achieve the second global target of 95–95–95. Among people who knew their status 83% were assessing ARV treatment. Early ART initiation, drug adherence, retention and subsequent viral load suppression are critical measures of HIV care. Viral load suppression significantly reduces the risk of ongoing HIV transmission.

Treatment adherence is being monitored by self verified adherence (SVA), pill counting and on time pill pick up.

Preexposure Prophylaxis

PrEP is defined as the administration of antiretroviral drugs to an uninfected person before potential HIV exposure to reduce the risk of infection and continued during risk. PrEP can be in the form of a pill taken by mouth or a gel applied to the vagina or rectum. The rational of this approach is to administer a preventive dose of drug(s) before exposure to HIV, so the moment virus enters the body, HIV replication is inhibited and HIV is not able to establish permanent infection. For high-risk individuals who test HIV negative, offering PrEP is recommended in addition to the provision of free condoms, circumcision, education about risk reduction strategies, etc. Voluntary male medical circumcision has shown up to 60% reduction in transmission risk in circumcised heterosexual men.[4]

A drug named Truvada which is a combination of tenofovir disoproxil fumarate (TDF) and emtricitabine (FTC) has been approved by the US Food and Drug Administration on July 16, 2012, for PrEP regimen in combination with safer sex practices to reduce the risk of

sexually acquired HIV-1 in adults at high risk. It has been recently approved in India for prevention of HIV costing about Rs 2200 for a month.

Towards achievement of third 95 (i.e. 95% of those initiated on antiretroviral treatment should have suppressed viral load) NACO has set up 64 public sector labs apart from public private partnership (PPP). Of persons on ART, 85% were virally suppressed in 2020.

l. Mainstreaming and partnership and social protection: It is key strategy to strengthen multisectoral response to HIV through 18 key ministries and departments.

m. Strategic information management (SIM) for monitoring and evaluation: NACP needs data/information to make decisions for managing the epidemic in the country. The data on HIV is being generated through routine reports of HIV through ICTCs, PPTCT, ART centres, STD clinics, blood banks, HIV sentinel surveillance, IBBS, national family health surveys and special studies. The raw data is analysed and interpreted to generate information on the HIV trends, prevalence in different populations and geographical areas, HIV load, need for ART and **planning and evaluation** of different strategies for NACP. The goal is to generate district level data and information for local planning or district health action plans on HIV prevention and control as also for **evaluation**. HSS + generates mainly urban data, ownership of such data lacks at state and district level data and information is seldom used by healthcare delivery system at district level planning and evaluation.

HIV/AIDS Act: April 2017

This Act safeguards the right of people living with HIV and those affected by HIV. It enhances the access to prevention and treatment services and addresses stigma and discrimination. State governments have appointed ombudsmen to inquire into violation of the Act. The Act prohibits discrimination or unfair treatment of HIV infected persons on any grounds.

FEMALE SEX WORK PATTERNS AND IMPLICATIONS: A CASE STUDY

Commercial sex work is being propagated from generation to generation in the state or Rajasthan and Karnataka in close communities—Nats and Kanzer (in Rajasthan). These communities live in close knit families at the outskirt of a village or nearby highway. Nats and kanzers were landless and marginal communities with poor socio-economic status. Traditionally, the communities earned their livelihood by way of entertaining people through special skills—singing, dancing, performing stunts: Balancing on ropeway and ropeway walking and performing acrobatics and aerobatics as also indulging in sex work. The birth of a girl child is most welcome in Nats community. The girl children are brought up very well and graduated to sex work by their parents. Most girls in these communities do not get married, but trained to pursue sex work, which is most often home based. Income generated from sex work sustains the life of family and whole family thrives on income generated through sex work. Most Nats families have now become rich as they own a good house with all modern amenities—television, car, mobile phones and refrigerators. These young female sex workers have established a strong network in Mumbai and far flung place like Dubai to fetch more money by sex work tourism. Daughter marriage in Nats community means—selling the girls for lump sum money.

Whole of Jaisinghpura village in Tonk district in Rajasthan is inhabited by 55 Nats families, 2 km away from main village SODA. It is their stronghold and a kingdom for female sex work. Village Jaisinghpura is located close to religious place Diggi where lots of people keep on visiting Diggi temple throughout the year. Most tourists, truckers and young people from cities frequent young female sex workers at this village. Similarly, Bandersundri village on Jaipur, Ajmer highway—a hub of female sex workers of Nats community is a long distance trucker's paradise and transit station for sexual activity. Similarly, village Malpura in district Alwar close to national highway is a hub of female sex workers. Similarly Maniya in Dhaulpur abounds with CSWs.

Sex work in the state of Karnataka can be linked or associated with *Devadasi* tradition. In several areas of Northern Karnataka families dedicate one of their daughters, to temple, to appease gods. The daughters so dedicated are called *Devadasis* and once dedicated they are not allowed to get marry for the rest of their lives. They serve the sexual needs of priests and wealthy married men. Many of the *Devadasis* have become commercial sex workers. Peer educators involved in the programme are sex workers, as were their mothers and grandmothers before them (ICHAP, 2004).

REPRODUCTIVE TRACT INFECTIONS/ SEXUALLY TRANSMITTED INFECTIONS

Sexually transmitted diseases (STDs) remain a major public health problem in many parts of the world.

The term 'sexually transmitted disease' (STD) is used for all infections that are mainly transmitted through sexual contact, during unprotected vaginal, anal or oral intercourse. Some are also transmitted from mother to child, before, during and after birth and through unsafe blood, blood products, donated organs or tissues and contaminated needles.

The term sexually transmitted diseases (STDs) has been replaced by the term sexually transmitted infections (STIs). Since 1999, the term sexually transmitted infection has been adopted by WHO, as it covers *asymptomatic infections as well*.

Spectrum of Sexually Transmitted Infections (STIs)

STIs are group of communicable diseases which are predominantly transmitted by sexual contact. The spectrum, however, has been enlarged to include several additional diseases.

More than 30 different bacteria, viruses and parasites are known to be transmitted through sexual contact. Eight of these pathogens are linked to the greatest incidence of sexually transmitted disease. Of these 8 infections, 4 are currently **curable: Syphilis**, **gonorrhoea, chlamydia** and **trichomoniasis.** The other 4 are viral infections which are incurable: Hepatitis B, herpes **simplex virus** (HSV or herpes), **HIV**, and human papillomavirus (HPV). Symptoms or disease due to the incurable viral infections can be reduced or modified through treatment.

STIs are spread predominantly by sexual contact, including vaginal, anal and oral sex. Some STIs can also be spread through non-sexual means such as via blood or blood products. Many STIs—including syphilis, hepatitis B, HIV, chlamydia, gonorrhoea, herpes, and HPV—can also be transmitted from mother to child during pregnancy and childbirth.

A person can have an STI without having obvious symptoms of disease. Common symptoms of STIs include vaginal discharge, urethral discharge or burning in men, genital ulcers, and abdominal pain.

Clinical Spectrum of RTIs/STIs (Syndromes)

Clients having RTIs/STIs usually present with:

i Vaginal discharge
ii Urethral discharge
iii Genital ulcers vesicular and/or non-vesicular
iv Inguinal bubo
v Lower abdominal pain (LAP)
vi Acute scrotal pain/swelling
vii Genital skin conditions.
viii Ophthalmia neonatorum

GLOBAL DISEASE BURDEN

According to WHO estimates

- Each year, there are an estimated 376 million new infections with 1 of 4 STIs: Chlamydia, gonorrhoea, syphilis and trichomoniasis.
- More than 1 million sexually transmitted infections (STIs) are acquired everyday worldwide.
- More than 500 million people are estimated to have genital infection with herpes simplex virus (HSV).
- More than 290 million women have a human papillomavirus (HPV) infection.
- The majority of STIs have no symptoms or only mild symptoms that may not be recognized as an STI.
- STIs such as HSV type 2 and syphilis can increase the risk of HIV acquisition.
- 988000 pregnant women were infected with syphilis in 2016, resulting in over 350000 adverse birth outcomes including 200000 stillbirths and newborn deaths.
- In some cases, STIs can have serious reproductive health consequences beyond the immediate impact of the infection itself (e.g. infertility or mother-to-child transmission).
- Drug resistance, especially for gonorrhoea, is a major threat to reducing the impact of STIs worldwide.

Problem of STD/STIs in India

Reproductive tract infections (RTIs) including sexually transmitted infections (STIs) present a huge burden of disease and adversely impact the reproductive health of people. They cause suffering for both men and women around the world, but their consequences are far more devastating and widespread among women than men. The exact data on STI prevalence in India especially in general population is lacking.

India has high incidence of STDs with an estimated incidence rate of 5% or 40 million new cases per year.

Sexually transmitted infections/reproductive tract infections (STI/RTI) are an important public health problem in India. A community based STI/RTI prevalence study conducted during 2002–03 by the Indian Council of Medical Research (ICMR) has shown that 6% of the adult population in India has one or more STI/RTI. This amounts to occurrence of about 30–35 million episodes of STI/RTI every year in the country. Controlling STI/RTI helps to decrease HIV infection rates and provides a window of opportunity for counselling on HIV prevention and improving sexual and reproductive health.

Currently, the available data from the STI/RTI control and prevention programme suggests a significant decline of bacterial STI (syphilis, gonorrhoea), chancroid is almost on the verge of disappearance. The overall sero-positivity of syphilis at national level ranged between 0.2% and 1.6% in 2020–21 in India. On the other hand, viral STI (herpes, genital warts, hepatitis B) are showing an increasing trend. There is a significant burden of lower RTI (trichomoniasis, bacterial vaginosis and candidiasis) among women with no evidence to suggest a decline in their prevalence, thus affecting the quality of their reproductive health.

STDs in High-risk Groups

The prevalence of STIs and RTIs among high-risk groups is very high. Up to 50% of CSWs in major cities such as Mumbai, Pune, Delhi and Chennai have STIs suggesting that frequent unprotected sexual intercourse is widespread. Similarly, prevalence of STIs is much higher in injecting drug users, prisoners and migrant workers (industrial workers) and in men having sex with men.

Risk Behaviours and Practices Associated with STIs

1. **Urbanization, industrialization and migration:** Many young persons (single male migrants) migrate to urban areas in search of livelihood leaving their families in rural areas. Similarly, long distance truckers and cleaners are away from their families for days together and many other persons whose occupation is such that they have to be away from home and families. Such persons often have unprotected sex with FSWs and consequently acquire STIs. Behaviour of such persons determines the occurrence of STIs.
2. **Multiple sexual partners and extramarital and premarital sexual intercourse** with strangers without use of condom or irregular use of condoms make them more vulnerable to STIs. Around 9% of men had non-regular sexual partners and practice high-risk behaviour.
3. **Poverty:** Driven by extreme poverty, many of the young girls migrate to cities and adopt the profession of CSWs and exchange sex for money. These girls have little negotiating power and cannot force their clients to use condoms. Legally, prostitution is banned but female sex workers (FSWs) have established in major cities and on highways. FSWs contract and transmit STIs to their clients. FSWs seldom seek early treatment for STIs. "Call girls" in cities is a prolific business for exchange of sex for money.
4. **Behaviour of adolescents and youth:** Sexual activity gets initiated during the period of adolescence, uncontrolled and unprotected sex makes them most vulnerable to STIs. Their knowledge and access to information will determine the spread of STIs. Many of the adolescents and young people have poor knowledge of STIs and their transmission.
5. **Illiteracy:** Knowledge is power but it is missing with many, and health illiteracy is widespread in India. Health illiterates have poor access to information, including information on STIs occurrence and transmission and consequences of STIs.
6. **Occupation:** Industrial workers, migrant labourers and adolescent unemployed youths are most vulnerable groups for STIs.
7. **Stigma and treatment seeking behaviour:** Since STIs carry a stigma and discrimination, people tend to hide such infection and do not seek treatment or seek treatment from quacks. Partner notification is rare. Only women came forward to seek treatment during intensive campaign of family health awareness.
8. **Partner notification** and failure to get sexual partners treated simultaneously leads to **recurrence** of infection and maintenance of infections and continuation of transmission.
9. Many of STIs remain asymptomatic and awareness of signs and symptoms and importance of STI treatment is poor as revealed by behaviour surveillance surveys (BSS).

Consequences

The STI could lead to infertility, ectopic pregnancy, pelvic inflammatory disease (PID); HIV infection is potentially fatal, congenital syphilis, congenital malformation, cervical cancer, fetal wastage, or stillbirths neonatal deaths, low birth weight, ophthalmia neonatorum, blindness and systemic infections and economic burden is also very high. Presence of STIs also compromises with contraceptive acceptance and continuation.

Syndromic Case Management of STI/RTI

1. The traditional approach to clinical diagnosis of a presumed STI was through etiological diagnosis established by microscopy and laboratory cultures and serological tests. This approach was expensive and slow in obtaining the results and leads to delay in initiation of treatment. It requires sophisticated laboratory equipment and trained manpower. Many of the clients of STI are lost as they may not come again to the facility or clinic.
2. Moreover, most clients of STI are seen and attended by private sector (private practitioners and clinics) who have limited diagnostic facilities. Clinical diagnosis without any test would be cheaper but it is inaccurate and incomplete in majority of instances.
3. The limitation of this approach has led to the development and advocacy of a third strategy, which is known as 'syndromic approach'.

The 'syndromic approach' is a simple practical tool to improve diagnosis and treatment. The simplified syndromic-based approach, developed and promoted by WHO and is currently being used in large number of countries in the developed world.

Majority of STIs fall under the categories of, genital ulcer, vaginal discharge and urethral discharge, inguinal swelling and lower abdominal pain. Most STIs patients consult a doctor or healthcare providers with complaints related to above-mentioned syndromes.

Definition

A syndrome is defined as a group of consistent common symptoms and signs caused by more than one organism. An STI/RTI syndrome is a combination of symptoms and signs typically associated with sexually transmitted microorganisms, e.g. **genital ulcer disease** syndrome, which may be due to syphilis, chancroid, herpes simplex, etc.

Aim

The aim of STI/RTI syndromic case management is to identify the syndrome correctly and manage them accordingly. While clinical diagnosis is based on identifying the specific causative agent. Syndromic diagnosis leads to immediate treatment for all of the most

important possible causative agents. This is important because mixed infections occur frequently in STI/RTI. Besides, syndromic management of STI/RTI can effectively treat cases in settings with limited or no **laboratory facilities**. This means syndromic treatment can quickly render the patient non-infectious.

Advantages

The major advantages of syndromic approach are:

1. Diagnosis and treatment is done in one visit.
2. It can be implemented on large-scale even at the primary healthcare level, being simple, rapid and inexpensive.
3. It requires minimum training and can be applied by health workers.
4. Patients are treated for possible mixed infections by addressing all the important causes of a syndrome.

Essential Steps of Syndromic Case Management (SCM)[10, 11]

It necessitates **history taking** (history of recent unprotected sex and sex of partner, multiple sexual partners, recent change in sexual partners with symptoms suggestive of RTI and type of exposure—oral, vaginal and anal), **clinical examination**, (genital, oral and ano-rectal bimanual and speculum examination, minimal laboratory tests), **correct diagnosis**, by using flow charts early and **effective treatment**, with *single oral dosages wherever possible*, counselling on sexual behaviour, voluntary testing for HIV, provision and promotion of condoms, partner notification and treatment, case reporting and follow-up after 7 days for all STI, 3rd, 7th and 14th day for LAP hence it is much more than mere treatment, therefore, we call it enhanced syndromic case management (ESCM).

Criticism of Syndromic Approach

The syndromic approach is too simple for a physician, unscientific procedure, it does not use a provider's clinical skill and experience.

- It wastes a lot of drug.
- It promotes development of antibiotic resistance.
- Simple laboratory tests should be included.

Relationship between HIV and STI

STI and HIV have nexus:

- The predominant mode of transmission of both HIV and STI is through unprotected sexual intercourse.
- The same risk behaviour, which predisposes for STI also predisposes for HIV infection. Thus, many of the measures for prevention of STI and HIV are the same.
- Target groups for intervention are the same.
- The severity of STI and their manifestations and infectivity, in the presence of HIV infection, goes very high and the response to therapy decreased.

Prevention of STDs/STIs

The following guidelines can be helpful to prevent STIs/STDs. Most STIs are *curable* and *preventable*.

- *Use of condoms:* Educate about correct and consistent use of condoms in every time one has sex and refer all patients to ICTC.
- Have one faithful uninfected sex partner.
- Avoid sex with partners who have genital rashes, redness, sores or discharge.
- Stay away from casual sex/reduce sex partners.
- Most STIs are curable. Early and complete treatment is always desirable to prevent complications and further spread of infection. Sexual abstinence during the course of treatment is helpful.
- Good quality, non-stigmatizing services for diagnosis and treatment of STI should be provided in the existing health system in an integrated manner. Collaboration with private, industrial corporation and NGO sectors and re-orientation of specialized STD clinics can help to reduce the incidence of STI.
- Partner notification and treatment helps.
- Promote voluntary counselling and testing for HIV, syphilis and hepatitis B.
- Immunization against hepatitis B.
- **Safe injections** and safe blood.

NATIONAL GUIDELINES ON PREVENTION MANAGEMENT AND CONTROL OF RTIs/STIs 2014

The enhanced syndromic case management **(ESCM)** is a comprehensive approach for STI management endorsed by WHO for resource limited setting. This is being practiced in major part of the world. The approach classifies the STIs into syndromes, which are easily identifiable group of symptoms and signs and provides treatment at first visit, with no or **minimal laboratory tests**. It also provides the other important components of STI case management, namely treatment compliance and follow-up, counselling, partner treatment and condom promotion, apart from voluntary testing for HIV at integrated counselling and testing centre.[10, 11]

Management of STI/RTI is one of the major strategies for HIV control in India under National AIDS Control Programme. Under NACP II, the STI services were provided through designated STI clinics at the district level and medical colleges. Under NACP III, this has been expanded to primary health centres (PHCs) and community health centres (CHCs) in convergence with RCH II under National Rural Health Mission. Over 60–70% of STI/RTI patients seek services from **private sector,** hence their involvement in the programme is a must to enhance coverage, besides demand generation for STI, services through education.

Services of contracted preferred private providers are made available to high risk groups at community level for free treatment of STI/RTI under targeted intervention.

Pre-packed STI/RTI kits: Pre-packed colour-coded kits (kit 1–7) have been provided for free supply at all Government STI/RTI clinics, CHCs, PHCs and TI NGOs for enhanced syndromic case management (through standard treatment protocols). Treatment with single oral doses is a preferred strategy (Table 8.6).

Important Considerations for Management of all STI/RTI

- Educate and counsel client and sexual partner/s regarding STI/RTI, safer sex practices and importance of taking complete treatment.
- Treat partner/s
- Advise sexual abstinence or condom use during the course of treatment.
- Provide condoms, educate about correct and consistent use.
- Refer all patients to ICTC.
- Follow up after 7 days for all STI, 3rd, 7th, and 14th day for LAP and 7th, 14th, and 21st day for IB.
- If symptoms persist, assess whether it is due to re-infection and advise prompt referral.
- Consider immunization against hepatitis B.

NACO is supporting 1822 designated STI/RTI clinics (DSRCs) which are providing STI/RTI services based on enhanced syndromic case management. NACO has branded the STI/RTI clinics as 'Suraksha clinics' and has developed a national communication strategy on STI/RTI service delivery for demand generation; one **counsellor** is provided to each of these designated clinics besides one laboratory technician. Supplementing syndromic case management with point of care and simple laboratory tests are the cornerstone of STI/RTI management under NACP.

Laboratory tests include test for HIV, syphilis and microscopic examination of discharge after Gram staining.

RTI/STI *among special populations*. STIs including HIV are most common among young people aged 15–24 (including adolescents) and more so in young women. Adolescents are being covered in the RCH II, though adolescent reproductive and sexual health (ARSH) strategy.

Core high-risk groups like female sex workers (FSWs) and men having sex with men (MSM) and injecting drug users (IDUs) show higher prevalence of STIs than general population. Nearly 50% of FSWs suffer from any one symptom of STIs which increases HIV transmission. Targeted interventions (TIs) for high-risk groups under NACP provide services for RTIs and STIs (medical check ups for STIs once in 3 months and syphilis and HIV testing twice a year) through drop in centres/clinics managed by

Table 8.6: STI/RTI syndromic case management

Syndromes					
UD, CD, RD, painful scrotal swelling*	*Vaginal discharge*	*Genital ulcer—non-herpetic*	*Genital ulcer—herpetic*	*Lower abdominal pain (LAP)*	*Inguinal bubo (IB)*
• Pain or burning while passing urine, increased frequency • Low backache • Systemic symptoms like malaise, fever	• Nature and type of discharge (quantity, colour and odour) • Burning while passing urine, increased frequency • Genital complaints by sexual partner • Low backache *(take menstrual history to rule out pregnancy)*	• Genital ulcer, single or multiple, painful or painless • Burning sensation in the genital area • Enlarged lymph nodes	• Genital ulcer or vesicles, single or multiple, painful, recurrent • Burning sensation in the genital area	• Lower abdominal pain • Fever • Vaginal discharge • Menstrual irregularities like heavy, irregular vaginal bleeding • Dysmenorrhoea, dyspareunia, dysuria, tenesmus • Lower backache • Cervical motion tenderness	• Swelling in inguinal region which may be painful • Preceding history of genital ulcer or discharge • Systemic symptoms like malaise fever, etc.
Tab. azithromycin 1 g OD stat + Tab. cefixime 400 mg OD stat	Tab. secnidazole 2 g OD stat + Cap. fluconazole 150 mg OD Stat	Inj. benzathine penicillin (2.4 MU)—1 vial Tab. azithromycin (1 g)—single dose Kit 3/white **If allergic to Inj. penicillin:** Doxycycline 100 mg (BD for 15 days) + azithromycin 1 g (single dose)	Tab. acyclovir 400 mg TDS for 7 days	Tab. cefixime 400 mg OD stat + Tab. Metronidazole 400 mg BD × 14 days + Doxycycline 100 mg BD × 14 days	Tab. azithromycin 1 g OD stat + Tab. doxycycline 100 mg BD for 21 days
Kit 1/Grey	KIT 2/Green	KIT 4/Blue	Kit 5/Red	Kit 6/Yellow	Kit 7/Black

*UD—Urethral discharge, CD—Cervical discharge, RD—Rectal discharge

non-governmental organizations and 3400 preferred private providers (PPP).

Outcomes: Complete treatment of STI/RTI reduces the transmission rate of HIV infection by over 40%.

Surveillance of STI

Syndromic surveillance of STI is being encouraged through regular reporting of STIs every month by 'Suraksha clinics'. Laboratory support and counselling services have been made available at STI clinics.

Integrated Counselling and Testing Centres (ICTCs) and their Role in STI Prevention and Management

Clients with STI have shown high-risk sexual behaviour. Based on this high-risk behaviour, the healthcare workers should inform the client about the links between STIs and HIV and should encourage all clients to undergo an HIV test as the risk of HIV among STD is up to 10 times higher. At ICTC, the STI client will receive comprehensive and accurate information on HIV/AIDS and HIV counselling to facilitate an informed choice regarding an HIV test.

New Initiatives under STI/RTI Programme

i Elimination of parent to child transmission of syphilis and HIV by universal testing of all pregnant women for HIV and syphilis and treatment of those found reactive.
ii Partnership with private sector.
iii National strategic plan on RTIs/STIs.

National strategic plan (NSP) for STI/RTI 2017–2024

Vision: The vision of RTI/STI control and prevention is to provide standardized STI/RTI services and sexual and reproductive health services (SRH) at all levels of health system through convergence with **NHM** and **private sector** especially focusing on women, adolescent and marginalized population.

Key Strategies

i Interrupt transmission where it spreads faster.
ii Provide services for all who may need them, i.e. comprehensive STI/RTI services not only to vulnerable populations and HRGs but also to general population and communities at large in convergence with general health system and partnership with private sector.
- Programme should work towards elimination of congenital syphilis and HIV.

STI/RTI and NCDs

Collaboration with non-communicable diseases control programme to expand screening for cervical cancer of women attending STI/RTI clinics, ART centres and FSW by strengthened referral linkages between these facilities and NCD clinics, as also feasibility of introduction of vaccination for HBV and HPV to most at risk population.

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EPIDEMIC OF TUBERCULOSIS (TB) IN INDIA

EPIDEMIOLOGY AND NATURAL HISTORY OF TUBERCULOSIS

Causative Organism

Tuberculosis (TB) is an infectious disease caused predominantly by ***Mycobacterium tuberculosis***. TB is curable and preventable. Over 85% of TB cases can be successfully treated with a 6 months regimen and regimens of 1–6 months can be used to treat Latent TB infection.

Burden of TB Disease in India 2020

Tuberculosis is a global problem and distributed worldwide. India has the highest burden of TB in the world followed by Indonesia, China, Nigeria, Pakistan and South Africa. Out of 10.6 million new cases worldwide in 2021, India contributed 2.59 million cases (26% of global incidence). WHO in 1993 declared TB as global emergency (Fig. 8.6).

Incidence: India has highest burden of both TB and MDR-TB and second highest of HIV associated TB. An estimated 2.59 million **new cases** of TB and 1,24,000 cases of MDR-TB emerge annually in India. Disease burden in 2014 was estimated at 2.5 million (prevalence) cases, out of which 1.2 million were bacillary cases. National level

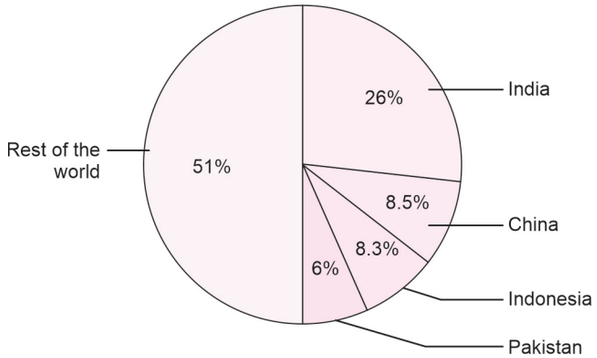


Fig. 8.6: India's share in global incidence of TB 2021

surveys done in 1958 and year 2000 indicated high burden (prevalence) of 8.5 to 9 million cases and the case load has declined over the years to about 2.5 million cases because of programme interventions.

National TB Prevalence Survey in India (2019–21)

Overall disease burden due to tuberculosis of all forms (point prevalence) was 4.30 million persons in 2021 (Table 8.7). Bacteriologically confirmed cases load was 3.20 million. India is thus a high burden country for TB disease.

For the first time in 20 years TB cases are on rise world over.

Big Drop in TB Notification in India

Annual incidence reported by notification (surveillance) in 2020 and 2021 was 1.8 million and 1.93 million cases in comparison to 2.4 million cases in 2019. There was big drop in notification to the extent of 41% in 2020 and 25% in 2021. This was due to disruption of essential TB services caused by Covid-19 pandemic and its effect was seen globally. The countries that contributed most to the global drop between 2019 and 2020 were India (41%), Indonesia (14%), the Phillipines (12%) and China (8%). Mortality due to TB increased in 2020 and 2021. Thus Covid-19 Pandemic reversed years of progress.[1]

Crude TB infection rate in persons 15 years of age and above was 31.4% in India down from 40% in 2002.

Treatment Gap

Distressingly 36% of symptomatics sought treatment from government and private sector in almost equal proportion, while 64% of symptomatic population did not seek healthcare services. The prevalence to notification ratio was 1.52 for smear positive and 2.85 for CBNAAT (Table 8.5). Survey of 2019–21 also provides estimates of prevalence at sub-national and state/group of states for local planning.[2]

Transmission: It is lung to lung transmission. Tuberculosis is most commonly transmitted by inhalation of infected droplet nuclei which are discharged in the air when an untreated TB patient coughs or sneezes in open. Indiscriminate coughing and spitting by open cases of TB, spreads infection to healthy people.

Reservoir and Source of Infection

The pulmonary tuberculosis case with sputum smear positive acts as reservoir and source of infection. India has a large reservoir of pulmonary TB as we detect over one million sputum positive cases every year.

Population Density and Crowded Households

The density of population and size of family, crowded localities like urban slums have higher risk of TB than planned development. Poor ventilation and crowded living are risk factors for TB.

Close Contacts

Contact with open case of TB, who is untreated or partially treated case, increases the chances of transmission of TB. Complete treatment at home after early detection prevents spread of infection in close contacts. There is no need of **isolation** of TB cases in the home or hospitals if the individual observes cough etiquettes and precautions—covering of mouth with piece of cloth while coughing and sneezing and regular and complete treatment and safe disposal of sputum.

One smear positive case if left untreated can infect 10–15 other persons each year creating a self-perpetuated pool of infection, hence it is imperative to treat all known cases of TB with DOTS at the earliest, to interrupt transmission of TB.

Table 8.7: National TB prevalence survey in India. Actual disease burden of TB 2019–21 population of India in 2020 1380 million

Indicators	*Numbers*	*Rate per lakh*
• Prevalence of all forms of TB for all ages	4.30 million	312
• Prevalence of microbiologically confirmed pulmonary TB in ⩾15 years age	3.20 million	316
• Annual incidence of TB	2.59 million	188
• Annual mortality of TB	5.1 lakh	37
• Prevalence of TB infection (IGRA test) among population ⩾15 years age	3.33 million	31.4%
• Treatment seeking behaviour of symptomatic population	36%	
• The prevalence to notification ratio for CBNAAT	2.85	

Lifetime Risk of TB and Risk Factors

All those who get infected do not necessarily develop TB disease. The **lifetime risk** of breaking down to disease among those infected with TB is 5–10%, which gets increased to 60% among those co-infected with HIV. HIV infection accelerates the development of TB disease in TB infected persons and thus HIV gives a push to TB epidemic and increases disease burden substantially. Other determinants or risk factors such as diabetes mellitus, smoking tobacco products and alcohol use, malnutrition and silicosis increase the risk of progression of TB infection to TB disease.

In 2017, India re-estimated its national figures of the burden of tuberculosis incorporating additional information source—private sector notification. The estimated TB burden in India as per National TB survey report 2020 is depicted in Table 8.5.

Mortality from Tuberculosis in India

The mortality rate has decreased from 38 in 1990 to 37 per lakh population, in 2020. TB killed an estimated 5 lakh Indians every year and more than 1400 everyday. TB mortality in sputum positive cases has been reduced from 29% in pre-RNTCP era to 4% in RNTCP era.

TB and Poverty (Economic Impact of TB)

Poverty and TB form a vicious cycle. More than 89% TB patients are in economically productive age group (15–69 years). The economic and social cost to them and their family is enormous. On an overage 3 months of work time is lost if an adult has TB, resulting in loss of 20–30% of household income.

Notification of TB Cases—"Missing Million"

Government of India made TB as notifiable disease in India from June 2012 onward to ensure early treatment and prevent drug resistance, and to establish a surveillance system. Case based on line patient tracking system (NIKSHAY) has been launched which led to 34% increase in notification and pushing to high incidence levels of TB in India in 2015. Of estimated incidence of 2.64 million cases in India, 2.40 million cases have been notified in 2019 through NIKSHAY portal. India had "one million missing cases" in 2018 and that has come down to 2.36 lakh in 2019 due to improved notification of 6.78 lakh cases (25%) by private sector alone. However TB notification in India declined by 41% due to Covid pandemic in 2021.

Drug Resistance TB or MDR-TB

Based on National drug resistance survey of 2017 in India 2.84% of new TB cases and 11.6% of previously treated TB cases have MDR-TB (multidrug resistant TB). An estimated 124,000 cases of MDR-TB emerge annually from notified cases of pulmonary TB in India.[3]

TB Infection (TBI)

Once a person breathes in, the air that contains droplets contaminated with TB bacilli, most of larger droplets settle in the nose or throat where they are unlikely to establish infection. However, fine droplets containing a few TB bacilli may reach lung alveoli. Within alveoli the bacilli are ingested by alveolar macrophages and other phagocytes. Live virulent bacilli multiply within macrophages which get destroyed in the process. The bacilli are subsequently ingested by other macrophages and remain viable and multiply in these macrophages. Within 2–4 weeks after infection, the host mounts a specific cell-mediated immunity that will arrest TB infection in more than 90% of infected persons.

TB infection means that tubercle bacilli are viable within the body but are not multiplying and causing disease due to body immune system. People who have TB infection but not TB disease are non-infections. Nearly 31.4% of adults in India are infected with TB bacilli they look and feel quite healthy persons. Infection in a person can be detected by tuberculin test or by Interferon-Gamma-release Assay. Prevalence of TB infection in India is about 31.4% (Fig. 8.7).

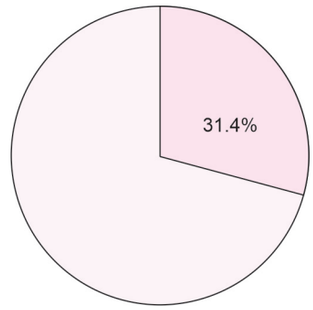


Fig. 8.7: Infection rate of TB in persons age 15 years and above in 2019–21

Annual risk of TB infection (ARTI) in India is 1.1%. ARTI means proportion of population that gets newly infected or reinfected with tubercle bacilli over a course of one year.

Tuberculin Skin Test (Mantoux Test)

This test is not recommended for diagnosis of active tuberculosis but may be used as a complementary test in children. It is a tool for detection of TB infection. A dose of two tuberculin unit (TU) of PPD-RT 23 is recommended for surveys, 0.1 ml of tuberculin PPD is injected intradermally to raise a wheel of 6–10 mm diameter on the forearm. The results are read after 48–72 hours. The diameter of induration is measured, if it is equal or more than 10 mm, the test is considered to be positive in people born in countries where TB disease is common (India, China, Indonesis). The test is very sensitive but not specific. Determining the prevalence of tuberculosis infection is seriously hampered by the presence of cross reactions due to environmental bacteria and BCG vaccination.

TB Disease

5–10% of TB infected persons develop TB disease in their lifetime. **Pulmonary tuberculosis** (TB of lungs) is the most common form of TB as more than 85% all TB cases are of pulmonary tuberculosis. **Pulmonary tuberculosis** is an **infectious form** of **tuberculosis** as it affects lung parenchyma and tracheobronchial tree. **Extrapulmonary (EP) TB** can affect lymph nodes, pleura, intestine, bones and meninges or brain TB and miliary tuberculosis.

HIV and TB—The Deadly Combination

HIV and TB have mexus. A total of 71000 HIV associated TB patients emerge annually. India is facing double epidemic of TB and HIV. HIV and TB form a lethal combination. Tuberculosis is the most common opportunistic infection among HIV infected persons. With superimposition of TB, the HIV infected person becomes frank case of AIDS. Drug resistance is high in patient having TB and HIV. TB accounts for 25% of deaths among people living with HIV and AIDS. In India 3.4% of incident TB cases are TB HIV co-infected patients. Coordinated approach has been adopted in RNTCP for better outcome of treatment of TB.

TB Tobacco, and Alcohol

TB and tobacco use association is evident, as almost 38% of TB deaths are associated with the use of tobacco. Smoking increases the risk of tuberculous infection and the risk of developing TB as also risk of relapse. Use of alcohol and drug addiction increases the risk of TB infection progressing to TB disease. Silicosis, HIV, diabetes are other risk factors for TB.

TB Control Strategies

National TB Control Programme (NTCP) 1962

During the period 1950–1960 significant research on TB was undertaken in India, and based on this in 1962 National TB Control Programme was launched. 446 districts TB centres, 330 TB clinics and more than 47600 beds were established in the country. Three decades later in 1992 a review of TB observed that there was inadequate funding, an over-reliance on X-ray chest for diagnosis, frequent interrupted supplies of drugs and incomplete treatment. Only 30% of diagnosed were completing treatment. There was no decline is morbidity and mortality due to TB. The programme was revised in 1992 and in 1997 RNTCP was launched as National Programme to scale up in phased manner.

Revised National TB Control Programme (RNTCP) Renamed as National Tuberculosis Elimination Programme (NTEP)

Objectives

i To achieve high cure rate of 85% among new smear positive cases.
ii To detect at least 70% of TB cases.
iii To reduce morbidity and mortality by 50% by 2015.

These objectives have been replaced by NSP—2017 to 2025

Components of RNTCP/NTEP

DOTS (Directly Observed Treatment Short Course Chemotherapy) Strategy

1. **The heart of DOTS** is 'directly observed treatment' by a person (treatment observer) who is not a family member, who is accountable, accessible and acceptable, such as health worker, ASHA, teacher or NGO worker who watches as the patient swallows the anti-TB medicines is called DOTS provider. DOTS strategy is being practiced in over 200 countries of the world.
2. **Good quality anti-TB drugs:** Regular uninterrupted supply of quality anti-TB drugs: Monthly patientwise boxes (PWB) of medicines are earmarked under RNTCP, hence supply never fails.
3. **Good quality diagnosis:** Reliable and early-diagnosis sputum smear microscopy at designated microscopy centre (DMC) at CHC for self-reporting of chest symptomatic.
4. **Political and administrative commitment:** To ensure the provision of organized comprehensive TB control services as close as possible to patient.
5. **Systemic monitoring and accountability:** To monitor initiation of treatment, sputum conversion rate, cure rate or treatment success rate of every patient at the end of intensive and continuation phase of treatment as also long-term follow-up to assess recurrence of TB. These indicators help to evaluate the programme.
6. **Organization:** The major organizational change was creation of sub-district level tuberculosis unit for systematic monitoring of diagnosis and treatment aspects of the programme. One TB unit has been established for 5 lakh population with dedicated staff of one medical officer and dedicated treatment supervisors. In urban areas one tuberculosis unit for two lakh population have been set up. The sub-district level unit was aligned with health system under National Health Mission to improve the quality of DOTS. Currently 643 **DRTBC** (including 148 NDRTBC) have been established in India (2018).

   Treatment success rates: RNTCP has more than tripled the treatment success rates from 25 to 84% in 2020 and cure rate of 67% have been achieved for pulmonary TB.

NATIONAL STRATEGIC PLAN (NSP) 2017–25

An accelerator campaign to NSP—"TB Mukt Bharat" has been launched in 2019.

NSP has been crafted in line with National Health Policy 2017, WHO "End TB Strategy" by 2030, and Sustainable

Development Goals of United Nations. NSP replaces all previous strategies.[3]

Vision: TB free India with zero deaths, zero disease and zero poverty due to TB.

Goal: To achieve a rapid decline in burden of TB, morbidity and mortality and elimination of TB by 2025, i.e. five year ahead for SDG-2030-Global Target.

Objectives: Find all drug sensitive TB and drug resistant TB and HIVTB cases with emphasis on reaching TB patients seeking care from private providers and undiagnosed TB in high risk population, i.e. universal access to quality **diagnosis** and **treatment** for all TB patients.

Key Strategies

- "Go where the patient go" private sector engagement as currently they treat over 50% of TB cases and over 80% of persons with TB first attend private sector.
- Active case finding.
- Drug resistant TB case management.
- Addressing social determinants—catastrophic expenditure.
- Develop robust surveillance system.
- Community engagement and multi-sectoral approach.

Expected Outcomes by 2025 from Base Year 2015

1. 80% reduction of TB incidence rate (new and relapse cases—from 217 per lakh to 44 per lakh.
2. 90% reduction of TB mortality—from 32 per lakh to 3 per lakh
3. To reduce TB prevalence by 80%—from 320 to 65 per lakh population
4. Patient having catastrophic expenditure—from 35% to zero %.

Strategic Pillars (DTPB)—Levels of Prevention

i **Detect:** Find all DS-TB and DR-TB.
ii **Treat:** Initiate and sustain treatment.
iii **Prevent:** Prevent emergence of TB in susceptible population—contacts, HIV infected, and diabetics. Preventing progression from latent Tb infection (LTBI) to active TB in high risk groups, i.e. **testing** and **treatment** for latent TB infection in contacts of bacteria logically confirmed cases and in individuals at high risk of getting TB disease.
iv **Build:** Policies, human resources, and finances.
v Scale up air-borne infection control measures at healthcare facilities.

Case Finding and Diagnosis National Policy or Strategy

Case finding strategies: Passive case finding, intensified case finding and active case finding. To achieve universal access to early accurate diagnosis of TB and enhancing case finding efficiency, identification of **presumptive TB cases** at the first point of care and linking them to the best available diagnostic test is of paramount importance. Early case detection is vital to interrupt the transmission of TB disease.

Early identification of people with a high probability of having active TB (presumptive TB) is the most important activity of the case finding strategy. Screening and diagnosing patients with appropriate tests and strategies will largely determine the response to appropriate treatment.

1. Passive Case Finding

Over 50% of patients with symptoms of TB voluntarily seek healthcare from Govt/private health facility. Medical officer follows diagnostic algorithm for evaluating presumptive TB patients. About 3% of new adults attending OPD have symptom of cough more than 2 weeks.

2. Active Case Detection by Campaign Mode

In addition to passive case detection now active case detection is in place to reach vulnerables. To reach unreached, the programme has carried out systematic active TB screening among high-risk populations through house visits or target setting visits covering tribal population, slums, old age homes, prisons, orphanges, transit camps, migrants (high-risk groups) homeless, asylums, etc.

Objective

Detecting TB cases early by finding symptomatic persons (presumptive TB cases) in targeted groups and initiating treatment promptly (collection of 2 sputum samples and examination of these at designated microscopy centre).

Three phases of active case finding, each phase lasting for 15 days were conducted till December 2017 covering 378 districts. In 2021 nearly 22.38 million were screened and 73772 TB cases were diagnosed and put on treatment. In 2020, over 62958 additional cases in 277 million population were detected and put on treatment.

3. Intensified TB Case Finding (ICF)

It is basically provider initiated activity to "Screen" high risk or vulnerable groups coming to health facility. Target groups for screening include clients attending HIV care, substance users, diabetics, healthcare workers, household contacts of active TB case, antenatals and malnourished.

Definitions of Presumptive TB[4]

1. **Presumptive pulmonary TB** refers to person with any of the symptoms and signs suggestive of TB including persistent cough >2 weeks, fever >2 weeks, significant weight loss, hemoptysis, any abnormality in chest

radiograph. Usually 2–3% of new adults attending OPD have cough of more than 2 weeks.

Note: In addition, contacts of microbiologically confirmed TB patients, PLHIV, diabetics, malnourished, cancer patients, on immune-suppressant or steroid should be regularly screened for sign and symptoms of TB.

2 **Presumptive extrapulmonary TB** refers to the presence of organ specific symptoms and signs like swelling of lymph node, pain and swelling in joints, neck stiffness, disorientation, etc. and/or constitutional symptoms like significant weight loss, persistent fever for ≥2 weeks, night sweats.

3. **Presumptive paediatric TB** refers to children with persistent fever and/or cough for more than 2 weeks, loss of weight*/no weight gain and/or history of contact with infectious TB cases**.

4. **Presumptive DR-TB** refers to the patient who is eligible for rifampicin resistant screening at the time of diagnosis or/and during the course of treatment for DSTB or H mono/poly. This includes following:

   i All notified patients (public and private)

   ii Follow up positive on microscopy including treatment failure on standard first line treatment and all oral H mono/poly regimen.

   iii Any clinical non-responder including paediatric (if specimen available).

Tools for Microbiologically Confirming TB

All efforts should be undertaken for microbiologically confirming the diagnosis in presumptive TB patients. Under RNTCP, the acceptable methods for microbiological diagnosis of TB are:

1 Sputum smear microscopy (for AFB) is the most commonly used test.

2 Sputum culture is highly sensitive and specific (gold standard) but requires 2–8 weeks to yield results and hence alone does not help early diagnosis.

3 Nucleic acid amplification test (NAAT) offers enormous potential for accurate rapid diagnosis within 2 hours.

4 Chest X-ray: It is used as screening tool to increase the sensitivity of diagnostic algorithm.

National Policy for Diagnosis of TB

Drug-sensitive TB: Direct sputum smear microscopy by Ziehl-Neelsen acid-fast staining/fluorescence microscopy is the primary case detection tool in RNTCP for patients with infectious tuberculosis presumed to be drug sensitive and is also for monitoring their response to treatment.

Drug resistant TB: Patients at risk of DR-TB as defined by the programme (multidrug resistant TB, MDR-TB), are diagnosed using WHO endorsed rapid diagnostics like cartridge based nucleic acid amplification test (CBNAAT)/line probe assay (LPA). Response to treatment for MDR is monitored by follow-up culture on liquid culture Mycobacterium Growth Indicator Tube (MGIT) system (critical follow-ups requiring clinical response) and identification of mycobacterial species is performed by commercial immunochormatic test—ICT).

CBNAAT can be performed on smear positive, smear negative and extrapulmonary specimen. The test detects TB and resistance to R. By 2018, 1180 CBNATT and 350 truenat machines have been made functional.

Line probe assay is performed in smear positive specimen. The test detects TB and resistance to R and H (FL-LPA) as well as class FQ and class SLI (SL-LPA).

True NAT: Developed by Indian firm MOIBIO Diagnostic Pvt Ltd. in 2018. The true NAT TB test is a new molecular test can diagnose TB in one hour as well as testing for drug resistance to rifampicin.

Integrated DR TB Diagnostic and Drug Resistant TB—2019 Algorithm—Universal Drug Susceptibility—DST in TB (Flowchart 8.1)

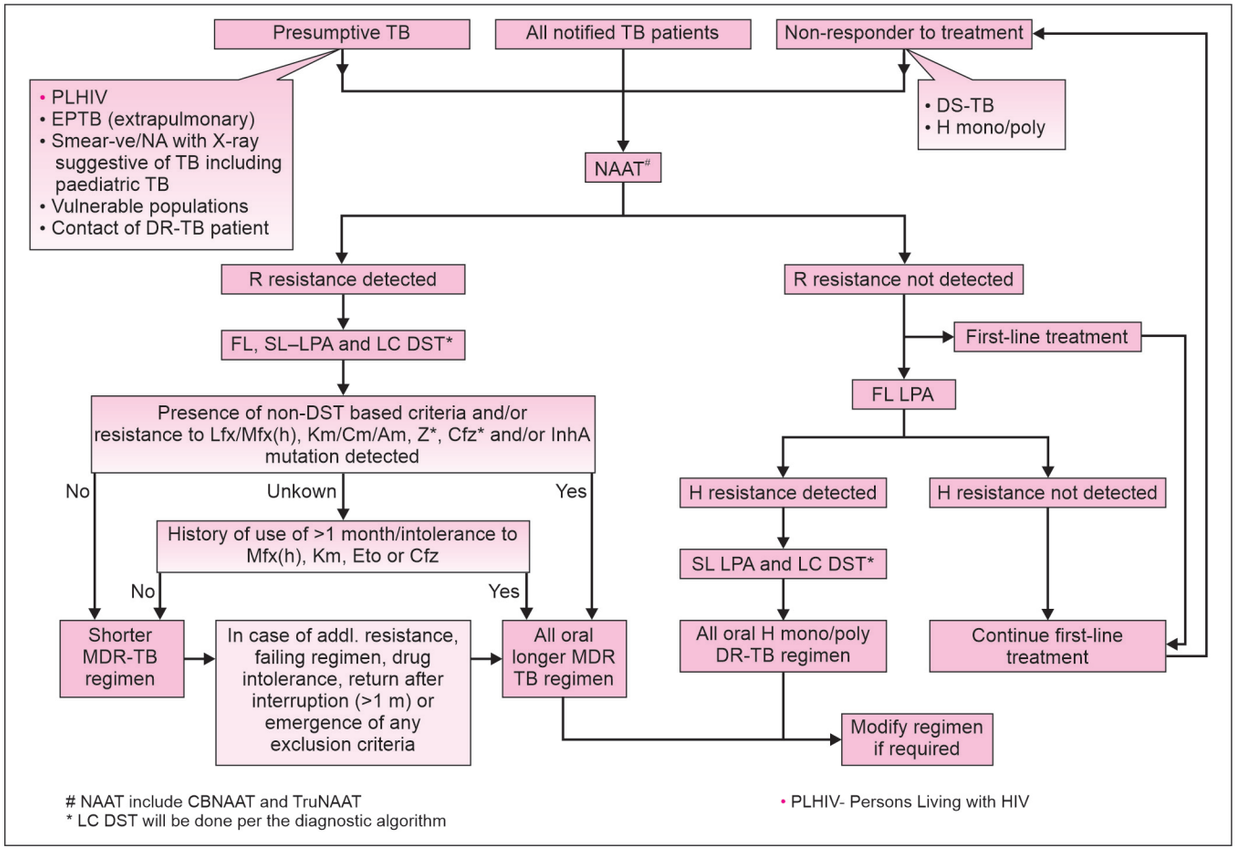
The vision of the programme is to offer DST to TB patients at the earliest time in their course of disease. The integrated diagnostic algorithm starts with three groups of patients who are either presumptive TB, notified TB or non-responders to treatment. The main objective of this algorithm is to segregate DR-TB and offer appropriate treatment based on drug resistance status at least for resistance to R or H at the time of diagnosis of TB. Two diagnostic sputum specimens would be collected from patient—one early morning and one spot specimen for cartridge based nucleic acid amplification test (CBNAAT).

The integrated DR-TB algorithm clearly indicates the management strategies to be followed right from the day the result of NAAT test is available. The programme must strive to offer DST to all notified TB patients at diagnosis of TB or a maximum within 15 days of first line treatment initiation. The algorithm further offers FL LPA for the patients found R resistance not detected on NAAT. The states must ensure availability of LPA lab capacity in consultation with central TB division, for both SL and FL LPA as per the estimated requirement including patient notified from the **private sector**. Within the first 2 months, patients would receive the LC DST results, reach their final classification and treated.

*History of unexplained weight loss or no weight gain in past 3 months; loss of weight is defined as loss of more than 5% body weight as compared to highest weight recorded in last 3 months.

***In a symptomatic child, contact with a person with any form of active TB within last 2 years may be significant.*

Flowchart 8.1: Integrated DR-TB diagnostic and resistant TB algorithm



The **left path** of the algorithm starts with persons presumed to have TB. Presumptive TB refers to person with any of the symptoms or signs suggestive of TB. Diagnosis of TB is difficult in certain key groups of the presumptive TB patients. From this group, those belonging to the PLHIV, EP group or with a smear negative chest X-ray suggestive of TB (including children), vulnerable group as defined by technical operational guidelines—2016 and contact of DR-TB patient will be offered NAAT test. By virtue of using NAAT as the TB diagnostic test, the R status is also available simultaneously along with TB detection.

The **middle path begins** with offer of NAAT to all notified TB patients if not already tested for R resistance during the current episode of TB.

The **right path** offers NAAT to non-respondent at different time points. The subsequent time points when DST is offered if any of the following events occur during the course of a TB treatment schedule:

- Bacteriologically positive during the course of DS-TB or H mono/poly DR-TB treatment;
- Failure to respond to treatment as per RNTCP definitions;
- For patients who are retrieved after lost to follow-up; any other reason as per treating physician's advice.

Based on the result obtained on the NAAT, the patient would be classified as R resistant detected (RR-TB) or R resistance not detected to guide decision of the appropriate treatment (Flowchart 8.1).

As soon as the NAAT results are available, the reports must be immediately updated in Nikshay by the NAAT lab and communicated to the concerned district, DDR TBC, DTO, MO PHI and the patient.

Any discordance in test results for rifampicin between NAAT and FL LPA, repeat NAAT will be carried out at C-DST lab using the decontaminated deposit. The final result will be based on consensus of the 3 tests (2 NAAT and 1 LPA). If 2 of 3 are R resistant, then the final result will be R resistant; if resistance is not detected in 2 of 3 specimen, then the final result will be resistance not detected. If third test result is inconclusive or specimen is not available to make consensus, decision to treat the patient is in ambit of DR TBC committee.

DRUG REGIMEN FOR TREATMENT—DAILY REGIMEN

- First-line drugs: R, H, E, Z
- Second-line drugs: S, Lfx, Mfx, Km, Cm, Am
- Other drugs: Lzd, Cfz, Bdq, Dlm, PAS

DRUG SENSITIVE TB

RNTCP has introduced country wide implementation of universal drug susceptibility test (UDST) in 2018 to provide appropriate regimen for TB patients. The programme has introduced daily regimen for treatment of drug sensitive tuberculosis. The daily regimen now has been scaled up to the entire country in November 2017.

The principle of treatment for tuberculosis (other than confirmed drug resistant forms of TB) with daily regimen is to administer daily fixed dose combinations (FDC) of first line anti-tuberculosis drugs in appropriate revised weight bands, for adults **within seven days of diagnosis**.

Drug sensitive new TB cases: The treatment in intensive phase (IP) will consist of 2 months of isoniazid, rifampicin, pyrazinamide and ethambutol in daily dosages as per four weight band categories. There will be no need for extension of IP. Only pyrazinamide will be stopped in the **continuation phase** (CP), while the other three drugs will be continued for another 4 months as **daily dosages**.

Policy decision on discontinuation of regimen for previously treated TB patients containing injectables: India envisages implementing injection free regimen for all TB patients. As per the recommendation of the national technical expert group (NTEG) on treatment of TB (erstwhile known as category II), was discontinued under RNTCP in Dec. 2018. All previously treated TB patients need to be assessed for presence of rifampicin and isoniazid resistance at the time of TB diagnosis and decision on the choice of regimen should be made accordingly. Patient found sensitive to both the drugs are to be continued on standard first line anti **TB daily regimen** (2HRZE/4HRE) as prescribed for new TB patients (Table 8.6) while patients found to be resistant to isoniazid or rifampicin are treated with **isoniazid mono/poly-resistant** TB regimen or multidrug resistant TB regimen, respectively (Table 8.8A).

The CP may be extended by 3–6 months in certain forms of TB like CNS-TB, skeletal TB, disseminated TB, etc. based on clinical decision of the treating physician. Extension beyond 12 weeks should only be on recommendation of experts of the concerned field. Loose drugs would be needed as substitutions in case of adverse drug reaction or with comorbid conditions.

Table 8.8A: Daily regimen for drug sensitive TB for new and previously treated patients

Type of TB case	*Treatment regimen in IP*	*Treatment regimen in CP*
New	(2) HRZE	(4) HRE
Previously treated	(2) HRZE	(4) HRE

Programmatic Management of Drug Resistant TB (PMDT)—Erstwhile Dots Plus[5]

The term programmatic management of drug resistant TB (PMDT) refers to programme based DR-TB diagnosis, treatment and cure. PMDT (erstwhile DOTS PLUS) was rolled out in India in 2007 and complete geographical coverage was achieved in 2013. India is following WHO PMDT revised guidelines (2016). Updated guidelines on PMDT in India of 2017 and 2019 are an advancement over RNTCP technical and operational guidelines of 2016.

Now universal drug susceptibility testing (UDST) facilities and universal diagnosis of drug resistant TB tests (DRT) are in place in India at district level. Multidrug resistant TB (MDR-TB) has become a significant public health problem.

Magnitude of DR-TB in India

The first national anti-TB drug resistance survey (NDRS) in 2014–16 indicates that:

- Extent of MDR-TB was 6.19% in all patients (2.84% among new and 11.6% among previously treated patients).
- Any drug resistance among new patients was 22.54%, and among previously treated patients it was 36.82% and among all patients 28.02%.
- Any H-resistance (16% in all with 11.6% in new and 25.09% in previously treated patients) being the drivers for R-resistance.
- Almost all RR-TB patients were resistant to H with/without other first or second line drugs.

Definitions and Classification of DR-TB Patients

The following are the definitions and classification for DR-TB patients.

Presumptive DR-TB *(see page 328)*

Mono-resistant TB (MRTB): A TB patient, whose biological specimen is resistant to one first line anti-TB drug only.

Poly-drug resistant TB (PDR TB): A TB patient, whose biological specimen is resistant to more than one first line anti-TB drug, other than both H and R.

Isoniazid-resistant TB (Hr TB): A TB patient whose biological specimen is resistant to isoniazid and susceptibility to refampicin confirmed.

Rifampicin resistant (RR) TB: A TB patient, whose biological specimen is resistant to R, detected using phenotypic or genotypic methods, with or without

resistance to other anti-TB drugs. It includes any resistance to R, in the form of mono-resistance, poly-resistance, MDR or XDR.

Multidrug resistant (MDR) TB: A TB patient, whose biological specimen is resistant to both H and R with or without resistance to other first line anti-TB drugs. MDR-TB patients may also have additional resistance to any/all FQ or any/all SLI anti-TB drug.

Extensively drug resistant (XDR): An MDR-TB patient whose biological specimen is additionally resistant to at least a FQ (Ofx, Lfx Mfx) and a SLI (second line injectable) anti-TB drug (Km, Am, Cm).

It is to be noted that R resistance is quite rare without H resistance. Majority of DST results with R resistance will also be H resistant, i.e. MDR-TB. This has been substantiated in the National Drug Resistance Survey (2014–16). Therefore, RNTCP has taken the programmatic decision that patients, who have any R resistance, should be managed as if they are an MDR-TB patient and this is in line with WHO global guidelines for PMDT.

Under RNTCP, the following are the standard DR-TB regimens:

1. An injection free All oral H mono/poly DR-TB regimen
2. Shorter MDR-TB regimen
3. All oral longer MDR-TB regimen

Guidelines on the PM DT in India 2019, integrates use of the shorter MDR-TB regimen and all oral longer MDR-TB regimen with new drugs with an opportunity to modify the regimen based on DST results (Table 8.8B).

Table 8.8B: Standard regimen for initiating treatment of MDR/RR-TB or H mono-poly DR-TB based on WHO consolidated guidelines for treatment of DR-TB

Regimen class	*Intensive phase*	*Continuation phase*
H mono/poly DR-TB (R resistance not detected and H resistance)		
All oral H mono/poly DR-TB regimen	(6/9) Lfx R E Z	
MDR/RR-TB		
Shorter MDR-TB regimen@	(4–6) Mfx^h Km/Am* Eto Cfz Z H^h E	(5) Mfx^h Cfz Z E
All oral longer MDR-TB regimen	(18–20) Bdq(6) Lfx Lzd# Cfz Cs	

* If the intensive phase is prolonged, the injectable agent is only given three times a week in the extended intensive phase.

@ Neither replacement of drug (except the use of Am instead of Km) nor extension of treatment duration (beyond 11 months) is permitted for shorter MDR-TB regimen.

Reduce Lzd to 300 mg/day in CP. Reduced Lzd to 150 mg/day for first weight band in CP.

Note: Pyridoxine to be given to all DR-TB patients as per weight band.

1. All oral H mono/poly DR-TB regimen is of 6/9 months with no separate IP/CP.
2. Shorter MDR-TB regimen is of 9–11 months with 4–6 months of IP containing injectables and 5 months of CP. If the IP is prolonged, the injectable is only given three times a week in the extended intensive phase.
3. All oral longer MDR-TB regimen is of 18–20 months with no separate IP/CP. New drug like Bdq would be given for 6 months duration while the dose of Lzd will be tapered to 300 mg after the initial 6–8 months of treatment. This regimen will also be used for treatment of XDR-TB patients with 20 months duration.

Treatment Initiation

At Peripheral Health Institutions

If LPA reveal H mono/poly DR-TB, the patient will be initiated on the all oral H mono/poly regimen even at the PHI level. In case of any additional resistance, the patient may be sent to the nodal district drug resistant TB centre for modification in the regimen.

Extension of Treatment in Various DR-TB Regimens

All Oral H Mono/Poly DR-TB Regimen

H mono/poly resistance is known to be around twice as prevalent as RR-TB. Total duration of H mono/poly DR TB regimen is 6 months, can be extended to 9 months in certain conditions. In patients with extensive disease; uncontrolled comorbidity; extrapulmonary TB; if smear at the end of 4th month is found positive and three conditions of replacement drugs wherein regimen is modified, the treatment may be extended to 9 months. In CNS, skeletal and miliary TB, treatment may be given up to a year. In patients who remain sputum smear positive at the end of 5-month or later of treatment, the outcome will be declared as treatment failure. Smear microscopy every month from 3rd moth onwards and culture at the end of 3rd, 6th and 9th month (if applicable).

Shorter MDR-TB Regimen

Total duration of shorter MDR-TB regimen is for 9–11 months, depending on IP duration. IP should be given for at least four months. After fourth month of treatment, if the result of sputum microscopy is negative, then CP should be initiated. If sputum smear microscopy does not become negative by the fourth month of treatment, subject the patient to FL-LPA and SL-LPA and culture DST. If no additional resistance is detected, the IP should be prolonged until sputum smear converts. If the intensive phase is prolonged, the injectable agent is only given three times a week. IP should be extended to 5th or 6th month based on smear results at the end of 4th and 5th month of treatment. This will be done for a maximum of 2 months (i.e. total duration of IP is not more than 6 months). Duration of CP is fixed for 5 months. If the patient remains smear positive

at the end of 6th month of treatment, the patient will be declared as "Treatment Failure", re-evaluated as per integrated DR-TB algorithm and initiated on an appropriate modified regimen based on the extended DST. Smear microscopy monthly from 3rd month onwards till end of IP and culture at 3rd and end of treatment in follow up phase is envisaged in shorter regimen.

All Oral Longer MDR-TB Regimen

Total duration of all oral longer MDR-TB regimen is 18–20 months. At the end of 6th month of treatment, the patient must be reviewed based on the 5th month culture result. If 5th month culture result is not available at the end of 6th month, decision to taper the dose of Lzd to half (300/150 mg) will be based on 4th month culture result. If the 5th or 4th month culture result (whichever applicable) remains positive, the dose of Lzd (600/300 mg) and the regimen is extended by 1 more month. However, the duration of new drugs (Bdq or Dlm) is limited to 24 weeks only. Decision for continuation of extended IP with Lzd (600/300 mg) beyond 7th month, is decided based on the culture results of 6th/5th month and the clinical/radiographic response. Extension of IP beyond 8th month is not permitted and patient should be switched to CP (i.e. total duration of treatment is not more than 20 months). Culture every month from 3rd month onward to end of 6 months, quarterly beyond 6 months, two consecutive monthly culture if any culture + Ve from 6 months onwards during follow up phase ensured.

New Anti-TB Drugs

i Since 2016, new drugs like Bedaquiline and Delamanid are made available to DRTB patients through expanded access under NTEP in all states for better outcomes.

ii These are potent bactericidal drugs. Bdq has extended half life of 5.5 months and Del has 36 hours of half life.

Treatment Outcomes

Cured: Microbiologically confirmed TB patients at the beginning of treatment who was smear negative at the end of the complete treatment and on at least one-previous occasion.

Treatment completed: A TB patient who has completed treatment without evidence of failure or clinical deterioration BUT with no record to show that the smear or culture result of biological specimen in the last month of treatment was negative, either because test was not done or because result is unavailable.

Treatment success: TB patients either cured or treatment completed are accounted in treatment success.

Failure: A TB patient whose biological specimen is positive by smear or culture at the end of treatment.

Failure to respond: A case of paediatric TB who fails to have microbiological conversion to negative status or fails to respond clinically or deteriorates after 12 weeks of compliant intensive phase shall be deemed to have failed response provided alternative diagnoses/reasons for non-response have been ruled out.

Lost to follow-up: A TB patient whose treatment was interrupted for 1 consecutive month or more.

Not evaluated: A TB patient for whom no treatment outcome is assigned. This includes former 'transfer-out'.

Treatment regimen changed: A TB patient who is on first-line regimen and has been diagnosed as having DR-TB and switched to drug resistant TB regimen prior to being declared as failed.

Died: A patient who has died during the course of anti-TB treatment.

Turnaround Time (TAT)

Culture and DST results on solid LJ media have TAT of 84 days, liquid culture (through MGIT) up to 42 days and LPA up to 72 hours and CBNAAT by 2 hours.

New Initiatives and Policy Changes in 2020 to 2022

- Expansion of daily regimen for drug sensitive TB across the country
- Revised diagnostic algorithm for DR-TB
- Revised guidelines for PMDT 2017 and 2019.
- Universal drug susceptibility testing (DST) for all diagnosed patients in government and private sector.
- An injection free all oral longer regimen launched for all MDR/RRTB patients not eligible for shorter regimen in 2019.
- Implementation of guidelines for PMDT in India 2019 to ensure access to shorter MDR TB regimen or all oral longer MDR TB regimen across the country for all RR TB patients.
- Mandatory provision of DR-TB services in all Medical Colleges.
- Test and treat strategy
- National strategic plan (NSP) 2017–25 for TB elimination
- Expansion of bedaquiline regimen country wide.
- Conditional approval of delamanid, a new drug for DR-TB
- Active case finding in vulnerable groups and expansion of molecular diagnostic services (CB NAAT).
- Truenat a highly sensitive molecular test introduced in 350 PHCs in 2018.
- National level TB disease prevalence (burden) survey 2019–21 completed in India.
- Engaging private sector: Incentive of ₹1000 for notification of TB cases by private sector.
- ₹500 per month for the duration of treatment of TB via direct benefit transfer (DBT) to the patient for nutritional support, to reduce OOP expenditure and incentive treatment completion.

- Introduction of shorter regimen for MDR-TB. It has been rolled out in the country in April 2018.
- **ICT enabled adherence system:** 99 DOTS/MERM—improving TB medication adherence. TB 99 DOTS is an innovation that uses mobile phones and augmented packaging for medication (patient calls toll free lines which are visible when they dispense pills). This avoids drug resistant TB.
- Involvement of private sector—innovations to increase access to diagnosis and treatment. All these initiatives lead to early case detection, treatment adherence and better outcomes.

More recently the diagnostic algorithm has been modified in 2019 wherein CBNAAT is offered to three groups of patients. CBNAAT detects resistance to only rifampicin while LPA detects resistance to both rifampicin and isoniazid.

Isoniazid (INH) preventive therapy/Tuberculosis preventive treatment (TPT): TPT is globally recommended for prevention of incident TB among HIV infected individuals. Isoniazid and rifapentine are the most effective bactericidal drugs. It protects against both progression of latent TB infection to active disease (reactivation) as well as from reinfection when exposed to active TB case. Household contacts of pulmonary TB cases, PLHIV are targeted for TPT.

GUIDELINES FOR TUBERCULOSIS PREVENTIVE TREATMENT (TPT)—JULY 2021

About 40% of the Indian population is infected with TB bacteria, the vast majority of whom have latent TB rather than TB disease. The lifetime risk of reactivation of latent TB infection (TBI) in healthy HIV uninfected is 10%, with 5% developing TB disease during the first 2–5 years after infection. WHO has included scaling up of TB preventive therapy (TPT) for persons at high risk of developing TB in its 'End TB strategy'. The risk of TB disease after infection depends upon immunological status; risk of progression increases more than 25 times among contacts of bacteriologically confirmed TB patients, 16–21 times in case of HIV co-infection, 3–4 times in diabetics, and silicotic. India has the highest burden of tuberculous infection globally. In India, 350–400 millions have TBI of which 2.6 million are estimated to develop TB disease annually.

National Strategic Plan (2017–25)

Prevention of TB disease by treatment of TBI is critical component of National Strategic Plan. Scaling up of TPT would be key to hasten the decline of TB incidence from 2.5% at present to 10% required annually.

Target Population for Preventive Treatment (TPT)

India with one-fourth of the global burden of TB, has 40% of population infected with mycobacterium tuberculosis. Treating 40% of the population for latent TB infection based on tuberculin skin test (TST) positivity or interferongamma release assay is neither rational nor practicable, thus emphasizing the need for a focused approach on selection of high risk groups. Hence target groups are:

a Expanded eligible group including: Children above 5 years, adolescents and adults household contacts of pulmonary TB patients (bacteriologically confirmed TB patients) notified in Nikshay from public and private sector.

b Other risk groups—people living with HIV (adults and children more than 12 months, infants less than 12 months with HIV in contact with active TB case, and household contacts below 5 years of pulmonary TB patients), TPT is offered to all after ruling out TB disease.

- Household contacts 5 years and above of pulmonary TB patients offer TPT among TBI positive after ruling out TB disease.
- Individuals having—immunosuppressive therapy, silicosis, on anti-TNF (tumor necrosis factor) treatment, on dialysis should receive TPT after ruling out TB among TBI positive.

All household contacts of pulmonary TB patients regardless of their age should be given TPT after ruling out TB.

- In children household contacts under 5 years of age offer TPT after ruling out active TB without tuberculin skin test.
- In children over 5 years of age and adults—TBI testing and chest X-ray would be offered wherever possible.

TB Preventive Treatment

Target population	*Treatment*
• People living with HIV (+ ART) – Adults and children >12 months – Infants <12 months with HIV in contact with active TB • HHC below 5 years of pulmonary TB patients	• 6 months daily isoniazid (6H) • 3 months weekly isoniazid and rifapentine (3HP) in persons older than 2 years
• HHC 5 years and above of pulmonary TB patients	• 3 months weekly isoniazid and rifapentine (3HP) • 6 months daily isoniazid (6H)
• Children/adults on immunosuppressive therapy, silicosis, anti-TNF treatment, dialysis, transplantation	• 3 months weekly isoniazid and rifapentine (3HP) • 6 months daily isoniazid (6H)

Dosage of 6H Regimen

Regimen	Dose by age and weight band
6-months of daily isoniazid monotherapy (6H)	Age 10 years and older: 5 mg/kg/day* Age <10 years: 10 mg/kg/day (range, 7–15 mg)

*Maximum dose of H if given daily would be 300 mg/day.

- All efforts must be made to ensure that CXR and TBI testing is made available. However, TPT must not be deferred in their absence. Tests for TB infection are: Tuberculin skin test and IGRA.

Post-treatment TPT for PLHIV

All CLHIV/PLHIV who had successfully completed treatment for TB disease earlier should receive a course of TPT after completing treatment of TB.

Monitoring during TPT

- Individuals receiving TPT should be monitored at every contact with the healthcare providers.
- Every dose of the treatment must be preferably taken under direct supervision, particularly the 3HP regimen that has weekly doses.

Tuberculosis vulnerability screening has been initiated in April–May 2022.

LEPROSY

EPIDEMIOLOGY

It is one of the oldest diseases known to mankind. Leprosy is a chronic infectious disease caused by bacteria: *Mycobacterium leprae*; an acid-fast, rod-shaped bacillus. When *M. leprae* was discovered by GA Hansen in 1873, it was the first bacterium to be identified as causing disease in man; however, treatment became available only in 1940s with the introduction of dapsone. Leprosy is the least infectious out of the communicable diseases. It mainly affects the skin, peripheral nerves and occasionally the mucosa of respiratory tract. It is a *curable disease*.

Global Distribution

It once affected every continent and it has left behind a terrifying image in history and human memory of mutilation, rejection and exclusion from society. Now the global prevalence has been reduced by 90%. By the end of year 2000, leprosy has been eliminated as a public health problem at the global level by reducing the prevalence level to 0.88/10000. Now, early in 2003, 110 countries have reached the elimination target at the national level and leprosy remains a public health problem in only 12 countries. Leprosy burden is now concentrated in the five most endemic countries (Brazil, India, Madagascar, Mozambique and Nepal) which account for 83% of prevalence and 88% of detection worldwide. The combined prevalence in these countries is about 4/10000 population.

Global leprosy strategy (2016–2020: Leprosy free world. The vision is "Zero disease, Zero transmission, Zero disability, Zero stigma and Zero discrimination".

Epidemiological Situation of Leprosy—Disease Burden in India

The national prevalence level of leprosy in 1981 was 57.6 per 10,000 population which declined to 0.84 per 10,000 population in 2005 due to programme interventions. Though the prevalence level of less than 1 case per 10,000 population has been achieved at national level, however, 133 districts and many blocks of some states have prevalence levels higher than 1 case per 10,000 population. Till 31st March 2018 prevalence level of less than 1 case per 10,000 has been achieved in 29 states/UTs and 572 (81.3%) districts out of 705 districts achieved elimination level. Chhattisgarh and one UT—Dadar and Nagar Haveli have never achieved elimination so for. Odisha, Bihar, Jharkhand and Lakshadeep have reported prevalence level of more than 1 per 10,000 population after achieving elimination.

Source of Infection

Untreated leprosy affected person is the only known source of infection for *M. leprae*.

Transmission Portal of Exit

Leprosy is transmitted from one untreated multibacillary patient to another healthy person via droplet infection or skin lesion. The major sites from which bacilli escape from body of an infectious patient are the nose and mouth. Nose appears to be major site of entry of bacilli. It is acquired through prolonged exposure and only a small proportion of population is affected. Leprosy is not highly infectious disease. Leprosy affects all ages and both sexes.

Incubation Period

The disease has very long period of incubation or latency running into several years varying from few weeks to 30 years. On an average, incubation period is between 5 and 7 years.

Types of Leprosy

- Proportion of multibacillary (MB) and paucibacillary (PB) is variable but in the community 20–30% cases are of MB leprosy and rest are PB cases.

- Around 15–20% of leprosy cases are in children (below 15 years). Childhood leprosy is significant because the proportion of new child cases detected in a year is an important indicator of recency of transmission of disease in the community.
- Leprosy is not hereditary disease and it is acquired and caused by germ.

Leprosy is serious public health problem in Chhattisgarh, and Dadra and Nagar Haveli where prevalence rate is more than 1/10,000. In Delhi, the high prevalence rate was due to migration from these high endemic areas and high proportion of re-registered MB cases continuing MDT beyond fixed duration of 12 months in tertiary care hospitals.

Annual new case detections (ANCDs) significantly declined after effective MDT application, however, in India which contributes 58% of global annual new case detection, the annual new case detection (ANCD) was stagnant at very high level which may be due to re-registration of cases or several operational and administrative shortcomings (Fig. 8.8).

Social Stigma and Disabilities

The leprosy has been notorious amongst the infectious disease to inflict social stigma and out-casting and desertion. Physical disabilities of clawhand, clawfoot and autodissolution of fingers and toes as also disfigurement of nose and face are well-known consequences of untreated leprosy cases and delay in treatment. Now with early treatment with modern drugs—MDT the disabilities have almost disappeared or considerably reduced. Social impact of leprosy is much more than medical impact. Attitude of people and community, family and relatives towards leprosy cases are still unfavourable. Discrimination and stigma prevails widely in rural and urban areas. United Nations General Assembly in 2010 resolved to eliminate discrimination against persons affected by leprosy.

Grading Disabilities in Hands and Feet

Grade 0: No anaesthesia, no visible deformity or damage.

Grade 1: Anaesthesia present but no visible deformity or damage.

Grade 2: Visible deformity or damage present in hand or foot or damage in leprosy includes ulceration, shortening disorganization, stiffness or loss of part or all of hand and foot.

Under NLEP it is aimed to reduce Grade 2 disability (visible disability) (G2D) to less than 1 per **million population** and to have Zero G2D among new child cases by 2020.

Eyes

Grade 0: No eye problem. No evidence of visual loss.

Grade 1: Eye problem due to leprosy present but vision not severely affected.

Grade 2: Severe visual impairment (vision worse than 6/60, inability to count fingers at 6 meters).

Eye problems due to leprosy include corneal anaesthesia, lagophthalmos and iridocyclitis. Rehabilitation of disabled is a challenge. Early detection and prompt treatment with MDT prevents disabilities. Government and NGOs are undertaking many rehabilitation programmes for leprosy cases.

Diagnosis of Leprosy

A case of leprosy is diagnosed by eliciting cardinal signs of leprosy through systematic clinical (and wherever possible bacteriological) examination.

Cardinal signs: At least one of the following cardinal signs must be present to diagnose leprosy.

1 Hypopigmented or reddish skin lesion(s) with definite loss of sensation.

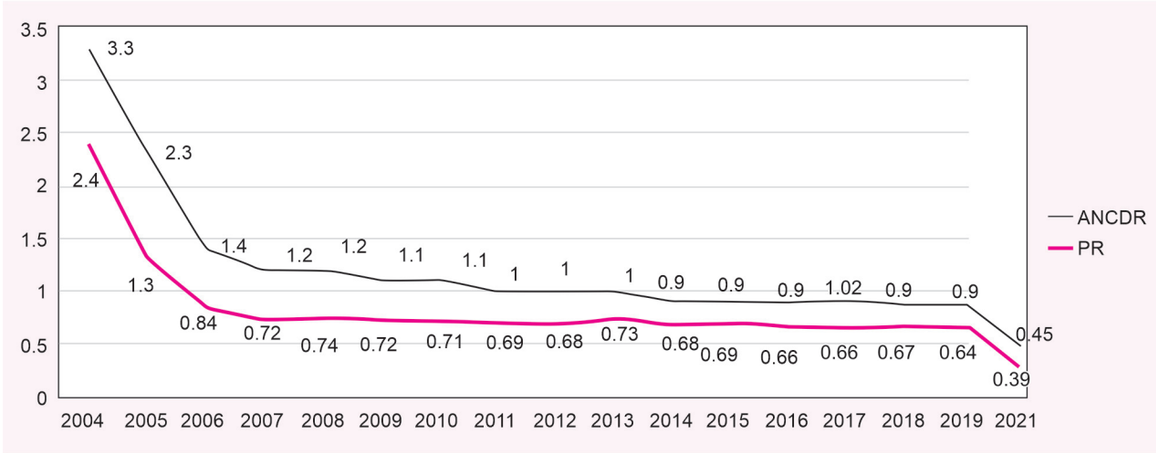


Fig. 8.8: Leprosy annual new case detection and prevalence rate per 10,000 population

2 Involvement of peripheral nerves as demonstrated by definite thickening with loss of sensation and weakness/paralysis of the muscles of the hands, feet or face.

3 Demonstration of *M. leprae* in the lesions.

The first two cardinal signs can be identified by clinical examination alone, while the third can be identified by examination of the slit skin smear.

Leprosy patches can be pale or reddish or copper coloured, can be flat or raised, do not itch, usually do not hurt, lack sensation to heat, touch or pain and can appear anywhere.

A case of leprosy: A person with at least one cardinal sign of leprosy and yet to complete full course of MDT may be called "case of leprosy".

New leprosy case: A leprosy patient who has never taken MDT drugs anywhere in the past.

Re-registered case: A case of leprosy, partially or fully treated with MDT in the past at any health facility and who is re-registered again as a new case for treatment.

Leprosy defaulter: A patient who has not collected treatment for 12 consecutive months is a defaulter and should be removed from prevalence.

Cured patient: A patient who has completed a full course of fixed duration of MDT (6 months for PB and 12 months for MB) is cured.

Released from treatment (RFT): A cured person is released from treatment (RFT).

Lepromin test is of academic interest. This detects cell-mediated immunity. The test is positive in tuberculoid leprosy and negative in lepromatous leprosy. Lepromin antigen by intradermal injection of 0.1 ml is deployed for this test and test is read after 48 hours and 21 days after injection. If the area of redness is more than 10 mm, it is considered as positive. The widespread BCG vaccination has produced cell-mediated immunity in Indian population and interpretation of lepromin test in children may be difficult.

Classification of Leprosy

Leprosy has been a subject of several classifications but WHO recommends only two classifications for the purpose of treatment. Diagnosis of leprosy is mainly based on clinical signs and symptoms. In pre-MDT era, skin smears were routinely used for classifying a case of leprosy as PB or MB. WHO has made clear that skin smears are not a prerequisite for managing leprosy elimination programme and there is no need to maintain or establish skin smear services exclusively for leprosy. The clinical system of classification for the purpose of treatment includes the use of number of skin lesions as the basis for grouping the leprosy patients into MB and PB. If in doubt, the patient should be treated with MB regimen. Use of skin smears should be limited to referral centres only for special investigations (suspicion of resistance, complex and relapse cases) and research purposes.

1 *Multibacillary case (MB):* 6 or more skin lesions with loss of sensation and Skin smear positive at any site.

2 *Paucibacillary case (PB):* 1–5 lesions with loss of sensation. Skin smear negative at all sites.

Multidrug Therapy (MDT) in Leprosy

Leprosy is *curable* by MDT which is available free of cost at health facilities. Since its introduction in 1982, MDT has remained highly effective in varying field conditions for the following reasons.

- It cures leprosy and stops transmission.
- Relapse rates are low (less than 1%).
- There is no reported resistance to combined drugs.
- Side effects are negligible.
- Disabilities are prevented through early treatment.
- Health workers can be easily trained to administer the drugs.
- It is easy to administer as it is taken orally.
- It is conveniently available in blister packs containing 4 weeks treatment.
- The drugs can be stored under ordinary storage conditions.

MDT was important technical advance to prevent primary and secondary drug resistance to dapsone. MDT treatment is provided in blister packs, each containing 4 weeks treatment. Specific blister calendar packs (BCP) are available for multibacillary (MB) and paucibacillary (PB) leprosy for adults and children.

- Standard adult treatment regimen for MB leprosy is:
  - Rifampicin 600 mg once a month (supervised)
  - Clofazimine 300 mg once a month and 50 mg daily
  - Dapsone 100 mg daily

  Completion of 12 monthly pulses.
- The standard adult treatment for PB leprosy is:
  - Rifampicin 600 mg once a month (supervised)
  - Dapsone 100 mg daily

  Completion of 6 monthly pulses.
- Standard child (10–14 years) treatment regimen for MB leprosy is:
  - Rifampicin 450 mg once a month
  - Clofazimine 150 mg once a month and 50 mg every other day
  - Dapsone 50 mg daily

  Completion of 12 monthly pulses
- The standard child treatment regimen for PB leprosy is:
  - Rifampicin 450 mg once a month
  - Dapsone 50 mg daily

  Completion of 6 monthly pulses

Children under the age of 10 should receive appropriately reduced doses of the above drugs as per body weight.

Releases from Treatment (RFT)

When the patient has completed the required number of doses (monthly pulses) of standard MDT treatment regimens, he/she is released from treatment (RFT).

The efficacy of MDT has been clearly demonstrated by extremely low relapse rate (average 0.1% per year for PB and 0.06% per year for MB) following successful completion of treatment; these figures are based on reports from a number of countries and information available at WHO. In addition, the MDT is highly acceptable because of low frequency of side effects. The available evidence shows that there is significant reduction in the frequency and severity of Reversal reactions (type 1) and erythema nodosum leprosum (ENL) reactions (type 2) in leprosy patients on MDT.

Rifampicin is an exceptionally potent bactericidal agent against *M. leprae*. A single dose of 600 mg is capable of killing more than 99.9% of viable organisms. The rate of killing is not proportionately enhanced by subsequent doses. Rifampicin also exerts a delayed antibiotic effect for several days, during which the organism is incapable of multiplying. The high bactericidal activity of rifampicin makes a single monthly dose of the drug feasible and cost-effective for leprosy control programme.

Persisting *M. leprae*, by definition, are those viable organisms that are fully susceptible to antileprosy drugs but survive despite adequate treatment with these drugs. The phenomenon probably occurs because these organisms are in low or dormant metabolic state. The evidence to date indicates that persisters do not play an important role in the occurrence of relapse among leprosy patients treated with MDT.

Clofazimine is a repository drug, i.e. it is stored in the body after administration and is then slowly excreted. A loading dose of 300 mg is given once a month to ensure that the optimal amount of clofazimine is maintained in the body tissues, even if the patient misses his/her daily dose.

Accompanied MDT: Accompanied MDT has been designed to help patients who have to interrupt their treatment because of their inability to attend the health facility regularly or due to geographical distance. These patients are provided more doses of MDT in case patient is not likely to come for next collection.

Red coloured urine after MDT is due to the colour of rifampicin, which is taken once every month. This lasts for only a few hours after taking drug. Darkening of skin is due to clofazimine used daily for treating MB patients. This is harmless and will disappear within a few months after completing the treatment. Patient must be assured that these are harmless. In case of allergic reactions, patient should be treated at nearby health facility with prednisolone.

NATIONAL LEPROSY ERADICATION PROGRAMME (NLEP)

The Government of India launched the leprosy control programme in the year 1955. Eradication means complete absence of the disease and the organism that causes it throughout the world. At present, we lack the tools both to protect people from developing leprosy and to diagnose and treat the disease in its subclinical form, hence eradication is difficult proposition. On the contrary, elimination is feasible and practical proposition. In 1983, a new strategy based on MDT was introduced and the programme was renamed National Leprosy Eradication Programme (NLEP).[6] In 1991, the world health assembly passed a resolution to eliminate leprosy as a public health problem by the year 2000.

Elimination was defined as a prevalence rate of less than 1 case per 10,000 population, although this has been achieved at global level by the end of 2000, extra efforts are still needed to achieve the goal at national level in some countries. India eliminated leprosy in December 2005 at national level.

Special Efforts for Leprosy Case: Detection and Prompt MDT

Modified leprosy elimination campaign (MLEC) was an attempt to intensify case detection and prompt MDT in the entire country during the year 1997–1998, 2000 and 2002–2003. Paramedical workers were involved to identify suspect cases, which were subsequently confirmed by medical officers of health facility. During these operations (campaigns), 4.63 lakh, 2.13 lakh and 1.65 lakh patients were detected and treated with MDT, respectively. This was active search of cases from house to house and voluntary reporting of cases (VRC). Active search was resorted in areas with prevalence rate >5/10,000 and VRC were adopted in areas with PR less than 5 per 10,000.

The elimination strategy is based on detecting and treating all cases with MDT and thereby reducing the disease burden to a very low level. At this level, the transmission of *Mycobacterium leprae* is likely to be reduced to such an extent that the occurrence of new cases in the community would gradually decrease. The key will be to ensure that all new cases continue to have access to MDT services. Leprosy is one of the few infectious diseases to meet the strict criteria for elimination:

- There is only one source of infection, untreated, infected human being.
- Practical and simple diagnostic tools are available: Leprosy can be diagnosed on clinical signs alone.
- The availability of an effective intervention to interrupt its transmission: Multidrug therapy (MDT).
- Under natural conditions, 'incident cases' (new cases in which the disease has recently developed) make up

only a small fraction of the prevalence pool. Below a certain level of prevalence, any resurgence of disease is very unlikely.

Goal: Reduce prevalence less than 1 case per 10,000 population and incidence to zero **in all districts** and Grade 2 disabilities to zero among new cases of leprosy.

Component of National Leprosy: Elimination Programme

a Early Case Detection and complete treatment by Universal access to MDT through primary healthcare delivery system—as also through secondary and tertiary care facilities.

b Integrating leprosy services (diagnosis, treatment and recording and reporting of cases) with general health services. Leprosy elimination should no longer be vertical health programme. This would enhance the access and coverage of population.

c Renewed emphasis on prevention of disability and medical rehabilitation.

d Monitoring leprosy programme through acceptable indicators (prevalence rate, annual new case detection rate, case holding, treatment completion rate, child cases, female cases, MB and PB cases and deformity rate) through simplified information system (SIS).

e Behaviour Change Communication (BCC) activities at all the levels of healthcare delivery system to disseminate messages that leprosy is curable and MDT treatment is available free of cost at all health facilities.

f Training and retraining of health workers and medical officers and specialists to make them responsible for elimination of leprosy.

Global Alliance for Elimination of Leprosy and 'The Final Push' Strategy

At the initiative of WHO, the global alliance for elimination of leprosy (GAEL) was established in November 1999. After eliminating leprosy at global level, the next challenge was to eliminate disease at the national level from every country in the world by the year 2005. It was expected that about 2.5–2.8 million cases will be detected and cured during the period 2000–2005. The key elements of the final push strategy were:

- Integration of leprosy services into general health services to improve access to treatment
- Capacity building to enable general healthcare staff to diagnose and treat leprosy
- Improve logistics to ensure adequate stocks of MDT at health services
- Change society's perception of leprosy and motivate people to seek timely treatment
- Ensure high cure rates through flexible and patient friendly drug delivery systems
- Simplify monitoring to keep track of progress towards elimination.

Leprosy Elimination Monitoring (LEM)[7]

The objectives of LEM is to assist the decision makers and programme managers to assess the progress towards leprosy elimination by providing additional information on elimination indicators such as prevalence rate, annual new case detection rate, case holding, accessibility of MDT services, integration of leprosy with general health services, quality of MDT blister packs, adequacy of MDT, and information and education level of community on leprosy, etc. Three rounds of LEM have taken place from 2002–2004. According to LEM, the overall prevalence rate has declined to 3.1 and new case detection rate was 4.5 during the year 2004.

Validation of Leprosy Diagnosis by Specialists

During the year 2003, the total number of cases over reported by the health staff were 27.9% (9.4% wrongly diagnosed, 13.5% re-registered and 5% non-existent). These figures of over-reporting are a real concern. When applied to the entire country it represents a large number of cases, as well as MDT supply. During the year 2004, the figure of over-reporting was 33.3% (due to re-registration 18.7%, wrong diagnosis 9.4% and non-existent cases 5.2%, respectively).

Epidemiological Situation Disease Burden[8]

Leprosy elimination, i.e. prevalence rate of less than 1 per 10,000 population was achieved at national level in 2005, however, some districts continue to show high prevalence, i.e. more than 1 per 10,000 population. Annual new cases detected per annum have declined from 126164 cases in 2018 to 68646 new cases per annum in 2020. Proportion of MB was 50.9% and proportion of female was 38.8%.

Major Indicators in 2020–21

- Annual new case detection rate (ANCDR) has declined to 0.45 per 10000 population.
- Prevalence rate has decreased to 0.39 per 10000 population.
- Child cases percentage among new cases detected has reduced to 5.76%.
- Percentage of Grade 2 disability among new cases detected has decreased to 2.48%.
- The Grade 2 disability among new cases per million population is decreased to 1.14.

Leprosy Case Detection Campaign (LCDC): Secondary Prevention in Leprosy

a LCDC in line with pulse polio campaign was initiated in 163 high endemic districts of 20 states to achieve the goal of elimination. House to house visits by team

consisting of ASHA and male volunteer (field level worker) as per microplan prepared for block and district level for case detection were undertaken. House to house activities were supervised by field supervisors. Case detection campaign was followed by treatment of all 32,666 new cases detected in 600 million population in the year 2017 and 2018.

Recent Developments

Focused leprosy campaign[8]: For hot spots, i.e. rural and urban areas wherever G2D is detected in low endemic districts and special plan for case detection in hard to reach areas has been launched.

b **Convergence:** For early case detection in children 0–18 years and in persons above 30 years of age, the NLEP has been integrated with RBSK, RKSK and population based screening of NCDs respectively.

c **Active case detection and regular surveillance for leprosy:** Active search of cases round the year once a year in low endemic and twice a year in high endemic area has been launched to prevent G2 Disability. ASHA baased surveillance for Leprosy suspects (ABSULS) has been started in 459 districts.

d **Tertiary prevention in leprosy:**
Strengthen disability prevention and medical rehabilitation in leprosy: More emphasis is being given on correction of disability in leprosy affected persons through reconstructive surgery (RCS). Besides government, NGOs institutions were also involved in RCS.

e **Reduction in the level of stigma associated with leprosy (Sparsh leprosy awareness campaign):** Intensive information, education and communication activities are being conducted for awareness generation to reduce stigma and discrimination against leprosy affected patients. 30th January of every year is being observed as antileprosy day.

f **Primary prevention of leprosy among contacts:** Postexposure chemoprophylaxis with single dose of rifampicin for contacts of new leprosy cases during leprosy case detection campaign. Contact is a person above 2 years of age living with newly detected case for more than 3 months and 20 hours per week.[9]

Immunoprophylaxis: Using vaccine *Mycobacterium indicus* pranii (MIP) to family members and contacts can give protection around 60%.

Though the NLEP has been integrated with general health services to improve access to diagnosis and treatment, the system fails to detect new cases. LCDC is a partial answer. Health system needs to be strengthened by capacity building.

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VECTOR-BORNE DISEASES

World Health Day 2014 'small bite big threat': Major vector-borne diseases are being discussed here, other vector-borne diseases have been discussed in Chapter 3.

NATIONAL VECTOR-BORNE DISEASE CONTROL PROGRAMME (NVBDCP) 2003–04

Goal: Eliminate malaria, filaria, kala-azar and control outbreaks and epidemics.

The national vector-borne disease control programme is comprehensive umbrella programme for prevention and control of vector-borne diseases, namely—malaria, filaria, kala-azar, Japanese encephalitis, dengue fever and chikungunya which are now covered under the overall umbrella of NHM. The NVBDCP was launched in 2003–4. The programme is being implemented by the states through existing healthcare infrastructure. The general strategy for prevention and control of vector-borne diseases under NVBDCP is described below.

1 **Disease management:** Including early case detection with active, passive and sentinel surveillance and complete effective treatment, and strengthening of referral services.

2 **Epidemic preparedness** and rapid response.

3 **Integrated vector management** (for transmission and risk reduction) by: Indoor residual spray (IRS) in selected high-risk areas, use of insecticide treated bednets (ITN), and long lasting insecticidal nets (LLINs) use of larvivorous fish, anti-larval measures

in urban areas including bio-larvicides, and source reduction by minor environmental engineering methods.

4 **Surveillance:** Surveillance of NVBDCP is an important epidemiological tool to control the spread of NVBD and predict epidemic, to investigate epidemic and to ensure rapid response.

5 **Entomological surveillance:** Under NVBDCP entomological surveillance in the programme is being carried out by entomological zones and entomological set up at regional offices. The parameters being collected are breeding places, vector density, and susceptibility status (adults test and larval test).

6 **Supportive interventions** including behaviour change communication, (BCC), public–private partnership and intersectoral convergence, human resource development through capacity building, operational research including studies on drug resistance and insecticide susceptibility, monitoring and evaluation through periodic review/field visits and improving management information system (MIS) besides involvement of ***Panchayati Raj*** Institutions. Using standard treatment Protocols for treating vector-borne diseases at various levels is another important component.

7 Vaccination only against JE.

8 Annual mass drugs administration (only against lymphatic filariasis).

MALARIA

EPIDEMIOLOGY OF MALARIA[1]

Malaria has been recognized as potential life-threatening significant public health problem in India. League of Nations in 1930 estimated that one-third of global population suffered due to malaria and in 2015—over 44% of global population was exposed to the risk of malaria. Malaria is endemic disease in 85 countries. Recent estimates indicate that 241 million cases and 0.627 million deaths occur per annum due to malaria worldwide, 94% of which occur per annum in tropical Africa (World Malaria Report, 2021).[1] In 2020 malaria cases and deaths increased due to disruption of services during Covid-19 pandemic. Malaria parasite was discovered in 1880 by Laveran, a French army surgeon. Later in 1898, working in India Sir Ronald Ross reported that disease was transmitted through mosquitoes.

Malaria is an acute infectious disease caused in humans by 4 species of Protozoa, genus *Plasmodium* and transmitted by various species of mosquito genus *Anopheles*. The disease is characterized by a cyclical course with periods of acute febrile attacks and paroxysm free intervals.

Species of Human Malaria/Causative Organisms[2, 3]

There are 4 species of human malaria, namely—*Plasmodium vivax*, *P. falciparum*, *P. malariae* and *P. ovale*, which is rare. The fourth species, namely *P. ovale* has been recently recorded in some tribal areas of Odisha.

- The *Plasmodium vivax* is the most common and considered to be widespread. Relapses are common in *P. vivax* (due to persistence of exo-erythrocytic phase in liver) and hence relapsing malaria is feature of *P. vivax* usually. Relapse rate in *Vivax* malaria in India is around 30%. As a rule, *P. vivax* infection and *P. ovale* have similarities and cause relapses.
- Of late, *P. falciparum* has taken over *P. vivax,* almost 63% of malaria in India is now *P. falciparum*. There are no relapses with *P. falciparum*, but it is killer malaria. Deaths in malaria are due to *P. falciparum*. *P. falciparum* is showing resistance to chloroquine, which is widespread in North Eastern States of India, Odisha, Karnataka and Gujarat.

Malaria—Disease Burden in India—Current Trends

Malaria is on its verge of elimination in India. Pre-independence estimates of malaria were about 75 million cases and 0.8 million deaths annually. The problem was virtually eliminated in the mid-sixties but resurgence led to an annual incidence of 6.47 million cases in 1976. Modified plan of operation was launched thereafter in 1977 to control malaria. The annual case load declined between 2–3 million. During the period from 2000 to 2015 case load further declined from 2.03 million to 1.16 million (44% decline). The *Plasmodium falciparum* malaria proportion remained around 50% from 2000 to 2013 but rose to 67% from 2014 to 2017, contributed by increased Pf detection by widespread use of RDTs by ASHAs, as also due to drug resistance, inadequate surveillance and weak healthcare delivery systems. The highest proportion of Pf cases (nearly 70%) were detected in four states Odisha, Chhattisgarh, Jharkhand and Tripura. Epidemiological trends are presented in Table 8.9 which indicates 91% decline of malaria morbidity and mortality between 2000 and 2020. Nearly 4.3 lakh cases in 2018 and 3.34 lakh cases in 2019 were reported against 186532 cases in 2020.

Reservoir and Source of Infection and Problem of Malaria in India—Natural History of Malaria

Human beings or cases of malaria and the infected mosquitoes are the reservoirs and source of infection in malaria. Hence, to control malaria we have to control mosquito breeding or to kill adult mosquitoes and secondly to treat all cases of malaria with effective drugs.

The development of parasite involves two hosts—**mosquito** and **man.** Cycle in mosquito is sexual cycle and it gets completed in 8–10 days period, we call this period as **extrinsic incubation period** when gametocytes in mosquito develop to sporozoites. Asexual phase of life cycle of parasite occurs in humans. Pre-erythrocytic phase lasts for 10–15 days in liver cells followed by erythrocytic

Table 8.9: Epidemiological situation and trends in malaria incidence over the years

Year	*Total malaria cases in million*	*API**	*P. falciparum proportion (%)*	*Reported deaths*
Before Independence	75	–	–	80000
1965	0.1	–	–	0
1976	6.47	11.24	11	59
1994–2001	2.51	2.19	40	1000–1100
2002–2005	2–3	2–5	30–40	1000
2000	2.03	2.09	1.05	932
2006	1.79	1.66	47	1707
2007	1.50	1.39	49.11	1311
2008	1.53	1.36	50.81	1065
2009	1.56	1.36	53.72	1144
2010	1.60	1.37	52.12	1018
2011	1.31	1.10	51.0	754
2012	1.01	0.88	50.0	519
2013	0.88	0.72	53.0	359
2014	1.10	0.89	66.55	562
2015	1.16	0.92	67.1	287
2016	1.08	0.85	67.0	331
2017	0.84	0.64	67.0	194
2018	0.43	0.32	48.0	96
2019	0.33	0.25	45.69	77
2020	0.18	0.14	63.02	93

* API: Annual parasite incidence

cycle of 48–72 hours. This is called **intrinsic incubation period**. Sporozoites in man develop into asexual forms—ring stage, schizonts, merozoites and gametocytes.

Incubation Interval

It is the sum of intrinsic plus extrinsic incubation period. In case of *P. vivax* it is of 21 days and in case of *P. falciparum* it is 35 days. Hence, malaria surveillance cycle of fortnightly with less than one incubation interval is justified to prevent secondary cases.[2]

Extra erythrocytic cycle: Persistence of *P. vivax* and *P. ovale* infection in liver cells is responsible for relapses in malaria. There is no exo-erythrocytic cycle in *P. falciparum* malaria, hence no relapses. Erythrocytic cycle destroys red blood cells and repeated infections and no treatment or lack of treatment can lead to **severe anaemia**.

Transmission of Malaria

Man to man transmission of malaria occurs by the bite of infected mosquitoes. Anopheles mosquitoes are the most efficient vectors for transmission of malaria. Infective mosquito injects sporozoites into blood. Infectivity in mosquito is lifelong and average lifespan of mosquito is one month.

Transmission Dynamics in Malaria

Transmission depends on agent, host, vector and environmental factors, apart from availability of health services.

Host factors include—innate resistance to malaria, duffy antigen, blood groups, haemoglobinopathies, nutritional status, and asymptomatic malaria cases. Habits of host like clothing, sleeping habits, use of bed nets, occupation, animal keeping, migration of population for construction or project work, and for search of job in industrial areas.

Factors related to vectors are vector density, flight range, feeding habits, resting habits, biting time lifespan and sensitivity to insecticides, besides entomological inoculation rate (EIR), i.e. the average number of infectious bites by malaria infested mosquitoes delivered to an individual human resident in that area in a period of one year.

Due to difficulties in measuring EIR parasite rate in young children (infant parasite rate) is used as proxy for transmission intensity.

Environmental factors in malaria include humidity, rainfall, altitude, and geographic contours.

Agent factors include parasite load, and sensitivity to drugs.

Factors of services—availability and surveillance operation also determine the transmission dynamics.

After feeding of human blood, the mosquitoes tend to rest on surface of wall and if the walls and ceilings are sprayed with residual insecticides, the mosquitoes will die within few hours to few days depending upon the duration of contact with the insecticide. This will only happen if mosquito is endophilic and endophagic (i.e. indoor biting and indoor resting habits). If mosquito vectors of malaria are exophilic and/or exophagic (outdoor biting and outdoor resting), the vector will survive. Aquatic stages of mosquito (eggs, larvae and pupae) are most vulnerable to chemicals like Paris green, insecticides and oils which are frequently used as antilarval measures in urban setting to control the mosquitoes population. Breeding places should be minimized or eliminated (source elimination). The source elimination is real prevention but it is most difficult to achieve.

Incubation Period

It is the time between the infective bite and the appearance of clinical symptoms. In *P. falciparum*, it is 12 days range being 9–14 days. In *P. vivax* it is 15 days range being 12–17 days and in *P. malariae*, it is 28 days range being 18–40 days.

Vectors of Malaria

In Rural Areas

In India out of 9 species of malaria vectors, the major vector for rural malaria responsible for 70% of malaria

transmission, are ***Anopheles culicifacies*** found all over the country and it breeds in clean ground water collections. Other important Anopheles species, namely ***An. minimus*** and ***An. fluviatilis*** breed in running channels, drains with clean water.[3]

In Urban Areas

In urban areas malaria is mainly transmitted by ***Anopheles stephensi*** which breeds in man made containers in domestic and peridomestic situations such as tanks, wells, cisterns which are more or less permanent in nature and hence can maintain transmission throughout the year.

Types of malaria: Two types

i ***Falciparum*** malaria is killer malaria or fatal malaria.

ii ***Vivax*** malaria though not fatal but relapses are common in *Vivax* malaria due to persistence of exo-erythrocytic phase in liver. Relapse rate in *P. vivax* is 30%. Nearly 50% of cases in India are due to *P. falciparum* and 33% of cases are due to *P. vivax*. Treatment of liver stage of *P. vivax* requires a 14 days course of primaquine.

Geographical Distribution (High Transmission Areas)

Out of 36 states/UTs five states contributed 71% of malaria in 2014 to 2016. These states were Odisha 36%, Chhattisgarh 12%, Jharkhand 9%, Madhya Pradesh 9% and Maharashtra 5%. The above mentioned states and North-eastern states such as Meghalya, Mizoram and Nagaland which have forest areas, hilly terrains tribal population, and conflict affected and difficult to reach areas along with poor healthcare delivery services contributed majority of malaria cases in the country. Hence these hard core areas are priority areas for intensified control measures under malaria elimination programme (Fig. 8.9).

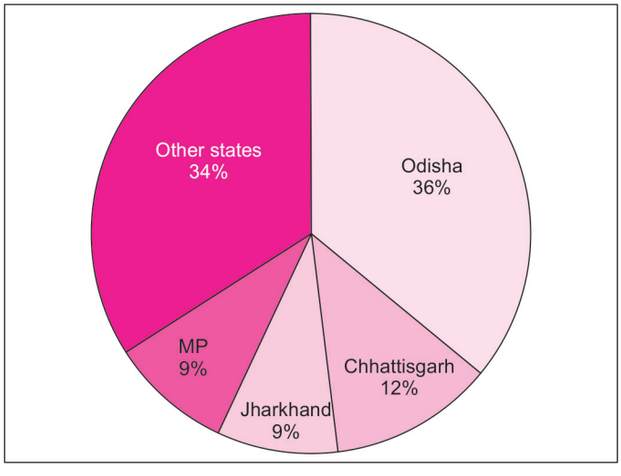


Fig. 8.9: Distribution of reported malaria in India—2014 and 2016

Seasonal Variations

Unstable malaria: Transmission is seasonal during rainy and post-rainy seasons in low endemic areas. Fluctuation in incidence are marked and these areas are epidemic prone areas (Haryana and Western UP, Gujarat, MP, West Bengal and Rajasthan). In these states *P. vivax* malaria predominates and vector is *An. culicifacies*.

Stable malaria: These areas (NE States) show consistently high incidence of malaria. Transmission occurs throughout the year. Peak is in November and December months. *Falciparum* malaria dominates, (over 80%) endemicity is very high and pre-dominant vectors are *An. culicifacies* and *An. fluviatilis*.

Long-term Secular Trends of Malaria

Long-term study of malaria from 1947 to 2020 indicates that malaria has declined in the country from high incidence of 75 million cases to about 0.18 million cases per year (Table 8.8), thus malaria is on verge of elimination.

Drug Resistance in Malaria

Resistance in *Plasmodium falciparum* to chloroquine was observed to be very high and frequent from 2001 onwards. Therefore, artemisinin-based combination therapy (ACT) is now being used as first line of treatment for all Pf cases in the country. However, in North-eastern states signs of resistance to currently used artemisinine. Sulfadoxine-pyrimethamine (SP–ACT) has been observed therefore effective combination of artemether–lumefantrine (ACT-AL) has been introduced for Pf cases.

Resistance to Insecticides in Mosquitoes

There is growing evidence of resistance to insecticides against the vectors in many parts of the country. Indiscriminate use of insecticides in agriculture sector is a matter of great concern.

Malaria Outbreaks/Epidemics

Epidemics in various parts of the country have been reported from 1994 to 2015 with large number of cases and deaths in the states of Rajasthan, Gujarat, Goa, West Bengal, AP, Assam, Bihar, Western UP, MP, Karnataka, Haryana, Manipur and Tripura. These outbreaks are due to sub-optimal functioning of health system, poor supply chain management and inadequate vector control measures. Hence epidemic preparedness in these areas is a dire necessity for effective response. Rapid response teams have been constituted to deal with epidemics under IDSP.

National Malaria Control Programme (NMCP) in India

NMCP was initiated in 1953. Encouraged with the results national malaria eradication programme was launched in 1958. Over the years the successes and failures have taught

us many lesions in malaria. From year 2007 onwards the nation evolved two strategic action plans from 2007 to 2012 and 2012 to 2017. Objective was to bring down incidence of malaria to less than 1 case per 1000 at national level by 2017 and reduce mortality by 50% by 2017. Though the API (annual parasite incidence) has been reduced to 0.18 in the year 2020 at the national level, there are variations of malaria incidence in states and districts of the states. Four states are high endemic states, and 32 districts reported ⩾1 API in India in 2020 against 154 districts in 2015.

Therefore, there is shift in strategy and vision: 'From **malaria control to malaria elimination**'. District is the unit of planning now. States have been categorized to different levels based on indicator of annual parasite incidence (API).[4]

NATIONAL FRAMEWORK FOR MALARIA ELIMINATION IN INDIA 2016–2030

The national framework for malaria elimination in India 2016–30: National strategic plan for malaria elimination was launched in 2017.

Vision

Eliminate malaria nationally (means zero indigenous case of malaria in the country) and contribute to improved health, quality of life and alleviation of poverty.

Goals

The goals of the national framework for malaria elimination in India are:

- Zero indigenous case of malaria in the entire country by 2027 and elimination by 2030.
- Maintain malaria free status in areas where malaria transmission has been interrupted and prevent re-introduction of malaria.

STRATEGIC APPROACHES[5]

Programme Phasing

Because of variations of incidence of malaria in the country the phasing or stratification of states into various categories is essential for elimination of malaria. Accordingly the states/UTs have been categorized into four categories based on the **annual parasite incidence** (API), i.e. malaria cases per 1000 population per annum (Table 8.10). Similarly the districts, blocks, community health centres, primary health centres, subcentres and even villages have been classified into different categories based on API.

All the states have been classified into 4 categories

- *Category 0*: Prevention of re-establishment phase (states and UTs with zero indigenous case of malaria).

Table 8.10: Classification of states/UTs based on annual parasite rate (malaria cases per 1000 population) in year 2020

India achieved national API in 2012	Less than 1/1000 population
National API in 2020	0.14 per 1000 population
States with API less than 1	32 States and UTs
States with API more than 1	2 states (chhatisgarh 1.19 and Mizoram 6.82)
Dist. with zero malaria cases	116 districts
Dsit. with API one and above	32 districts

- *Category 1*: Elimination phase (states and UTs including their districts reporting an API of less than 1 case per 1000 population at risk).
- *Category 2*: Pre-elimination phase (states and UTs with an API of less than 1 case per 1000 population at risk, but some of their districts are reporting an API of 1 or above per 1000).
- *Category 3*: States/UTs, with an API of 1 case per 1000 population at risk or above.

All districts, CHCs, PHCs, SCs and sections have been classified into above mentioned categories based on the annual parasite incidence (API) as the main criteria.

District is a unit under malaria elimination.

Objectives

The overall objectives of the malaria elimination programme are rapid reduction of transmission in areas with high malaria incidence; interruption of malaria transmission in low transmission areas; and prevention of re-establishment of malaria in areas where transmission has been interrupted.

Strategies

The broad strategies of the malaria elimination framework are:

A **Early diagnosis by surveillance and radical treatment**

B **Integrated vector management (IVM) by:**
- Indoor residual spary (IRS)
- Long-lasting insecticidal nets (LLINs)/insecticide treated bed nets (ITNs)
- Larval source management (LSM)

C **Epidemic preparedness and early response**

D **Advocacy, coordination and partnerships**

E **Behaviour change communication and community mobilization**

F **Monitoring and evaluation of malaria**

G **Programme planning and management.**

EARLY DIAGNOSIS BY EPIDEMIOLOGICAL SURVEILLANCE AND CASE MANAGEMENT IN MALARIA

Surveillance is an important epidemiological tool in malaria. It means early case detection of malaria and complete treatment (EDCT). Surveillance precisely means 'information for action' for effective control and prevention. Steps in malaria surveillance include collection of data on fever and malaria, analysis, interpretation and dissemination of relevant information for action at various levels.

Malaria surveillance is based on active case detection (ACD) and passive case detection (PCD).

- **Active case detection** ACD is carried out by trained health workers (multi-purpose health workers male) through fortnightly house to house visits and testing people with current or recent fever and chills in the past 14 days with bivalent RDTs. If the RDT result is positive, appropriate treatment is initiated and the blood slide/smears are discarded, and if RDT is negative, the blood slide is forwarded to laboratory for examination. Results of microscopy must be made available and communicated within 24 hours.
- **Passive case detection (PCD)** is carried out among fever cases who report themselves to a health facility or health volunteers for treatment of fever at PHC, subcentre and ASHA/AWW or health volunteer, with bivalent RDTs. Thick and thin blood smears are also prepared.

Surveillance in Category 3 (Intensified Control Phase) Areas with API ≥1

Objective is to reduce incidence of malaria.

Active Case Detection (ACD)

ACD is carried out by trained health workers (MPHW/ANM) with bi-valent antigen detecting RDTs through fortnightly house to house visits to cover 5000 population in plain and 3000 in tribal/hilly areas.

Passive Case Detection (PCD)

- By trained health volunteers (ASHA, USHA, CHV) at community level and at **subcentre** by ANM with bivalent antigen detecting RDTs.
- At PHC/CHC/district hospital/medical college and private practitioners/dispensary, etc. the PCD is done through microscopy only, however, bivalent antigen detecting RDTs will be used in emergent situations, odd hours and non-availability of LT. Results of microscopy should be made available within 24 hours.
- If a fever case is found positive for malaria, treatment should be initiated within 24 hours of detection and ensure complete treatment.
- Referral system should be in place to deal with severe cases of malaria to prevent deaths.
- Surveillance should sustain monthly blood examination rate (MBER) of minimum 1.5% during transmission months.

Surveillance in Category 2 (Pre-elimination Phase)

Same as category 3 given above. In addition, more focused attention in project areas and construction sites and among migrant populations and slum population.

The monthly blood examination rate (MBER) should be sustained at a minimum of 1% during transmission months.

Case-based and Focus-based Surveillance in Category 1 (Elimination Phase)

- Malaria has been made notifiable in 20 states.
- ACD will be carried over by trained community level health workers (MPHW/ANM) by house to house fortnightly visits and collecting blood smears for microscopy examination*
- PCD will be carried out by trained community level health volunteers/health workers—ANM at subcentre, dispensary PHC, CHC, district hospitals and medical Colleges and private and other sectors by blood smear collection for microscopic examination*

*However, bivalent antigen detecting RDTs will be used in areas where microscopy results are not available within 24 hours, in emergent situations and odd hours when microscopy facility is not available.

- If a fever case is found to be positive for malaria, it should be **notified** and following actions should also be taken.
  i. Prompt treatment: Initiate treatment within 24 hours of detection and ensure complete treatment.
  ii. Case investigation: Detailed case investigations are carried out and a case is classified as indigenous or imported, introduced, induced or relapsed case. Case investigations should be completed within 3 days of detection.
  iii. Contact survey: Should be carried out by blood smears collection for microscopy in the surrounding 50 households by ASHA/MPHW/technical supervisor.
  iv. If additional cases are found on contact survey the area should be expanded and appropriate action initiated within 7 days.
  v. Follow-up: Positive cases should be followed up to ensure completion of treatment.
  vi. The annual blood examination rate (ABER) should be sustained at minimum of 7% in perennial transmission and minimum 5% in seasonal transmission areas.

Surveillance in Category 0 (Prevention of re-establishment Phase)

- Malaria should be made notifiable. Now malaria has been made notifiable in 31 states/UTs.
- Any fever case reporting to a healthcare provider/facility (private and other) and meets the case definition of suspected malaria (intermittent fever with rigors and sweating in a high endemic area) should be investigated using microscopy examination of blood smear.

- If a case is found positive for malaria it should be immediately notified to authorities and the actions i–vi as elaborated in elimination phase above should also be taken.

Screening at the points of entry at International and Inter-state borders should be established for the purpose of cross reporting, enumeration of cases and public health action.

Case-based surveillance in malaria: Every case of malaria is reported and investigated immediately and also included in the weekly reporting system. Each confirmed case of malaria in category zero and 1 requires both detailed epidemiological case and focus investigation by rapid response teams. Each case and focus is investigated and classified.

Case Investigation

Collection of information to allow classification of malaria case by origin of infection, i.e. whether it was imported, introduced, indigenous, induced or relapsing. Case investigation may include administration of standard questionnaire to a person in whom malaria infection is diagnosed as well as screening and testing of people living in the same household and surrounding areas of 50 households.

Indigenous Case

A case contracted locally with no evidence of being imported or being directly linked to transmission from an imported case.

Imported Case

Malaria case or infection in which the infection was acquired outside the area in which it is diagnosed.

Induced Case

A case whose origin can be traced to blood transfusion or other form of parenteral inoculation of parasite.

Introduced Case

A case contracted locally, with strong epidemiological evidence linking it directly to known imported case.

Relapsing Case

Recurrence of asexual parasitaemia in *P. vivax* or *P. ovale* infections. Relapse occur when hypnozoites persist in liver and mature to schizonts which after an interval of 3 weeks to 1 year rupture and release merozoites into blood stream.

Focus Investigation (Geographical Reconnaissance)

Once a case of locally acquired malaria has been detected, the second stage of surveillance, i.e. focus investigation is carried out to describe the area where malaria occurred and delineate the population at risk. A malaria focus is defined as a circumscribed area in a currently or former malarious area that contains the epidemiological and ecological factors necessary for malaria transmission such as breeding places, mosquito density, *Anopheles* vectors, human behaviour, e.g. sleeping outdoors and occupation and to decide or choose appropriate intervention. The focus is classified into active, cleared-up, potential and pseudo-focus.

1. Pseudo-focus

Where conditions are not suitable for malaria transmission throughout the year.

2. Active Focus

Where there is an evidence of current transmission or history of recent transmission, e.g. during the past two years and presence of introduced and/or indigenous cases.

3. Cleared up Focus

No case is present in the circumscribed area.

4. Potential Focus

It is a focus where only imported or induced or relapsing and other categories (introduced and/or indigenous) cases are present.

Case-based Surveillance

Each confirmed case of malaria in category 0 and 1 states requires both detailed epidemiological case and focus based investigation by rapid response team. Each case and focus is investigated and classified as above.

Sentinel Surveillance

Sentinel surveillance is necessary for events which are not being captured by the regular system of surveillance or reporting, viz. severe cases of malaria, their management and on malaria deaths and effectiveness of antimalarial drugs being used. Further, to track these events in the light of introduction to RDTs and ACT for *Falciparum* malaria, it is expected that changes in API would occur and these improvements lead to decrease in incidence of severe malaria and malaria deaths. Thus, monitoring of these latter events may indicate the availability and efficiency of primary level services. The hospitals with large OPDs and in-patient case load have been chosen as sentinel sites. A minimum of two sentinel sites will be selected in each high endemic district to provide reliable data on *trends of severe malaria* and *deaths*. Sentinel Site Medical Officer (SSMO) will be incharge of all activities regarding malaria in the sentinel sites. Trained laboratory technicians will be placed at sentinel sites.

Entomological surveillance: It supplements and supports case-based surveillance and focus investigation. It collects information on vector species, vector density and sensitivity to insecticide and potential breeding places.

Early Diagnosis and Complete Treatment (EDCT)

The primary purpose of case management is to shorten the duration of illness, prevent the development of severe disease and death. EDCT reduces parasite load in the community, and thereby interruption of transmission. It also minimizes the risk of selection and spread of drug resistant parasites.

Therefore, case management for malaria must be based on early diagnosis, which is followed immediately by complete effective treatment.

Diagnosis of Malaria

A patient with fever and no other obvious cause of fever is considered as a case of 'suspected malaria'. Any volunteer, health worker or health professional observing a case of 'suspected malaria' must immediately initiate a diagnostic test by:

1. Microscopy of blood for malaria parasite
2. Rapid diagnostic test (RDT).

Microscopy

It is highly sensitive and specific, detects parasites at low densities, quantifies parasite load, and also useful to distinguish the various species of malaria parasite and their different stages of life cycle. Microscopy of stained thick and thin smears remains the gold standard for confirmation of diagnosis of malaria. The microscopy tests involve staining and direct visualization of the parasite under the microscope whether from peripheral smear study or quantitative buffy coat (QBC) test.

Rapid Diagnostic Test (RDT)

Apart from clinical and microscopic examination, the rapid diagnostic tests (RDTs) have been developed. RDTs are based on detection of **antigen** derived from malaria parasite in lysed blood, using immunochromatographic methods. Quality assured antigen detecting bi-valent RDTs (*P. vivax* and *P. falciparum*) are being used in the programme. If there is high clinical suspicion of malaria (intermittent fever with rigors and sweating in a high endemic area) in a RDT negative patient when no other cause can be found, the RDT should be repeated after 24 hours and all efforts should be made to get the microscopy results rapidly.

Antigens can persist for up to 4 weeks after clearance of asexual parasitaemia resulting in false positive test results. If a patient who has been treated, is febrile within one month after the treatment and the RDT is positive, the malaria diagnosis should be confirmed by microscopy before treatment is started. In areas where RDTs have been supplied, RDT is done and blood smears are made at the same time. If the RDT is positive, blood smear is discarded and if RDT is negative, the blood slide is forwarded to laboratory for examination.

NATIONAL DRUG POLICY ON MALARIA (2013)

Effective treatment of malaria under the National Drug Policy aims at:

- Providing complete cure (clinical and parasitological) of malaria cases
- Prevention of progression of uncomplicated malaria into severe malaria and thereby reduce malaria mortality
- Prevention of relapses by administration of radical treatment
- Interruption of transmission of malaria by use of gametocytocidal drugs
- Preventing development of drug resistance by rational treatment of malaria cases.

Treatment of Uncomplicated Malaria[6]

1. It is stressed that all fever cases should be suspected of malaria after ruling out other common causes and should be investigated for confirmation of malaria by microscopy or rapid diagnostic test (RDT) so as to ensure treatment with full therapeutic dose with appropriate drug to all confirmed cases.
2. The malaria case management is very important for prevention of serious cases and deaths due to malaria. So, the private healthcare providers should also follow the National Guidelines for treatment of malaria as per the Drug Policy 2013.
3. *P. vivax* cases should be treated with chloroquine for three days and primaquine for 14 days. Primaquine is used to prevent relapse but is contraindicated in pregnant women, infants and individuals with G6PD deficiency.

   Note: Patients should be instructed to report back in case of haematuria or high colored urine/cyanosis or blue colouration of lips and primaquine should be stopped in such cases. Care should be taken in patients with anaemia.
4. *P. falciparum* cases should be treated with ACT (artesunate 3 days + sulphadoxine pyrimethamine 1 day). This is to be accompanied by single dose primaquine preferably on day 2.
5. However, considering the reports of resistance to partner drug ACT-SP in north-eastern states, the Technical Advisory Committee has recommended to use the co-formulated tablet of artemether (20 mg)-lumefantrine (120 mg ACT-AL) as per the age-specific dose schedule for the treatment of Pf cases in North Eastern States. (Not recommended during the first trimester of pregnancy and for children weighing <5 kg.)
6. Production and sale of artemisinin monotherapy has been banned in India.
7. Pregnant women with uncomplicated *P. falciparum* should be treated as follows:
   - First Trimester: Quinine
   - Second and third Trimester: ACT

   Note: *Primaquine is contraindicated in pregnant woman*

8 In cases, where parasitological diagnosis is not possible due to non-availability of either timely microscopy or RDT, suspected malaria cases will be treated with full course of chloroquine, till the results of microscopy are received. Once the parasitological diagnosis is available, appropriate treatment as per the species, is to be administered.

9 Presumptive treatment with **chloroquine** is **no more** recommended.

10 Resistance should be suspected if in spite of full treatment with no history of vomiting, diarrhoea, patient does not respond within 72 hours, clinically and parasitologically. Such cases not responding to ACT, should be treated with oral quinine, with tetracycline/doxycycline. These instances should be reported to concerned district malaria/state malaria officer/ROHFW for initiation of therapeutic efficacy studies.

Treatment of Vivax Malaria

Diagnosis of vivax malaria may be made by the use of RDT (Bivalent) or microscopic examination of the blood smear (Table 8.11A). On confirmation following treatment is to be given:

Table 8.11A: Dosage (in mg) chart for treatment of uncomplicated vivax malaria

Age	*Day 1 CQ (150 mg base)*	*Day 2 CQ (150 mg base)*	*Day 3 CQ (150 mg base)*	*Day 1 to 14 PQ (2.5 mg)*
Less than 1 year	75	75	37.5	0
1–4 years	150	150	75	2.5
5–8 years	300	300	150	5
9–14 years	450	450	225	10
15 years or more	600	600	300	15
Pregnancy	600	600	300	Nil

Note: CQ 250 mg tablet is having 150 mg base; PQ. primaquine

Drug Schedule for Treatment of P. vivax Malaria

1 **Chloroquine:** 25 mg/kg body weight divided over three days, i.e.
10 mg/kg on day 1,
10 mg/kg on day 2 and
5 mg/kg on day 3.

2 **Primaquine*:** 0.25 mg/kg body weight daily for 14 days.

* Primaquine is contraindicated in infants, pregnant women and individuals with G6PD deficiency.
14 days regimen of primaquine should be given under supervision.

Treatment of Uncomplicated *Falciparum* Malaria

Diagnosis of *Falciparum* malaria may be made by the use of RDT (monovalent or bivalent) or microscopic examination of the blood smear. It is imperative to start the treatment for *Falciparum* malaria immediately on diagnosis. The treatment for falciparum malaria is as follows:

In other states (other than north-eastern states)

1 **Artemisinin based combination therapy (ACT-SP)*:** Artesunate (AS), available as 50 mg tablets are given for three days, and sulfadoxine—pyrimethamine (S–P) tablets, containing 500 mg sulfadoxine and 25 mg pyrimethamine are given for one day, as shown in the dosage chart (Table 8.11B).
All tablets for a day should be taken together, swallowed with water. In addition, primaquine (PQ large) tablets should be given on the second day.

Drug schedule for treatment of uncomplicated P. falciparum cases

1 **Artemisinin-based combination therapy (ACT-SP)*:** Artesunate 4 mg/kg body weight daily for 3 days plus sulfadoxine (25 mg/kg body weight): Pyrimethamine (1.25 mg/kg body weight) on first day.

* ACT is not to be given in first trimester of pregnancy.

2 **Primaquine:** 0.75 mg/kg body weight on day 2.
With the introduction of different coloured blister packs for different age groups, treatment by the field level staff has been made easy. The colour code for different age groups for packing of Tablet ACT + SP has been given in Table 8.11B.

In North-Eastern States (NE States)

Due to signs of *P. falciparum* resistance to ACT-SP in some areas in the NE states, artemether–lumefantrine (ACT-AL) has been introduced as the ACT combination to be used for treatment of *P. falciparum* cases in NE states under the national drug policy.

1 ACT-AL co-formulated tablet of artemether (20 mg)-lumefantrine (120 mg)* (Table 8.12).

*ACT-AL is not to be prescribed for children weighing less than 5 kg and first trimester of pregnancy.

Table 8.11B: Dosage chart (in mg) for treatment of falciparum malaria with ACT-SP schedule

Age group (years)	*1st day*		*2nd day*		*3rd day*
	AS	*SP*	*AS*	*PQ*	*AS*
0–1 Pink blister	25	250 + 12.5	25	Nil	25
1–4 Yellow blister	50	500 + 25	50	7.5	50
5–8 Green blister	100	750 + 37.5	100	15	100
9–14 Red blister	150	1000 + 50	150	30	150
15 and above White blister	200	1500 + 75	200	45	200

***Note*:** SP is not to be prescribed for children <5 months of age and should be treated with alternate ACT primaquin and ACT-SP are not to be given to pregnant women and they should be treated with alternate ACT.

Table 8.12: ACT-AL recommended regimen by weight and age group in NE states for *P. falciparum*

Co-formulated tablet ACT-AL	*5–14 kg (>5 months to <3 years)*	*15–24 kg (≥3–8 years)*	*25–34 kg (≥9–14 years)*	*>34 kg (>14 years)*
Total dose of ACT	20 mg	40 mg	60 mg	80 mg
Total dose of AL	120 mg	240 mg	360 mg	480 mg
		Pack size		
No. of tablets in the packing	6	12	18	24
Give	One tablet twice daily for 3 days	Two tablets twice daily for 3 days	Three tablets twice daily for 3 days	Four tablets twice daily for 3 days
Colour of the pack	Yellow	Green	Red	White

***Notes*:** Primaquine is given in a single dose of 0.75 mg/kg body weight on day 2 for its gametocydial properties.

ACT-AL is not to be used in women in first trimester of pregnancy treat infant weighing <5 kg with uncomplicated Pf malaria with an ACT at the same mg/kg body weight target dose as for children weighing 5 kg.

Treatment of uncomplicated P.falciparum cases in pregnancy

P. falciparum in pregnancy is a serious condition.

First trimester: Quinine salt 10 mg/kg 3 times daily for 7 days.

Quinine may induce hypoglycemia; pregnant women should not start taking quinine on an empty stomach and should eat regularly, while on quinine treatment.

Second and third trimesters: Area-specific ACT as per dosage schedule given above, i.e. ACT-AL in north-eastern states, and any ACT combination other than ACT-SP for other states.

Primaquine (PQ) prevents transmission of *falciparum* malaria to others by its ability to kill gametocytes. PQ tablets should be taken after a meal; not on an empty stomach. Children less than the age of one year and pregnant women should not be given primaquine. As pregnant women having falciparum malaria require different medicines, they should be directed to go to the nearest PHC or hospital immediately, without delay.

Treatment of mixed infections (P. vivax + P. falciparum) cases

All mixed infections should be treated with full course of ACT and primaquine 0.25 mg per kg body weight daily for 14 days.

- **In north-eastern states:** Treat with: Age-specific ACT-AL for 3 days + primaquine 0.25 mg per kg body weight daily for 14 days.
- **In other states:** SP-ACT 3 days + primaquine 0.25 mg per kg body wt. daily for 14 days (Table 8.13).

Treatment of P. ovale and P. malariae

In India these species are very rarely found in a few places. *P. ovale* should be treated as *P. vivax* and *P. malariae* should be treated as *P. falciparum*.

Treatment of Severe Malaria

Full doses parenteral artesunate is the treatment of choice for all severe malaria followed by a full dose of ACT orally. Treatment of asymptomatic cases detected by microscopy: Treat according to species.

Chemoprophylaxis

Chemoprophylaxis should be administered only in selective groups in high *P. falciparum* endemic areas. Use of personal protection measures including insecticide treated bed nets (ITN)/long-lasting insecticidal nets (LLIN) should be encouraged for pregnant women and other vulnerable population including travellers for longer stay. However, for longer stay of military and paramilitary forces in high *P. falciparum endemic* areas, the practice

Table 8.13: Dosage chart for treatment of mixed (*vivax and falciparum*) malaria with ACT-SP (doses in mg)

Age in years	*Day 1*		*Day 2*	*Day 3*	*Day 1–14*
	AS tablet	*SP tablet*	*AS tablet*	*AS tablet*	*Primaquine tablet*
0–1	25	250 + 12.5	25	25	0
1–4	50	500 + 25	50	50	2.5
5–8	100	750 + 37.5	100	100	5
9–14	150	1000 + 50	150	150	10
15 years or more	200	1500 + 75	200	200	15

Tablet SP (sulfadoxine 500 mg and pyrimethamine 25 mg)

of chemoprophylaxis should be followed wherever appropriate, e.g. troops on night patrol duty and decisions of their medical administrative authority should be followed.

Short-term Chemoprophylaxis (up to 6 Weeks)

Doxycycline: 100 mg once daily for adults and 1.5 mg/kg once daily for children (contraindicated in pregnant women and children below 8 years). The drug should be started 2 days before travel and continued for 4 weeks after leaving the malarious area.

Note: *It is not recommended for pregnant women and children less than 8 years.*

Chemoprophylaxis for Longer Stay (more than 6 weeks)

Mefloquine: 250 mg weekly for adults and should be administered two weeks before, during and four weeks after exposure.

Note: *Mefloquine is contraindicated in individuals with history of convulsions, neuropsychiatric problems and cardiac conditions. Therefore, necessary precautions should be taken and all should undergo screening before prescription of the drug.*

INTEGRATED VECTOR MANAGEMENT (IVM)

IVM is a process for managing vector population in a way to reduce or interrupt transmission of disease. The aim of IVM is to reduce number of bites by infected vector of malaria. The NVBDCP aims to achieve effective control by biological, chemical and environmental interventions of proven efficacy. Integration of IVM is done by using identical vector control methods to control malaria and leishmaniasis in rural areas and malaria and dengue in urban areas to achieve cost-effectiveness and synergy. The measures of vector control include:

- **Measures to control adult mosquitoes:** By indoor residual spray (IRS).
- **Anti-larval measures**
- **Personal protection:** Use of bed nets including insecticide treated nets (ITNs).

The national malaria control programme is currently using IRS as the primary method of vector control in rural settings, and anti-larval measures in urban areas. Insecticide treated bednets have been introduced in the programme, and the programme envisages to scale up their use as vector control option for full population coverage which replace IRS in areas, where operational factors indicated that this method alone will give sufficient impact.

Competency addressed: The student should be able to:
CM 3.8: Describe the mode of action and application cycle of common insecticides.

Indoor Residual Spray (IRS): A Contact Poison

Residual spraying is used for indoors, meticulously sprayed on walls, roof and other surfaces of the interiors. The endophilic malaria vectors that rest inside the houses after taking a blood meal from infected person are killed when their body parts come in contact with the insecticide and thus transmission is prevented. Cattle sheds are not sprayed to prevent shifting of mosquitoes to human dwellings.

IRS is at present carried out in high-risk areas with coverage of 80 million population. DDT is the insecticide of choice; in areas where **vector** has shown **resistance** to DDT, the alternatives are malathion and synthetic pyrethroids. Two rounds of spraying are done for DDT and synthetic pyrethroids to provide protection during the entire transmission season and in the case of malathion, three rounds of spraying is required.

Dose of DDT: 1 g/m^2 DDT (75% WP): 2/3 kg : 10 : 500, i.e. 2/3 kg of 75% DDT in 10 liters of water sprayed over 500 square meters (approximately equivalent to three houses).

Dose of DDT (50% WP): 1 g/m^2: 1:10 : 500, i.e. 1 kg of 50% DDT in 10 liters of water sprayed over 500 square meters. Residual effect is 10–12 weeks.

Dosage of malathion 25% WP 2 g/m^2, i.e. 2 kg in 10 liters of water for 500 square meters (three houses). Residual effect is 6–8 weeks. WP (wettable powder).

Dosage of deltamethrin (synthetic pyrethroids) 2.5% WP: 20 mg/m^2, i.e. 400 gm in 10 liters of water for 500 square meters. Residual effect lasts for 10–12 weeks.

Planning of IRS: The first round of spray in an area is usually done to coincide with the time of build-up of vector populations which precedes the malaria transmission season.

Objectives: To achieve at least 80% coverage of households in targeted high-risk areas with spray of effective insecticides.

Surveillance on **insecticide resistance will** form a critical component for taking decision on the insecticide to be used. Therefore, surveillance by National Institute of Malaria Research and Zonal Entomologist will be used. DDT is one of the persistent organic pollutant and its widespread use in agriculture leads to environmental pollution and it enters to food chain. In accordance with the Stockholm Convention on *Persistent Organic Pollutants,* reliance on DDT will be reduced by adopting other effective methods. But efforts will be made to progressively scale down its use.

Problem: Coverage rates for IRS tends to be low and refusal rates are very high and the impact with low coverage is minimal besides **insecticides resistance.**

Other Methods for Malaria Vector Control

The breeding of *Anopheles* mosquitoes can be reduced by a variety of physical, chemical and biological methods of larval control. In most situations these anti-larval measures have lesser impact than IRS and ITNs/LLINs which reduce the longevity of adult mosquitoes. However, in urban areas, larval control can play an important role; either or as an adjunct to IRS and ITNs.

Category-wise vector control measures	
Category of subcentre	*Vector control measures*
Category 0 (no case)	• Mapping of potential vector breeding sites • Vector prevalence and density monitoring • Environmental modification/manipulation for source reduction by VHSC. And UVBD scheme • Biological control by larvivorus fish • Foci-based adult vector control in and around 50 houses of positive case—space spray followed by IRS **Category 1, 2, and 3 states**
Subcentres with API <1	Same as in category 0 above
Subcentres with API ≥1	• Universal coverage with LLINs of all subcentres with API >1 • In subcentres with API >1 if not covered with LLIN, two regular rounds of supervised IRS • In LLIN covered subcentre, if there is an upsurge of cases, efforts to be made to increase compliance rate of LLIN usage • In outbreak situations—one additional round of IRS • Antilarval measures in urban areas in outbreak situation slum clusters can also be covered with IRS • Larval control through source reduction, biological and environmental measures
	Low endemic subcentre, i.e. with 0 or <1 API should be treated as category 1

Mosquito Larviciding

Petroleum oils and Paris green are effective and are still used in some countries. Biocides (*Bacillus thuringiensis* serotype H-14 and *Bacillus sphaericus*, larvivorus fish, monomolecular films) and insect growth regulators are finding increasing application in mosquito control programme. However, the main reliance is still on the chemical larvicides like organophosphates and pyrethroid insecticides. Recurrent use of temephos (abate) once a week as larvicide in towns is quite popular.

Biological Control

a. Fish as Mosquito Control Agent

One of the most widely used biological control agents against mosquito larvae is the fish *Gambusia affinis*, the top water minnow or mosquito fish. The fish other than *Gambusia*, which has received the most attention as mosquito control agent is *Poecilla reticulata*; the common guppy. There is much evidence that *P. reticulata* is not as effective at controlling mosquito larvae as *G. affinis*. The guppy though reproduces more rapidly than mosquito fish, but is not as effective in controlling mosquito larvae.

b. Role of Bacteria in Mosquito Control

Bacillus sphaericus and *Bacillus thuringiensis israelensis* (Bti) have been used against mosquito larvae. These are in pilot use under the programme.

Environmental Control Methods (Larval Source Management)

Source reduction: These are measures which prevent the breeding of mosquitoes or eliminate their breeding sites. If such measures are long-lasting or permanent like physical transformation of land, water and vegetation, they are often referred to as *environmental modification* (filling of sites, and improving drainage). When such measures have a temporary effect, and need to be repeated, they are known as *environmental manipulation* (observing dry days, removal of water plants, shading, cleaning and draining of pots, and stream flushing, etc.).

Use of ITNs including LLINs (Long-lasting Insecticidal Nets)

ITNs have emerged as an important tool in malaria control. Long-lasting insecticidal nets (LLINs) are mosquito nets which have the insecticide incorporated in their fibre, so that it is not removed by as many as 20 washes. Because these nets have an even and quality controlled insecticide application, they are generally more effective than conventional ITNs.

Furthermore the LLIN is more cost-effective (as it can be used for 3–5 years) than conventional bednets which need to be treated with insecticide once or twice a year. It is reiterated that ITNs are now becoming one of the main methods for control of malaria transmission. In population targeted for bednets, coverage must be as close to 100% as possible and the delivery should be a free public service.

ITNs and IRS are the two key methods of vector control promoted on large scale in the country. It is planned to scale-up use of LLINs over the coming years and simultaneously reduce the reliance on use of conventional bednets treated with insecticides.

Objective: To ensure that at least 80% of people sleep under effective ITNs/LLINs in target areas by 2017.

Strategies

- Rapid scale-up of ITN/LLIN coverage through a mass distribution campaign. Every eligible household

will be supplied with family size LLINs @ 1 net per 2 persons or use overall ratio of one LLIN for every 1.8 persons.
- Retreatment of plain nets with synthetic pyrethroids (Deltamethrin or Lamdacyhalothrin) done free of cost to the community.
- BCC to ensure regular use of ITN/LLINs.
- Social marketing of LLINs.
- Vulnerable community plan (VCP).

The NVBDCP has taken a conscious decision to use either IRS or bednets in a given area which means area chosen for one method will usually not to be covered by the second method of vector control.

Efficacy and Effectiveness of ITNs

Bednets whether impregnated or not act as physical barrier reducing the risk of the user getting any night-biting mosquito. ITNs like IRS, also reduce the longevity of vectors.

EPIDEMIC PREPAREDNESS AND EARLY RESPONSE

The aim of the NVBDCP including malaria is to prevent or identify epidemics/outbreaks in incipient stages and to prevent them from progressing into full blown epidemics. Prevention requires high level of preparedness and is closely linked with the integrated disease surveillance project (IDSP). The major causes of occurrence of outbreaks/epidemics are—climatic/environmental changes conducive to vector breeding, unplanned urbanization, population migration to and fro endemic areas, lack of manpower and facilities for malaria surveillance and resistance to anti-malarials and insecticides; lack of drugs and other commodities.

Definition of outbreak/epidemic: Occurrence of malaria cases in excess of the number expected in a given place and time. (Two standard deviations above the mean number of cases in preceding 3 years.)

Early Detection of Malaria Epidemics

The MO-PHC should keep a constant watch on parasite load by continuous monitoring of the number of fever cases and distribution of *P. vivax* and *P. falciparum.* Epidemiological factors which may assist in early prediction of an outbreak are given below.

- Increase in fever cases (fever proportion of one-third or more of new OPD cases) and severe malaria cases.
- Increase in fever incidence in the population (as informed by health workers and CHVs) or through weekly fever trends available through IDSP.
- Increase in malaria incidence (as compared to that of same month of previous years).
- Increase in test positive rate, *P. falciparum* %, proportion of gametocytes to other stages, increase in resistance, non-response to antimalarial, increase mortality, and increase in consumption of anti-malarials.

Fever alert surveillance for malaria has been integrated with the IDSP. Fever cases are being reported in the 'weekly fever report' from PHC to district nodal officer of IDSP and DMO/DVBDCO. If an increase in fever incidence is observed, nodal officer of IDSP will send an alert to the DMO and MOPHC. Similarly, the DMO/DVBDCO will inform the nodal officer of IDSP if any increase in fever incidence is observed.

Prevention and Control of Malaria Epidemics

The district should be prepared to respond rapidly to an outbreak/epidemic the requirements are:

- **Constitution of rapid response teams (RRTs):** RRTs should be constituted in collaboration with IDSP at district level and at local level such as PHC/CHC. The main function of RRT is to undertake urgent epidemiological and entomological investigations and provide emergency supplies and material, mobility as also additional manpower besides on the spot training.

Actions/Response

- **Rapid fever survey:** In every affected village/area all fever cases are identified and their blood smears are examined promptly by setting up field laboratory at the site of occurrence of outbreak. In areas where microscopy is not possible, RDT should be performed.
- **Mass survey:** In case the affected population is relatively small, a mass survey of the entire population may be carried out in every village irrespective of fever status. Children must be included in such surveys. Mass surveys of entire population should be completed within 10–14 days (within one extrinsic incubation period) to prevent secondary cases. All groups should be covered—children, pregnant women and migrants. Mass surveys are difficult to conduct.
  - i Blood smears collected should be examined within 24 hours or alternatively RDT should be conducted.
  - ii All positive cases should be given radical treatment at the recommended doses according to the slide or RDT result.
  - iii If the initial results indicate a positivity rate above 30% among fever cases (either blood smear or RDT it may be considered to treat all fever cases as soon as blood samples has been collected).
  - iv In areas where ACT has been rolled out and initial investigation reveal that the current outbreak is predominantly due to *P. falciparum*, treatment of cases may be started with ACT, even before the result arrive.

Anti-Vector Measures

Space Spray

- Every house in the affected area/village should be covered.
- Indoor space spray with pyrethrum should be carried out for 7–10 consecutive days or till IRS is completed

in all houses of the locality. The equipment to be used for space spray is the hand operated microdischarge fogging machine or hand operated atomizers (Flit pump).

IRS

- IRS should be started simultaneously with indoor space spray.
- The insecticide of choice will be the insecticide to which the local vector is susceptible according to best available information. All rooms of all houses and mixed dwellings will be sprayed to achieve full coverage (minimum of 80% of houses).

Entomological Investigation and other Vector Control Measures

The zonal entomological team should carry out vector density studies by entomological surveillance. They should point out prolific breeding places requiring immediate action such as antilarval measures along with IRS. Status of vector susceptibility to insecticide can be done on later date. The zonal team report their findings to RRT.

Follow-up Action

- Continue close surveillance for 1 month (twice the incubation period) after the outbreak has been contained (as demonstrated by epidemiological indices).
- Strengthen case detection and treatment services at all levels in the vicinity by ensuring that laboratories are fully functional, surveillance workers are deployed and supplies are ensured.
- Investigation to find out whether the epidemic was due to influx of migrants, breakdown of regular malaria control operations or natural calamities like floods, or heavy rain.

The final epidemic containment report should be submitted to higher levels.

SUPPORTIVE INTERVENTIONS ADVOCACY, COORDINATION

Capacity building: Recruit training, induction training, on the job training and off the job training for skill development apart from motivation is built into the programme.

Intersectoral coordination between various sectors happen through various coordination committees constituted at various levels by regular and periodical meetings at policy, planning and implementation level.

Reproductive and child health: Antenatal care services are utilized in distribution of LLINs to pregnant women in some areas of the country. Malaria is also included in integrated management of neonatal and childhood illness (IMNCI).

Community participation and behaviour change communication activities are organized for various components of the programme—early diagnosis and complete treatment, IRS, bednet distribution, referral services, bednet impregnation with insecticide, larval control and source reduction. All these areas need active community participation as also behaviour change to promote healthy practices for prevention and control of malaria and other vector-borne diseases.

Advocacy, Coordination and Public–Private Partnership

Most patients turn to private practitioners once they have fever. Training of private practitioners on standard treatment protocols and guideline on malaria, national drug policy on malaria and sharing information education material with them can go a long way in prevention and control of malaria. Involvement of NGOs, faith based organizations and community based organization as well as PRIs are imperative need for the success of the programme.

BEHAVIOUR CHANGE COMMUNICATION AND COMMUNITY MOBILIZATION

IEC strategy for malaria action programme (MAP).

Objective is to create awareness among the members of the community about causes, prevention, treatment and management of malaria cases leading to the reduction of morbidity and mortality (mortality nil and morbidity zero indigenous case).

Specific Objectives

1. To create awareness on the reduction in the frequency of contact between man and mosquito.
2. To create awareness among masses, about the measures which bring about reduction in parasite load in the community.
3. To create awareness on the methods, which can bring about reduction in mosquitogenic conditions leading to reduction in mosquito density.

The education to individual family and community has to be part of primary healthcare. Interpersonal communication and mass-media communication can play effective role. Observing anti-malaria month every year in June is intensification of education measures before transmission season. Since June 2005, it has been envisaged that anti-malaria month (AMM) campaign would not be confined to that specific month of June alone like earlier, but would be implemented in phases throughout the year.

In-depth review report 2007 and joint monitoring mission report-2007 have reflected inadequate knowledge, awareness, and inappropriate practices in high-risk areas particularly those that are rural and tribal having deficient health system. The BCC strategic plan is aimed at to cover at least 80% of population for improving knowledge, awareness and practices in relation to malaria.

Study, undertaken nationwide, provides an evidence that much needs to be done to build awareness against malaria and improve practices at household and community level.

During the NMEP spray operation people perceived, that NMEP goal is 'mosquito eradication' rather than parasite elimination. Government of India gave a slogan '*Macchar Rahega Par Malaria Nahin*' (there will be no malaria despite mosquito being there). People are ignorant about breeding of mosquitoes.

MONITORING AND EVALUATION IN MALARIA

Regular reports generated by the programme forms the basis of regular monitoring and evaluation of the programme. Weekly reports of IDSP, fortnightly and monthly report at various levels covering different aspects of the programme are used locally for early response and planning activities. Monitoring indicators for disease surveillance, integrated vector management, IRS and programme management have been developed.

Monitoring Indicators used in Disease Surveillance and Case Detection

1 Disease burden and impact: Indicators are total fever cases, malaria cases, *P. falciparum* cases and deaths due to malaria every month and cumulative for the year can be obtained/accessed from M-1, M-4 and SC, PHC M-4 data.

2 Monthly blood examination rate (MBER)

$$(\text{MBER}) = \frac{\text{Number of blood smears examined + RDTs positive in a month}}{\text{Total population under surveillance}} \times 100$$

MBER should be sustained at more than 1.5% of population in the transmission season in category 2 and 3 districts.

3 Annual blood examination rate (ABER)

$$= \frac{\text{Number of blood smears examined + RDTs positive in a year}}{\text{Total population under surveillance}} \times 100$$

ABER would include fever cases screened through slides as well as RDTs. Minimum target of ABER is 7% in perennial transmission areas and 5% in seasonal transmission areas, in category 1 of the total population. Both MBER and ABER measure the *incidence of fever* in the community. Based on fever incidence health worker male should collect 1% of slides (50 slides) per month in allocated population of 5000 or 500 slides per annum. This indicator measures the performance of the health worker male, further ABER is an indicator of operational efficiency of the programme. **Increase in fever proportion** (fever proportion of **one-third or more of new** OPD cases) is the indicator in early prediction of an outbreak of malaria in the community. The MO i/c of a PHC can monitor the fever incidence at PHC as well as in the community from the regular fortnight/monthly report or from community report/ complaints.

4 Annual parasite incidence (API)

$$= \frac{\text{Total number of blood smears positive for malaria parasite + RDTs positive for malaria parasite in a year}}{\text{Total population under surveillance}} \times 1000$$

The API measures the incidence of malaria in the community. Areas with API more than 2 are classified as *high-risk* areas and qualify for selective spray of IRS. Technical advisory committee on malaria in 2002 further rationalized the criteria for undertaking IRS on priority basis—all areas with more than 5 API should be covered with IRS (suitable insecticide) where ABER is 10% or more, taking subcentre area as a unit. Thus, API helps to identify *high-risk* areas to decide priority for spray activities. API is dependent upon effective surveillance and it is valid if ABER of 10% is achieved in the area. Over the years, the API which was more than 11 in 1977 has declined to the level of 0.14 case per thousand in the year 2020 which speaks the impact of the intervention. Now API is being used as primary criteria for classification of states/UTs and districts into various categories.

5 Annual *falciparum* incidence (AfI) rate

$$= \frac{\text{Total number of blood smears positive for } P.\ falciparum \text{ malaria parasite + RDTs positive for } P.\ falciparum \text{ malaria parasite in a year}}{\text{Total population under surveillance}} \times 1000$$

AfI like API measures incidence of *P. falciparum* malaria (killer malaria) in the community. This index measures disease burden due to *P. falciparum* malaria.

6 Test positive rate (TPR)/slide positivity rate

$$= \frac{\text{Total number of blood smears positive for malaria parasite + RDTs positive for malaria parasite}}{\text{Total number of blood smears examined + positive RDTs}} \times 100$$

This is independent of surveillance activity, therefore a better indicator for measurement of disease burden and impact. TPR of 5% or more in routine surveillance should always raise alarm. TPR indicates disease burden in the community, month-wise or year-wise. It is also good indicator for endemicity. Whenever the case detection mechanism is inadequate this is dependable parameter to determine progress of containment measures. It is more reliable than API even for those years when ABER fluctuates from year to year. TPR and API tend to be close to each other. Increase in TPR (doubled) in the current period as compared to the same period of previous year and/or TPR in routine surveillance is 5% or more is indicative of outbreak/epidemic of malaria. If the TPR is low but the fever rate is high, it indicates a disease problem, which is not malaria. In this case, the possibility of inadequate laboratory microscopic services should also be considered and improved accordingly (if required).

High TPR in areas with high and stable transmission of malaria is not considered an outbreak.

7 Test *Falciparum* rate (TfR)

$$= \frac{\text{Total number of blood smears positive for } P.\ falciparum \text{ malaria parasite + RDTs found positive for } P.\ falciparum}{\text{Total number of blood smears examined + positive RDTs}} \times 100$$

It is independent of surveillance and indicates *P. falciparum* preponderance. It measures disease burden due to *P. falciparum.* Declining trend will indicate impact of intervention. Area with TfR of more than 1% qualifies for RDT.

8 *P. falciparum* percentage (*P. falciparum*%)

$$(Pf.\%) = \frac{\text{Total number of blood smears positive for } P.\ falciparum \text{ malaria parasite + RDTs positive for } P.\ falciparum}{\text{Total number of positive blood smears + positive RDTs for malaria parasite}} \times 100$$

It measures disease burden due to *P. falciparum* malaria in the area. Over the years the disease burden due to *P. falciparum* malaria in India has increased and reached to over 67% in the year 2016. In some tribal districts in Jharkhand and Odisha the proportion of *P. falciparum* may be 70–80%. Rising trend of *P. falciparum* is indicative of drug resistance, inadequate surveillance programme and weak or non-functional health facilities and difficult access to services. Priority for IRS and ITNs is for those areas which have high burden due to *P. falciparum.* Different control strategies are required for those areas showing high burden due to *P. falciparum* malaria. RDT kits have been supplied in those villages or subcentres which show *P. falciparum*% >30. Passive surveillance has been stepped up in these areas.

9 *Infant parasite rate* (*see* page 288).

10 Percentage of community level facilities equipped with RDT in the last reporting period. This indicator can be obtained by:

$$\frac{\text{ASHAs/other community volunteers equipped with RDT}}{\text{Total ASHAs/other community volunteers}} \times 100$$

This is a process indicator for RDT. Frequency of this indicator is once in a quarter or once a year.

11 *Utilization of ACT:* Number of *P. falciparum* cases treated with ACT. Now under Drug Policy 2010 and 2013, all *P. falciparum* cases should be treated with ACT.

Urban Vector-Borne Disease (UVBD) Scheme

The UVBD under NVBDCP is being implemented in 131 towns with population more than 40,000 in 19 states and union territories. Since 1971, protecting 130 million population. The urban malaria scheme (UMS) aims at:

a To prevent deaths due to malaria
b Reduction in transmission and morbidity.

Epidemiological Situation

About 10% of total cases of malaria and deaths were reported from urban areas during 2008 to 2013 in the country.

The control of urban malaria lies primarily in the implementation of urban by-laws to prevent mosquito breeding in domestic and peridomestic areas, and government buildings. Larvicides are applied on weekly basis in water bodies that are unsuitable for fish use. The Government of India supplies larvicides to municipalities under urban malaria scheme. The UMS is implemented by the state authorities, including salary of staff employed for spraying the larvicides.

Urban malaria continues to pose problems because of unplanned rapid urbanization, migration of labour for construction or jobs in the industrial set-up of urban location. The urban malaria vector is *A. stephensi*, breeds in stored water and domestic containers. Construction activities and aggregation of labour provide ideal opportunities for transmission of urban malaria. Fifteen large cities in India account for nearly 80% of cases of urban malaria scheme. *P. vivax* contributes 85–90% of urban malaria.

The norms for establishment of UMS are as follows:

- The town should have minimum population of 40,000.
- API should be 2 or above.
- Town would promulgate and strictly implement the civic by-laws to prevent/eliminate domestic and peridomestic breeding places.

Staffing pattern: A biologist is an overall in-charge, is provided to supervise and monitor the scheme. Regular antilarval staff for each of 2.56 sq. km sector consists of superior field worker one, field workers two and a field worker for de-silting, deweeding and minor levelling. Each ward has one malaria inspector and one insect collector.

Under UMS, the following strategies are followed:

Parasite Control

To provide treatment to patients through passive surveillance by institutions such as hospitals, dispensaries and malaria clinics. One malaria clinic for 50,000 population is proposed in high-risk urban areas for early diagnosis and prompt treatment with the support of laboratory technician.

Vector Control

- ***Source reduction:*** Minor engineering methods like deweeding, desilting, levelling, etc. (environmental manipulation) to reduce breeding of vector.

- ***Habitat modification*:** These are permanent alteration of environment such as landskaping, surface water drainage filling and land reclamation.
- Recurrent antilarval measures by larvicide like temephos (abate) in towns once a week or mosquito larvicidal oil—MLO (malariol), or kerosene oil.
- Biological control measures using larvivorus fish like gambusia and guppy fish.
- Awareness campaigns such as observance of anti-malaria month in June every year.
- ***Aerosol-space spray:*** 50 houses in and around every positive case are sprayed with 0.1% pyrethrum.

Legislation: Enforcing By-laws

It is worth pointing that urban health services are weak and not well organized in slum population and accessibility and availability of primary healthcare is inadequate. Local bodies do not have enough funds and do not control slums development. Hence, urban slum population is high-risk population for malaria because of high density of population, overcrowding, and favourable breeding grounds for mosquito. Hence, urban malaria clinic must be located in urban slum area and urban health posts and RCH projects in slum areas can enhance malaria detection and ensure prompt treatment to reduce morbidity and deaths.

Epidemic Response

Early detection and early response to malaria outbreak is essential in all categories of malaria elimination, however, it is most critical in prevention of re-establishment phase, as even a single case of malaria during this phase has a potential of focal outbreak.

Malaria vaccine: WHO has recently approved the world's first malaria vaccine 'MOSQUIRIX'* in Sub-Saharan Africa (in Chana, Kenya and Malavi) in 2021. The vaccine is known as RTS, S against *P. falciparum*. It provides partial protection against malaria in young children, to be given at 6 weeks to 17 months of age.

PROGRAMME PLANNING AND MANAGEMENT

The programme planning and management has been decentralized to the village level and subcentre level. Annual district action plans for malaria elimination are prepared by aggregation of villages, subcentres, PHCs and CHCs plans. Ideally it should be part of district health action plan developed under National Health Mission. Every annual plan is based on the experience of previous year. Village health and Sanitation and Nutrition Committees should be involved in planning process. District annual plan on malaria elaborates population to be covered, status of health facilities, human resources, epidemiological situation of malaria, high-risk areas and population, information on outbreaks in the previous year, estimation of RDT, ACT and LLIN requirement, microplanning for IRS, training activities, BCC activities, commodity requirement, cash assistance and budget. District plans converge into State Plans and National Plans is evolved by directorate of NVBDCP at the national level. Management and accountability at each level is critical to achieve the elimination goals and targets to defeat malaria. Global fund supported malaria elimination project.

Global fund to fight AIDs, TB and malaria (GFATM) is implemented in high endemic Northest states (Odisha Jhharkhand and Chhatisgarh States).

*WHO approved first malaria vaccine—MOSQUIRIX in October 2021 for children, to be given at 6 weeks to 17 months of age.

LYMPHATIC FILARIASIS (LF)

EPIDEMIOLOGY

Filaria is a vector-borne disease; it covers wide range of manifestations. Of all, lymphatic filariasis deserves utmost attention because of its wider implications in terms of disease burden, deformity and disability, social stigma and economic loss. Lymphatic filariasis is a vector-borne parasitic disease caused by lymphatic dwelling nematode parasites namely *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori known as filariae*. The filariasis manifests as progressive lymphoedema leading to disfiguring **elephantiasis, hydrocele** and loss of respiratory function due to tropical pulmonary eosinophilia.

Global Disease Burden

Globally, there are nearly 1000 million people in 73 countries living in areas endemic for lymphatic filariasis and are exposed to the risk of infection.

Problem of Filariasis in India

Only Wuchereria and Brugia malayi are found in India. lymphatic filariasis (LF), commonly known as **elephantiasis** is disfiguring, disabling disease usually acquired in childhood but generally there are no symptoms. Vast majority of individuals may remain asymptomatic. Disease manifestation appears in a small proportion of infected individuals commonly over 10 years of age. Lymphoedema or **elephantiasis** and hydrocele are the main clinical symptoms of chronic filariasis and disrupt normal daily activities.

The disease is widespread and endemic in 272 districts of states/UTs. Nearly 670 million people are living in endemic states and are at risk of infection.

The line listing of lymphoedema and hydrocele cases were initiated since 2004 by door-to-door survey of filaria in 272 filaria endemic districts. The updated figures till 2020 revealed 494979 lymphoedema and 148954 hydrocele cases (total of 643933 cases with clinical manifestations).

Distribution

Rural–urban

Initially, filariasis was thought to affect urban and peri-urban areas only, but rural areas are equally affected with the disease, hence the control measures, which are predominantly restricted to urban areas, have to cover the rural areas as well. The filaria infection and disease affects children and adults. Children show high prevalence of filaria antigenaemia making them important target for intervention.

Social and Economic Effect of Filariasis

Lymphatic filariasis mostly affects economically weaker sections of people living in urban slums and rural areas and makes them poorer. The disease produces progressive physical deformities in limbs (lower legs and upper limbs) and reduces the work capacity of affected individuals. Lymphatic filariasis is the second leading cause of permanent physical disability in human beings next only to mood disorders. As over 6 lakh people are suffering from disease and various grades of lymphoedema. The economic losses are colossal. Economic loss due to filariasis has been estimated to be ₹5000 crore per annum. Apart from economic loss, the affected person carries a social stigma and is looked down upon by the society.

Reservoir of Infection

Individuals who have circulating microfilaria in their blood are known as carriers of microfilaria. India has large reservoir of infection, being maintained in the endemic areas. The goal of filaria elimination is to reduce this reservoir to a minimal acceptable level. These individuals should be targeted for intervention programme. National programme of filaria control and elimination is focusing on mass drug administration (MDA) for interruption of transmission.

Transmission

Filariasis is a vector-borne disease. *Culex quinquefasciatus* is the transmitting vector of bancroftian filariasis. In India 99.4% of infections are caused by *W. bancrofti*. In endemic areas, the vector breeds in polluted water, high humidity is favorable for breeding. This vector is endophilic (rests inside the house after blood meal) and anthropophilic (bites human being). The transmission is seasonal. The density of this vector is low in summer season and is on peak in monsoon and post-monsoon period. Vector for *Brugia malayi* is *Mansonioides* group of mosquitoes. This form of filariasis is confined to a limited geographical area of Kerala. *Mansonioides annulifera* and *M. uniformis* are the major vectors for *B. malayi,* these breed in polluted water ponds with vegetation of *Pistia stratiotes* (a kind of plant or hyacinth). The larvae of the vector have special affinity with *Pistia plant*.

The parasite cycle in the mosquito begins when the microfilariae are picked up by the vector mosquitoes during their feeding on the infected person (microfilaria carrier).

The microfilaria in mosquito develops into three stages and under optimum conditions of temperature and humidity; the duration of the cycle in mosquito (extrinsic incubation period) is about 10–14 days. When the infective mosquito feeds on other human host, the infective larvae are deposited at the site of mosquito bite from where the infective larvae get into lymphatic system. In the human host, the infective larvae develop into adult male and female worms. The adult worm survives for about 5–8 years or sometime as long as 15 years or more.

Incubation interval: Variable usually long incubation period of several years. The time interval between the introduction of infective larvae and first appearance of detectable microfilaria is known as 'pre-patent' period. It usually varies from 1 to 1½ years. The peak prevalence of infection occurs in age bracket 20–30 years, which can be considered as target age for case detection.

Epidemiological Indices for Filaria to Estimate Filaria Endemicity

1. ***Microfilaria (Mf) rate:*** Percentage of persons whose blood smears are positive for Mf. If it is 1% or more than 1%, the area is chosen for mass drug administration.
2. ***Disease rate:*** Percentage of persons having visible lymphoedema, hydrocele (clinical signs of filaria). 6.43 lakh have clinical disease in India.
3. ***Average endemicity rate:*** Percentage of persons showing Mf in the blood or disease manifestation (Mf % plus disease %) or both.
4. ***Average Mf density:*** Mean number of Mf per 20 cmm of blood.
5. ***Average infestation rate:*** Average number of Mf per positive slide.
6. Vector density per man hour.
7. ***Infected vector rate:*** Percentage of mosquitoes showing any stage of Mf (L1/L2/L3 stages).
8. ***Infective vector rate:*** Percentage of mosquitoes showing *Mf larvae* stage three only (infective larvae).
9. ***High endemic districts:*** Mf rate 1% and above.
10. ***Low endemic districts:*** Mf rate below 1%.
11. Coverage levels achieved with MDA. It should be above 80% for 5–6 years.

Detection of Carriers

This is being done through night blood survey before MDT as Mf appears in peripheral circulation during night. Surveillance operations during night (8.30 pm to midnight) are difficult and unpopular.

Because of these problems, a need was felt for development of rapid, specific, sensitive and reproducible diagnostic methods for field application for the detection of infection (microfilaraemia or adult parasites) both in humans and in vector mosquitoes. A rapid day blood immunochromatographic card test (ICT) has been found highly specific and more sensitive in India in comparison with the night blood smear examination. Although, it is costlier, it has the advantage of on the spot, day blood detection of parasite carriers in large number (compared to night blood smear examinations). ICT has been replaced by filaria test strips (FTS).

Surveys: Microfilaria survey in all the implementation units (districts) is being done through night blood survey before MDA. The survey is done in 4 sentinel and 4 random sites collecting total 4000 slides (500 from each site) to know the prevalence of microfilaria in an area and to decide MDT.

NATIONAL FILARIA ELIMINATION PROGRAMME (NFEP)[7, 8]

Filariasis has been identified as one of the 6 diseases (among over hundred considered); which could be targeted for elimination/eradication based on the epidemiological considerations.

- Human beings are the only reservoir of infection.
- Diethylcarbamazine (DEC) is the effective drug acting on the parasite is available without report of resistance over 5 decades. Mass annual single dose with selective vector control could eliminate infection by interruption of transmission.

Elimination of Lymphatic Filariasis

Goal: Global goal is to eliminate lymphatic filariasis by 2020. National Health Policy 2017 advocated elimination by 2020.

What is Elimination?

Achieving microfilaria rate of less than 1% in children of 6–7 years old in all the districts. District is a unit for elimination.

Strategy for Elimination of Lymphatic Filariasis

WHO Twin Pillars

a Transmission control—Interruption of transmission through—mass drug administration: Supervised annual mass drug administration (MDA). Initially the MDA was done with single drug DEC, since 2007 co-administration of DEC + Albendazole (DA) and Ivermention + DEC + Albendazole (IDA) was introduced for MDA. Annual single dose of DEC (diethylcarbamazine) and albendazole for minimum of 5 years or more to entire population at risk, except pregnant women and children below 2 years of age and seriously ill persons, to interrupt transmission of disease (to prevent occurrence of new infections and disease).

b Disability prevention and management: Home-based management of lymphoedema cases and up-scaling of hydrocele operations in identified CHCs/district hospitals/medical colleges.

Coverage Levels and Reduction of Disease:

- Reported coverage levels have improved from 73% in 2004 to 89% in 2015. There is a gap between coverage and actual compliance of drug. Intensive mobilization is required to achieve compliance above 90%.
- Overall microfilaria rate has been reduced from 1.24% in 2004 to 0.3% in 2015.

c Antivector measures: Integrated vector management (IVM) is one of the strategies implemented in areas of high burden (high prevalence of microfilaria). It is continued in towns as complementary to antiparasitic measures. Anti-larval measures and larval source management are also being undertaken.

d Information education and communication for preventive measures in the community, to create demand and utilization of services under NFEP.

Drug Dosage Schedule: Streamlined (Table 8.14)

Annual supervised single dose mass chemotherapy with DEC, agewise dose schedule: The single day mass DEC treatment will be as per the existing dose, i.e. 6 mg/kg body weight. Since, it is not feasible to weigh every individual in the field to calculate the exact dose to be administered, it is convenient to adjust the dose schedule as per different age groups adopted in the programme.

The advantage of streamlined DEC dosage is that the number of tablets are less and the three doses can easily be remembered by the peripheral drug administrator (Table 8.14).

Individual Treatment

The Mf carriers detected in filaria clinics and elsewhere will receive standard dose 6 mg/kg body wt/day for 12 days.

Adult and children above 10 years of age are given full dose 6 mg/kg body weight and children below 10 years are given half of the adult dose.

Table 8.14: Streamlined DEC drug dosage schedule

Age in years	*Dose of DEC*	*No. of tablets 100 mg each*
<2	Nil	Nil
2–5	100 mg	1
6–14	200 mg	2
15 and above	300 mg	3

Use of DEC fortified salt is another intervention recommended for filaria control.

Approach: 'Supervised drug administration by door to door visit supplemented with drug administration at booth' on a single day with 3 days mopping operation in all 250 endemic districts since 2004.

Inclusion Criterion for MDA

The MDA was launched in 2004. The selected district or PHC should meet the criteria of 1% or more microfilaria rate for inclusion under MDA.

DEC is as effective as ivermectin in drastically reducing the levels of transmission. Mass drug administration (MDA) or fortified salt requires effective methods of delivery system, through primary healthcare, integrated child development services (ICDS) and involvement of non-governmental organizations apart from massive education of people.

National Filaria Day (NFD)

Convincing healthy persons and carriers of Mf to consume DEC on National Filaria Day (NFD) once every year for 5–7 years or more can eliminate lymphatic filariasis, in community. Integrated control of vector and mass chemotherapy can achieve better results.

Selective Mass Therapy

Only persons who are Mf positive are given single dose of DEC 6 mg/kg body wt. per annum in known endemic areas of lymphatic filariasis.

Advantages of MDA

Advantages of single dose mass therapy:

i It avoids the cost of mass blood examination.
ii All members of community receive treatment and compliance rate is enhanced.
iii It is as effective as 12 days therapy for public health measure.
iv It has lesser side effects.
v It involves decreased delivery cost.
vi It does not require complex management infrastructure.
vii It can be integrated into existing primary healthcare system for delivery.
viii Single dose mass treatment annually has either eliminated or markedly reduced the transmission of lymphatic filariasis in some countries.

Side Effects of DEC

a Those due to drug itself: Headache, anorexia, nausea, abdominal pain, vomiting, dizziness, weakness and lethargy. These symptoms begin within 1–2 hours of taking drug and persist for a few hours.
b Those due to allergic reactions due to destruction of microfilariae and adult worms: Fever, local inflammation around dead worms.

Disability Prevention and Control (for Relief of Sufferings) for those who Already have Disease

This intervention aims at:

- Home-based management of lymphoedema by assisting lymph flow through elevation, exercises, bandages and personal hygiene.
- Prevention of acute inflammatory episodes by preventing secondary bacterial infection by use of soap and water, hygiene, skin care and treatment of "entry lesion".
- Hydrocele management by surgical repairs.
- Disability prevention and control clinics have started functioning at Varanasi, Calicut and Rajahmundry in endemic states.

Achievements

- MDA with DEC and albendazole has been scaled up. 98 districts have stopped MDT after successfully passing first TAS.
- 203 districts out of 250 endemic districts have achieved microfilaria prevalence less than 1%.
- The coverage levels have increased over 80% and microfilaria rates have steadily declined to 0.3% over the years.[8]

Coverage of MDA and Microfilaria Rates—Trends

Years	*2004*	*2005*	*2006*	*2007*	*2014*	*2015*
• Population coverage (%)	72	76	82	83	46.42–85.60	89
• Microfilaria rate (%)	1.24	1.02	0.98	0.64	0.52 to 0.44	0.3

Transmission Assessment Surveys for Monitoring and Evaluation

Phasing out of MDA has been started through validation. The validation is done through transmission assessment surveys (TAS). The TAS is a decision making tool for stopping MDA in a district (Fig. 8.10).

As per WHO guidelines 2011, the districts having observed minimum five rounds of MDA with more than 65% coverage of population of district covered under MDA and reporting microfilaria prevalence of less than 1% are subjected to transmission assessment survey.

TAS uses immunochromatographic test (ICT) for presence of circulating antigenemia/microfilaraemia. ICT has been replaced by filaria test strip (FTS) since 2015. If the current infection rate is less than 1% in children 6–7 years of age (born after initiation of MDA) area passes for TAS and MDA is stopped. Thus TAS is required to take a decision for MDA stoppage. As of now, 98 districts out of 272 districts have successfully completed or passed first

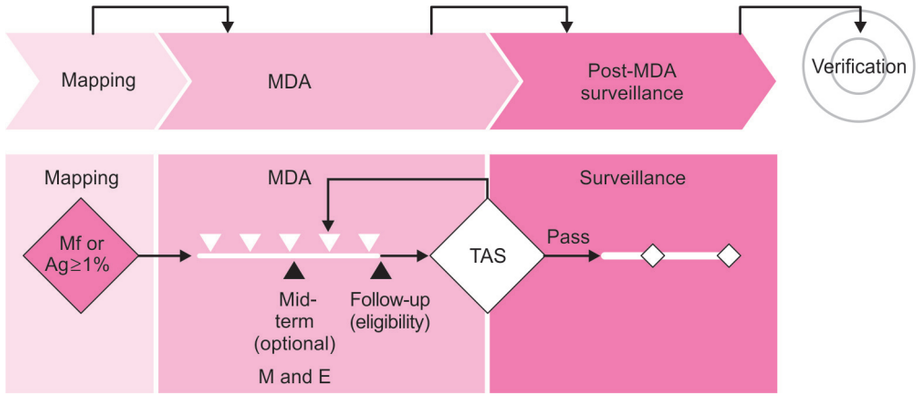


Fig. 8.10: Steps for interrupting transmission of lymphatic filariasis by mass drug administration (MDA) as described by WHO in 2011

TAS and qualified for MDA stoppage, 88 have cleared 2nd TAS and 42 cleared 3rd TAS by 2020.

All such districts which have successfully completed TAS are put under post MDA surveillance.

Morbidity survey: Door to door morbidity survey in non-endemic districts by ASHA to detect LF foci.

The problems faced: Inadequate coverage of population and poor compliance of drug therapy is a big problem. Carriers of Mf are healthy individuals and other healthy people in high endemic areas refuse to take drug.

Actual consumption (compliance) should be considered as major criterion rather than drug distribution.

New Initiatives

- Triple drug IDA (Ivermectin + DEC + Albendazole) therapy for MDA in selective 8 districts has been implemented in 2020.
- Introduction of DEC medicated salt as an adjunct to the existing MDA strategy.

KALA-AZAR (VL)

EPIDEMIOLOGY

Kala-azar (Visceral leishmaniasis) is caused by *Leishmania donovani* is confined to man only with no animal reservoir.

It is a vector-borne disease transmitted by female sandfly—*Phlebotomus* argentipes. The disease is fatal if not treated timely.

Distribution

It is worldwide distributed affecting 88 countries. About 350 million people are exposed to the risk of VL. India Bangladesh, Nepal, Sudan and Brazil contribute 90% cases of visceral leishmaniasis (VL). According to WHO estimates, more than 10 million are affected globally and 26% VL cases are from Indian subcontinent.

Indian Scenario

Presently kala-azar is endemic in 54 districts, 33 districts of Bihar, 11 in West Bengal, 6 in UP, 4 in Jharkhand are endemic and reporting cases of VL or kala-azar. Cutaneous leishmaniasis has been reported from Himachal Pradesh and Uttarakhand as well. Over 130 million population is exposed to the risk of kala-azar in the endemic areas. KA has been declared a notifiable disease in Bihar and West Bengal.

During 2018 and 2019 over 4000 and 2900 cases of KA were reported.

The causative agent for VL and PKDL in India is the *Leishmania donovani*. There are two distinct stages in the life cycle of parasite.

i Amastigote (aflagellar) or *Leishmania* stage which occurs in man. Man is the only host of *Leishmania donovani* in India

ii Promastigote (flagellar) or Leptomonad stage occurs in gut of sandfly and artificial culture.

The parasite (*Leishmania donovani*) primarily affects reticuloendothelial system and found in abundance in bone marrow, spleen and liver.

Vector

Visceral leishmaniasis or kala-azar is transmitted by the bite of infected female sandflies. ***Phlebotomus argentipes*** is the only known vector of kala-azar in India.

Incubation Period

Generally it varies from 1 to 4 months but in realty the range is from 10 days to 2 years (in India range is 4 months to 1 year). Extrinsic incubation period in vector is 4–25 days which is the time required for the vector to become infective after an infective blood meal.

Outbreaks and Resurgence

Resurgence of kala-azar has been a perpetual problem in Bihar and UP.

Indian Scenario

In India, two types of leishmaniasis are prevalent: Visceral leishmaniasis (VL) and cutaneous leishmaniasis (CL). VL is usually fatal when untreated. CL is disabling disease when lesions are multiple. Post kala-azar dermal leishmaniasis (PKDL) is a condition in which *L. donovani* invades cells of skin.

NATIONAL KALA-AZAR (KA) ELIMINATION PROGRAMME[9]

Kala-azar elimination is on top priority under WHO neglected tropical diseases.

Centrally sponsored kala-azar control programme has been operative since 1991 for control of disease in endemic areas. The programme has been successful in reducing the morbidity and mortality due to kala-azar as is evident through decline in annual incidence and 99% of reduction of deaths in 2014 as compared to 1992. Based on the recommendations of the expert committee in 2003 the Government of India approved 100% central assistance for kala-azar elimination by 2015. Out of 633 KA endemic blocks 617 (97.5%) have achieved the target of elimination by August 2021.

Elimination: Elimination is defined as reducing the annual incidence of kala-azar to less than 1 case per 10,000 population at the sub-district level (block level).

Goal: The national goal was elimination of KA by 2021.

Objective

- Reducing the incidence of KA in the endemic communities.
- Reducing case fatality due to KA
- Treatment of post kala-azar dermal leishmaniasis (PKLD) to reduce the parasite reservoir.
- Prevention and treatment of KA-HIV, TB co-infection.

Strategies

- Early diagnosis and complete treatment (EDCT)
- Integrated vector management and vector surveillance
- Advocacy, communication for behaviour impact and intersectoral convergence
- Programme management (supervision, monitoring and evaluation).
- Capacity building

Early Diagnosis and Complete Treatment (EDCT)

EDCT includes diagnosing a case early along with complete treatment to interrupt transmission. This strategy will reduce case fatality. The starting point for early diagnosis is to follow uniform suspect case definition.

- **A suspect case:** History of fever of more than 2 weeks and enlarged spleen and liver not responding to anti-malaria treatment in an endemic area.
- All patients with above symptoms should be screened with rapid diagnostic test (RK39) and if found positive should be treated with effective drug.
- Or a patient with above symptoms clinically examined by doctor and found positive on screening with rapid diagnostic test (RK39).
- Or in case with past history of kala-azar or in those with high suspicion of kala-azar but with negative RDT test result—confirmation of kala-azar can be done by examination of bone marrow/spleen aspirate for LD bodies at district hospital.

Treatment

Injection liposomal amphotericin B (LAMB) in single day single dose of 10 mg/kg as the first choice of treatment regimen. Other treatment regimens are:

i Combination of miltefosine and paromomycin injection
ii Amphotericin B emulsion
iii Capsule miltefosine for 28 days
iv Injection amphotericin B (15 injections on alternate day).

- Post kala-azar dermal leishmaniasis are to be treated with:
  - i Liposomal amphotericin B 5 mg/kg by infusion two times per week for 3 weeks for a total dose of 30 mg/kg or
  - ii Miltefosine: 100 mg orally per day for 12 weeks or
  - iii Amphotericin B deoxycholate: 1 mg/kg over 4 months 60–80 doses.

Surveillance for EDCT

KA disease surveillance is useful in planning IRS through mapping of areas to be sprayed and monitoring trends of kala-azar incidence.

Passive surveillance is the mainstay of the programme. This means regular, timely and accurate reporting (collection of information for action) on kala-azar cases who seek diagnosis and treatment from health facility in the government, private or NGO sectors (PHC, CHC, district hospitals). 2352 cases and 6 deaths of kala-azar were reported in 2020.

Active Surveillance (Active Case Search)

Active surveillance implies active search of kala-azar and PKDL case. Active surveillance in India at present is being done on quarterly active search basis**.** Health workers and volunteers visit households to find out individuals with fever of more than 2 weeks duration. Suspected cases are referred to PHC for clinical examination and rapid

diagnostic test for confirmation of diagnosis and treatment initiation. High focus has been given to strengthen the surveillance activity to carry out 6 rounds of active case detection by 2021.

Surveillance of Post Kala-azar Dermal Leishmaniasis (PKDL)

Surveillance of PKDL cases is important as PKDL cases serve as reservoir of disease transmission during the inter-epidemic period. Reporting of PKDL cases is an integral part of the programme for diagnosis and complete treatment. There is 7% increase in PKDL in 2021 as compared to 2020 and 40% reduction in KA cases up to August 2021. Till August 2021, 97.5% Kala-azar endemic blocks (617 blocks) achieved the elimination target of <1 KA case per 10,000 populaton at block level as a result of intensified action plan of 2019.

Vector Surveillance (Entomological Surveillance)

Vector surveillance (sandfly) means identification of breeding places, critical density of vector and control measures.

Integrated Vector Management (IVM)

The main objective of IVM is to reduce longevity of the adult vectors, eliminate breeding sites, decrease contact of vectors with humans and reduce the density of vector, sand fly. IRS is the mainstay of vector control for breaking human-vector-human cycle of transmission. Vector control is carried out by undertaking two rounds of spray annually with 50% DDT at a dose of 1 g/m^2 of wall surface inside walls of rooms up to height of 6 feet and full coverage of cattle sheds. In view of tolerance/resistance to 50% DDT it has been decided to use synthetic pyrethroids (SP) in seven districts reporting DDT tolerance as also high endemicity of kala-azar during 2015. More areas will be covered with SP in phased manner.

Programme Management (Supervision, Monitoring and Evaluation)

This involves coordination between centre and state and different sectors including private health sector and NGOs. Programme management is vital for success of elimination of KA. There is need to strengthen surveillance system for KA and PKDL including line listing of cases at village level to identify hotspot areas (villages reporting five or more cases in previous or current year), and update areas for microplanning for spray operations. Involve private sector to capture complete burden of diseases. Since the emergence of VL–HIV and TB co-infection is posing threat on achievements, surveillance of VL-HIV cases is important apart from early and long-term follow-up of KA and PKDL, cases (6 and 12 months, respectively) as well as information on relapses. Evaluation or validation of elimination will pave the way towards further reducing KA burden in the community.

Advocacy, Communication and Social Mobilization for Behavioural Impact and Intersectoral Convergence

Information on KA must be communicated to people in endemic areas to promote community participation for effective utilization of services provided under the programme. Interpersonal communication by health workers and available media/channels of communication including local channels should be used effectively and maximally.

Capacity Building

Continuing education/training of health volunteers (ASHAs) health workers, medical officers, and health managers and other stakeholders on newer strategies of KA elimination is essential to achieve the targets and goals of elimination apart from continuum of services.

DENGUE FEVER/DENGUE HAEMORRHAGIC FEVER

EPIDEMIOLOGY

Dengue has been identified as one of the 18 neglected tropical diseases (NTDs) by WHO. Dengue fever is an outbreak prone viral disease in many parts of the world and is re-emerging global health problem. Dengue fever is an acute febrile illness lasting 2–7 days, self-limiting but in few cases may progress to critical phase of plasma-leakage.

GLOBAL DISEASE BURDEN

According to World Health Organization (WHO), about 50–100 million new dengue infections are estimated to occur annually in more than 100 endemic countries. Almost half of world's population is living in 141 countries where dengue is endemic.

Indian National Scenario: Disease Burden

Dengue is endemic in 28 states and 9 UTs (except Lakshadeep). Every year during the period of July–November, there is an upsurge in the cases of dengue/DHF in northern parts of the country, howevers, in the southern and western parts of the country disease has become perennial. During 2017, a total of 188401 cases and 325 deaths were reported in India and in 2018 a total of 101192 cases and 172 deaths were reported. During 2019, a total of 157315 cases and 166 deaths were reported against 44585 cases and 56 deaths in 2020 and 60112 cases and 30 deaths in 2021 up to 30th September.

Case Fatality Ratio (CFR) in India

CFR which was 3.3% in 1996 has declined to 0.1% in 2021 because of better case management as per national guidelines.

Notification

Dengue is notifiable disease in 23 states, other states may follow soon.

Causative Organism

Dengue and DHF is caused by dengue virus which belongs to genus *Flavivirus*. There are four dengue virus serotypes which are designated as DENV-1, DENV-2, DENV-3 and DENV-4. These serotypes may be in circulation either singly or more than one in any area. Infection with any one serotype confers lifelong immunity.

Vector

Dengue viruses are transmitted from an infected person to others by the bite of female *Aedes* mosquito. In India *Ae. aegypti* is the main vector in most urban areas; however *Ae. albopictus* is also incrimated in many states.

Vector Bionomics

Breeding

Ae. aegypti breeds almost entirely in domestic man-made water receptacles found around households, water storage containers, water reservoirs, overhead tanks, desert coolers, unused tyres, coconut shells, disposable cups, industrial and domestic junk, construction sites, flower vases, broken bottles, earthen pots and all other receptacles with rain water or stored clean water stagnating for more than a week. The life cycle of *Ae. aegypti* is closely associated with the lifestyle of man; more so related with water storage practices in urban and rural areas.

Feeding Habits

Ae. aegypti is highly anthropophilic (bites human beings and prefers human blood meal). The female *Aedes* mosquito deposits eggs singly on damp surfaces just above the waterline. Under optimal conditions, the adult emerges in 7 days (after the aquatic stages in the life cycle of *Ae. aegypti*). The eggs can withstand desiccation (can remain viable in dry conditions) for more than a year and emerge within 24 hours once it comes in contact with water. This is thus a hurdle in prevention and control of dengue. The average survival of *Ae. aegypti* is 30 days and that of *Ae. albopictus* is about 8 weeks. *Aedes* is a daytime feeder and can fly up to limited distance of 400 metres. Adult rests in cool and shady places. It cannot survive below 16°C and above 41°C.

Transmission Cycle

The female *Ae. aegypti* usually becomes infected with the dengue virus when it takes a blood meal from a person during acute febrile (viraemia) phase of dengue illness. After an extrinsic incubation period of 8–10 days, the mosquito becomes infective. Dengue fever begins abruptly after an intrinsic incubation period of 4–7 days. The mosquito remains infective lifelong. There is also an evidence of vertical transmission of dengue virus from infected female mosquito to the next generation.

Seasonality

Peak incidence of DF is observed from July to November.

Urban Rural Distribution

The DF and DHF which was primarily confined to urban areas is no longer true. It is spreading fast to rural areas because of changing lifestyles in rural areas.

Re-emerging Threat

DF has been known to be endemic in India over two centuries as a benign and self-limiting disease. But in recent years the disease has changed its course and manifesting in severe forms as DHF and DSS.

NATIONAL MID-TERM PLAN FOR PREVENTION AND CONTROL OF DENGUE AND CHIKUNGUNYA (2011–13) AND BEYOND[10]

Objectives

- To reduce incidence of dengue and chikungunya to bring down disease burden.
- To reduce case fatality rate due to dengue.

The eight components (octologue) of mid-term plan were:

i. Surveillance—disease and entomological surveillance.
ii. Case management—laboratory diagnosis and clinical management.
iii. Integrated vector management—environmental management for source reduction, chemical control and personal protection and legislation.
iv. Outbreak response—epidemic preparedness and media management
v. Capacity building—training, strengthening human resources and operational research.
vi. Behaviour change communication—social mobilization and information education and communication (IEC) and community participation.
vii. Intersectoral coordination—health, urban and rural development, *Panchayati Raj* institutions, surface transport, education and water and sanitation.

viii Monitoring and supervision—analysis of reports, review, field visit and feedback.

Notification: DF is notifiable in 26 states/Uts.

Surveillance of dengue and chikungunya

a Syndromic surveillance under IDSP—fever of less than 7 days by all reporting units at subcentres, PHCs, CHC and district hospitals and sentinel surveillance hospitals.

b Sentinel surveillance hospitals—(serological surveillance) over 646 sentinel surveillance hospitals (SSHs) in the country undertake serological surveillance of dengue and chikungunya continuously. Laboratory facilities for diagnosis have been provided in SSHs and these sites are linked with 16 apex referral laboratories (ARLs). These SSHs generate data on trends and provide information on geographical spread and transmission and serotypes involved in transmission.[10, 11]

Lab surveillance kits supply: Antibody detection test IgM capture ELISA (MAC–ELISA) kits have been supplied to SSHs to detect infection on or after 5 days of onset of fever.

ELISA based antigen detection test (NS1) for diagnosis of cases from the first day to 5th day of fever.

Clinical criteria for DF/DHF/DSS and case definition are as under.

DENGUE CASE CLASSIFICATION AND MANAGEMENT CLINICAL CRITERIA FOR DF/DHF/DSS

Clinical Features of DF

An acute febrile illness of 2–7 days duration with two or more of the following manifestations: Headache, retro-orbital pain, myalgia, arthralgia, rash, haemorrhagic manifestations.

Dengue Haemorrhagic Fever (DHF)

a A case with clinical criteria of dengue fever

Plus

b Haemorrhagic tendencies evidenced by one or more of the following:
- 1 Positive tourniquet test
- 2 Petechiae, ecchymoses or purpura
- 3 Bleeding from mucosa, gastrointestinal tract, injection sites or other sites

Plus

c Thrombocytopenia (<1,00,000 cells per cumm)

Plus

d Evidence of plasma leakage due to increased vascular permeability, manifested by one or more of the following.
- 1 A rise in average haematocrit for age and sex 20%
- 2 A more than 20% drop in haematocrit following volume replacement treatment compared to baseline
- 3 Signs of plasma leakage (pleural effusion, ascites, hypoproteinemia)

Dengue Shock Syndrome (DSS)

All the above criteria for DHF with evidence of circulatory failure manifested by rapid and weak pulse and narrow pulse pressure (≤20% mm Hg) or hypotension for age, cold and clammy skin and restlessness.

Tourniquet test: The tourniquet test is performed by inflating a blood pressure cuff to a midpoint between the systolic and diastolic pressure and maintain for 5 minutes. The test is considered positive when 10 or more petechiae per one square inch area over forearm are observed. In DHF, the test usually gives a definite positive test with 20 petechiae or more. The test may be negative or only mildly positive during the phase of profound shock (DSS).

Case Definition

Probable DF/DHF

A case compatible with clinical description (clinical criteria) of dengue fever during outbreak.

OR

Non-ELISA based NS1 antigen/IgM positive.

(A positive test by RDT will be considered as probable due to poor sensitivity and specificity of currently available RDTs)

Confirmed Dengue Fever

A case compatible with the clinical description of dengue fever with at least one of the following.

- Isolation of the dengue virus (virus culture + VE) from serum, plasma, leucocytes.
- Demonstration of IgM antibody titre by ELISA positive in single serum sample.
- Demonstration of dengue virus antigen in serum sample by NS1-ELISA.
- IgG seroconversion in paired sera after 2 weeks with fourfold increase of IgG titre.
- Detection of viral nucleic acid by polymerase chain reaction (PCR).

Entomological Surveillance and Larval Indices

Vector surveillance should be regular, this helps in identifying areas for initiating control measures and assess impact. The larval indices used to determine the intensity of dengue vector are:

- ***House index:*** Percentage of houses positive for larvae or pupae of *Aedes aegypti*. House index provides information on extent of breeding.
- ***Breteau index (BI):*** Number of positive containers for *Aedes aegypti* larvae per 100 houses inspected. BI is used as yardstick for evaluation of control strategy.
- ***Container index:*** Percentage of water holding containers positive for *Aedes* breeding. It is mostly utilized for drawing vector control strategies. However,

a single water container found positive for *Aedes* breeding warrants for immediate action for source reduction.

- ***Adult landing/biting rate:*** *Aedes* mosquito can be collected on a human bait and landing rate/bait/hour is calculated. Adult collection in endemic areas is not envisaged as the adult may be infected with virus.

Epidemiological interpretation of various entomological indices

Entomological indices	*High-risk of transmission*	*Low-risk of transmission*
I Breteau index	>50	<5
II Larval house index	>10%	<1%
III Landing/biting rate	>2 per man hour	<2 per man hour

Case Management[11]

Management of dengue fever is symptomatic and supportive. There is no licensed vaccine available against dengue virus. Paracetamol is recommended to keep temperature below 39°C. ORS and adequate fluids should be given. Haematocrit should be monitored daily/frequently to detect plasma leakage. Simple DF can be managed at home. Management of DHF grades I and II with minor bleeds and DSS grades III and IV requires hospitalization and higher level of care.

Grading of DF/DHF

DF: Fever of 2–7 days with two or more of following headache, retro-orbital pain, myalgia, arthralgia with or without leukopenia, thrombocytopenia and no evidence of plasma leakage.

DHF I: Above criteria plus positive tourniquet test and evidence of plasma leakage. Thrombocytopenia with platelet count less than 100000/cu. mm and Hct rise more than 20% over baseline.

DHF II: Above plus some evidence of spontaneous bleeding in skin or other organs (black tarry stool, epistaxis, gum bleeds) and abdominal pain. Thrombocytopenia with platelet count less than 100000/cu.mm and Hct rise more than 20% over baseline.

DHF III (DSS): Above plus circulatory failure (weak pulse narrow pulse pressure <20 mm Hg, hypotension, cold clammy skin, restlessness). Thrombocytopaenia with platelet count less than 100000/cu. mm and Hct rise more than 20% over baseline.

DHF IV (DSS): Profound shock with undetectable blood pressure or pulse. Thrombocytopenia with platelet count less than 100000/cu. mm and Hct rise more than 20% over baseline.

Integrated Vector Control Measures

a. **Source reduction:** It means eliminate breeding places of aedes mosquitoes in and around household by people themselves. It is a real prevention. This can be achieved by effective solid waste management and by improving water/waste water management practices at household and community level.

b. **By chemical methods**—use of insecticide as mentioned below under outbreak response.

c. **Personal protective measures:** Avoid contact with mosquitoes by wearing full sleeves shirt, full trousers and stocking, use of insecticide treated nets for infants and young children, use of mats, coils, aerosols and repellents.

d. **Legislation:** Observe municipal by laws and regulations for water and solid waste management. Educating people and behaviour change communication are more important than legislative measures which are difficult to enforce on long-term basis.

Outbreak Response and Media Management

Dengue fever and chikungunya outbreaks evolve rapidly; requiring emergency control measures in order to interrupt transmission and to reduce or eliminate breeding sites of *Aedes* mosquitoes. Households, schools and community must participate. Two major components of outbreak response are:

a Early diagnosis of outbreak and case management to prevent dengue deaths—case management at home and in hospitals (for DHF and DSS).

b Emergency vector control measures to curtail transmission of dengue/chikungunya by:

i Constitution of rapid response teams

ii Investigation of outbreak and control measures.

Vector Control during Outbreak/Epidemic

Adult mosquitoes can be controlled by use of chemical insecticides. It should be emphasized, however, that rapid and effective source reduction or elimination of breeding sites of vector mosquitoes will achieve the results, moreover larval control is more economical and provides sustainable control by eliminating the source of newly emergent adult mosquitoes. Chemical space spray are not effective in most of the conditions and it is rare that an epidemic will be controlled by using these methods. Because of their visibility, however, people think that government is doing something.

Indoor residual spray (IRS) is generally not very effective against *Aedes aegypti* because of their habit of resting on unsprayed objects such as clothes curtains and other hanging fabrics rather than on walls and ceilings.

Space Sprays

a. Indoor Space Spraying

Insecticidal aerosols are used to kill adult mosquitoes during outbreaks. For indoor space spraying 2% pyrethrum after dilution with kerosene (1:19) is sprayed with flit pump

or hand operated fogging machine on weekly basis. Pyrethrum is non-toxic to human beings.

Outdoor Space Spraying

i Ultra low volume (ULV): Cold fog with technical malathion
ii Thermal togging with malathion or pyrethrum.

Larval Source Control Measures

These measures include—solid waste management, removal, disposal or burrying of all unused tins, cans, jars bottles, tyres, coconut shells and emptying desert cooless once a week, mosquito proofing of overhead tanks and underground reservoirs will prevent breeding.

Capacity Building

Training in-laboratory techniques MAC-ELISA and NS1, diagnosis and case management by using standard national guidelines, vector surveillance of dengue and chikungunya disease and outbreak response should be actively pursued.

Behaviour Change Communication

IEC activities for community sensitization and participation for source reduction and adopting personal protective measures by use of mass media and other communication channels is critical in outbreak situation and long-term sustainable measures.

Intersectoral Coordination

Various sectors such as health, water and sanitation, local bodies and PRIs, Builders and construction lobbies, town planning and administrative authorities should coordinate to control outbreak and prevent occurrence of outbreaks in the long run.

Monitoring and Evaluation

Monitoring of disease and vector surveillance indicators, trends, distribution and spread through routine reports of IDSP and special studies are helpful in programme management. These indicators must be shared with people and other sectors as mentioned above for effective control measures.

CHIKUNGUNYA FEVER

EPIDEMIOLOGY

Chikungunya is a debilitant non-fatal acute viral disease presenting with acute fever associated with severe arthralgia/arthritis (painful and stiff joints), followed by other constitutional symptoms and rash, lasting for a period of 1–7 days. The usual incubation period is very short, i.e. 2–3 days. Fever rises suddenly and often reaches 39–40°C.

CAUSATIVE ORGANISM

Chikungunya fever is caused by *chikungunya virus* which is a group IV (+) (RNA) virus belonging to family Togaviridae with genus *Alphavirus* and species *Chikungunya*.

Transmission

Chikungunya virus is transmitted to humans through the bite of an infected *Aedes aegypti* mosquito.

In **Africa** CHIK virus is transmitted by *Aedes* mosquito (*Aedes africanus*, *Aedes luteocephalus*; *Aedes opok* and *Aedes furcifer, Aedes taylori*, *Aedes cordillieri*). In Africa, the non-human primates (vertebrates) such as cercopithecus, monkeys or baboons amplify and maintain virus circulation in natural cycle and ensure survival of virus and local spillover into human population by mosquito.

Asia: Transmission in Asia follows different pattern. It is primarily transmitted from human to human by infected *Aedes aegypti* and monkeys have a little role in amplification of the virus.

CHIK activity has been reported in Thailand since 1958, with outbreaks in 1962 and 1980.

Epidemiology

Global

The outbreak of CHIK was reported in Port Klang in Malaysia in 1999, in 2005–06 in La Reunion, 2,04,000 people may have been infected by chikungunya virus since March 2005. Since Jan 2006, other countries in South West Indian Ocean (Mayotee, Mauritius and Seychelles) have reported chikungunya cases.

India

Chikungunya outbreaks in India have been reported since 1963. Outbreaks typically result in a large number of cases but deaths are rarely encountered. After a silent period of about three decades, outbreaks of chikungunya started in Andhra Pradesh in 2005 as also in Maharashtra and Karnataka. During the year 2006, over 1.39 million suspected fever cases of chikungunya and 2001 confirmed cases were reported and similarly 59,535 suspected fever cases of chikungunya and 1876 confirmed cases were reported in 16 states and UTs (AP, Karnataka, Maharashtra, Tamil Nadu, MP, Gujarat, A and N Islands, Delhi, Rajasthan, Puducherry, Goa, Odisha, West Bengal, Lakshadweep, Uttar Pradesh and Haryana) in 2007.

During the year 2008 about 95,091 suspected cases and 2425 confirmed cases were reported. During the year 2009 around 73,288 suspected cases were reported. Similarly, 48,176 cases in year 2010 and 20,402 cases in 2011 were reported. Over 57,000 cases were reported in 2018. During 2019 a total of 81,914 suspected cases were reported against 43,424 suspected cases in 2020 and 58,151 cases in 2021 up to September.

Chikungunya fever is usually self-limiting disease resolving with time and requires supportive treatment. There is no specific treatment or vaccine.

Diagnosis

Confirmatory diagnosis comes through laboratory tests. Chikungunya fever should be suspected when epidemic disease occurs with characteristic *triad* of *fever*, rash and *rheumatic manifestations*.

Case Definition

Suspect Case

An acute illness characterized by sudden onset of fever with joint pain, headache, backache, photophobia, arthralgia and rash.

Probable Case

As above and positive serology.

Confirmed Case

A probable case with any of the following.

- Fourfold HI antibody difference in paired serum samples.
- Detection of IgM antibodies.
- Virus isolation from serum.
- Detection of chikungunya virus in sera by RT-PCR.

Under NVBDCP IgM capture ELISA is being used for diagnosis.

For serology: Acute sample—collected up to 5 days after the onset of illness. Convalescent or paired sample should be collected 10–14 days after the first sample.

For isolation of the virus and RT-PCR, samples should be collected within first 5 days of illness. These should immediately be transported (within 48 hours) to the referral laboratory in cold (preferably frozen) chain system.

Prevention and Control

1. Vector control by elimination of breeding sites or source reduction is the best control method. *Aedes aegypti* is container mosquito and breeds in receptacles and containers having water.
   - All water tanks, cisterns, barrels, trash containers, etc. need to be covered tightly with a lid.
   - Remove or empty water in old tyres, tin cans, buckets, drums, coolers, bottles or from other places where mosquitoes breed.
2. Use of insecticide treated mosquito curtains/nets be advocated to avoid mosquito bites.
3. Insecticide spray should be done to kill mosquitoes. Fogging operation is recommended with 2% pyrethrum diluted with kerosene in the ratio of 1:19, space spray during outbreaks/epidemics or in high-risk villages/wards.
4. Epidemiological and entomological surveillance is helpful in early recognition and response as elaborated under dengue surveillance.
5. Education of people by media and by interpersonal communication.

JAPANESE ENCEPHALITIS (JE)—ACUTE ENCEPHALITIS SYNDROME (AES)

EPIDEMIOLOGY

Japanese encephalitis (JE) is a mosquito borne zoonotic viral disease of public health importance because of its epidemic potential and high case fatality rate of 25% and disability in survivals. In children who survive may suffer from neurological sequelae—physical and mental impairment. The children suffer highest attack rate. The JE virus affects central nervous system.

Global Distribution

First discovered in 1924 in Japan as Japanese B encephalitis and now it is called JE. It is worldwide distributed in Nepal, Bangladesh, Bhutan, China, Republic of Korea, Pakistan, Sri Lanka and Thailand.

Indian Scenario

It is endemic in 336 districts of 24 States/UTs. The states of Assam, Bihar, UP, Tamil Nadu and West Bengal are worst affected states as these states report 50–80% of cases. The disease is spreading to new districts. Over 375 million population in these states is at risk of JE. Epidemics are reported most often from UP and other northern states. Worst outbreak occurred in UP in 1986 when 7500 cases and 2627 deaths were reported. Thereafter in the year 2005 more than 6000 cases and 1500 deaths were reported. Over 11,651 cases and 1301 deaths were reported in the year 2016 in India. In 2017 reported incidence was 13,635 cases and 1097 deaths and in 2018 incidence of 11,388 cases and 636 deaths. In 2019 over 13,000 cases and 700 deaths were reported due to AES in India. During the year 2020 in India 5487 cases and 248 deaths due to AES were reported. Outbreaks are common in areas where there is close interaction between pigs/birds and human beings.

Causative Organism

It is caused by JE virus which belongs to genus Flavivirus within the same genus are also present dengue virus, KFD, Yellow fever and West Nile virus.

Reservoir and Transmission Cycles

Primarily the JE virus circulates and multiples in pigs and birds. In nature the virus of JE is maintained in birds, pigs and other animals. Pigs are major vertebrate hosts of JE.

Pig to pig cycle is maintained by *Culex vishnui* group of mosquitoes. Pigs develop viraemia but do not manifest any sign and symptoms. Pigs and birds act as amplifying host in the transmission cycle.

Birds cycle: *Ardeola gravii* (pond heron) and *Bubulcus ibis* (cattle egret) play definite role in maintenance of virus in nature.

Cycle: Pig ⇄ Pig ⇆ Birds
↓
Man

If the JE infection occurs first time in an area all the age groups are affected.

Rural Urban Distribution

In India most of the cases and outbreaks—over 90% occur in rural areas. These outbreaks have been associated with monsoon and paddy cultivation and piggaries close to households. The disease shows a scattered distribution of 1–2 cases reported per village. However, JE/AES cases have also been reported from some urban areas as well. For each clinical case in community there are 250 to 1000 inapparent infections. The cases of JE represent tip of the iceberg.

Trigger level: For JE is two cases of fever with altered consciousness/seizures in a village of 1000 population.

Man: Man is involved in the cycle incidently when mosquito density increases after rains and floods, the virus is transmitted from pigs to man by *Culex vishnui* group of mosquitoes.

Vector: *Culex vishnui* group of mosquitoes (*Culex tritaeniorhynchus*) are most important in transmission of JE virus from pigs to man. Man to man transmission is unknown, hence **man is the dead end of transmission** of **JE**. The vector is exophilic (outdoor resting habits after blood meal), hence indoor residual spray (IRS) not helpful. Vector breeds profusely in paddy fields and polluted water.

Incubation period in man is 5–14 days. The extrinsic incubation period in mosquito is 9–12 days.

Age and Sex and Case Fatality Rate

JE affects vast majority of children below 15 years of age. Case fatality rate (CFR) in children is very high at 25%, i.e. 25% of affected children die. Those children who survive, 30–40% develop neurological sequelae like mental impairment personality changes and paralysis.

NATIONAL PROGRAMME FOR PREVENTION AND CONTROL OF JAPANESE ENCEPHALITIS/ ACUTE ENCEPHALITIS SYNDROME (AES)[12]

In view of the evidence of the enteroviral and other non-JE viruses circulating in the endemic areas of Eastern Uttar Pradesh and occurrence of cases of JE round the year, the Government of India, on the recommendations of group of ministers, launched national programme for prevention and control of JE/AES in 2014. The national programme of JE covers 60 high priority districts in the states of Assam Bihar, Uttar Pradesh, West Bengal and Tamil Nadu.

Goal

The goal of the programme is to reduce morbidity, mortality and disability in children due to JE/AES.

Objectives

i To strengthen and expand the programme of JE vaccination in affected districts.

ii To strengthen surveillance, vector control, case management and timely referral of serious and complicated cases.

iii To increase access to safe drinking water and sanitation in rural areas and some urban areas.

iv To estimate disability burden due to JE/AES and to provide for adequate facilities for physical, medical, neurological and social rehabilitation.

v To improve nutritional status of children at risk of JE/AES.

vi To carry out intensive IEC/BCC activities.

Strategies or Interventions

Convergence of Ministries

Convergence of different ministries at various levels is the core strategy for prevention and control of JE/AES. Nodal Ministry or Department Health and Family Welfare is responsible for expansion of JE vaccine, case management, surveillance, monitoring and evaluation besides IEC and behaviour change communication activities and physical rehabilitation.

Ministry of drinking water and sanitation for provision of safe drinking water and sanitation in rural areas, in view of risk of transmission of AES through contaminated water by enteroviruses, Ministry of Housing and Urban Poverty Alleviation for safe water and sanitation in urban slums, Ministry of Social Justice and Empowerment for establishing departments of physical and medical rehabilitation in medical colleges and district rehabilitation centres for disabled and Ministry of Human Resource Development for arranging special facilities for education of disabled and Ministry of Women and Child Development for improvement of nutritional status of children in affected areas through ICDS programme. Thus multipronged strategy for prevention and control of JE/AES has been evolved and it is a big challenge to coordinate all the activities at ground level implementation.

Strengthening and Expansion of JE Vaccine Programme

JE vaccine (SA–14–14–2) for all children 1–15 years of age in one time campaign mode, in endemic areas was launched in 2006 and completed in 297 districts. After that JE vaccine became part of universal immunization programme. Now all young children get two doses of JE vaccine first dose at 9 months and second at the age of 16–24 months under routine immunization programme, since 2013. The programme has been expanded to cover 336 districts of endemic areas of JE.

Adult JE vaccination: All adults between 15–65 years of age get one dose of JE vaccine in selected 31 high burden districts of JE, in 3 states of Assam, UP and West Bengal, to knock out susceptible cohort.

Strengthening Public Health Activities

Additional resources in terms of manpower and material have been provided to endemic states, for containment of JE/AES.

District model action plans have been developed for community based surveillance, entomological surveillance, vector control and IEC/BCC activities.

JE/AES Surveillance

The purpose of JE surveillance is early detection of outbreaks, estimate disease burden, geographical spread, disease pattern, incidence and trends over the years for prevention and control of JE as also programme evaluation.

Surveillance Mechanism

For surveillance purpose JE is commonly reported under the heading of 'acute encephalitis syndrome (AES)'. Under WHO's guidelines for JE surveillance syndromic surveillance for JE is recommended. This means all cases of AES should be reported. The following case definition should be used for reporting of suspected JE cases in endemic areas.

Case Definition of Suspected Case

- "Acute onset of fever, not more than 5–7 days duration,
- Change in mental status with or without
  - New onset of seizures (excluding febrile seizures)"
  - Other early clinical findings may include irritability, somnolence or abnormal behaviour greater than that seen with usual febrile illness.

Important

- In an endemic situation fever with altered sensorium persisting for more than 2 hours with a focal seizure or paralysis of any part of body is encephalitis
- Presence of rash on body excludes JE
- AES with symmetrical signs and fever is likely to be cerebral malaria

Laboratory confirmation of suspected cases can be done where feasible, e.g. at SSSL at district level.

Surveillance Mechanism

a Sentinel surveillance sites with laboratory services at district level (SSSL)
b Sentinel surveillance sites (SSS) without laboratory services—linked to laboratory services.
c Informer unit (IU)—smaller health facilities or private practitioners.
d Routine reports of IDSP—for syndromic surveillance of JE.

All cases that are notified should be verified and investigated by designated surveillance medical officer/epidemiologist within 48 hours of notification to confirm that case meets case definition and collect serum or CSF for lab test.

JE Outbreak Investigations and Management

Surveillance data analysis gives information for predicting outbreaks of JE. Rapid response teams should start immediate containment measures after investigations. Control measures include—vector control by malathion fogging in the affected village, use bednets and other personal protective measures and effective case management and education of community.

Better Clinical Management of JE/AES Cases

As there is no specific treatment, JE patients require more supportive therapy such as feeding, maintain airways, anticonvulsants for seizure control and management of intracranial pressure which requires close monitoring. Under the programme 10 bedded 44 paediatric intensive care units (PICUs) have been made functional at district hospitals of 60 priority districts for management of critical cases. All community members, health staff and ASHAs can recognize danger signs and can refer such children to nearby PICU/district hospital for effective management, early recovery and prevention of deaths.

Vector Control

JE vectors are exophilic (outdoor resting habits after blood meal) and endophagic in nature. The risk of transmission increases when the human dwellings and animal sheds particularly piggeries are situated very close to each other. Because of outdoor resting habits of vector using indoor residual spray is technically not appropriate. Due to vast and enormous breeding habitats like perennial ponds, paddy fields and other water bodies, larval control using various anti-larval measures is not feasible as it is resource intensive. Therefore, vector control using ultra low volume (ULV) fogging with malathion/pyrethrum is the only

method for vector control and can be used during JE epidemics also.

Setting up of Department of Physical Medicine and Rehabilitation (PMR) at Medical Colleges and Disability Centres at District Level

In view of residual neurological sequelae in 30–40% of children who recover from JE/AES, there is 'felt need' of rehabilitation centres for assessment and management of disabilities/impairments. Departments of PMR in 10 medical colleges have been set up in endemic areas of five high burden states besides district disability rehabilitation centres in 60 districts. District counselling centres have also been set up in endemic areas.

Information Education and Communication and Behaviour Change Communication

The prime objective of IEC is to inform and educate people on all aspects of JE to increase demand for available services under JE and utilization of these services promptly. The second objective is to enhance community participation in all the programme components and interventions by using multimedia channels of communication.

Monitoring Supervision and Coordination

Monitoring reports are collected on daily basis during outbreaks/epidemic, weakly basis during transmission period and once a month during the inter-epidemic period. Based on the monitoring indicators, feedback and corrective action are ensured at various levels to reduce morbidity, mortality and disability due to JE.

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KYASANUR FOREST DISEASE (KFD)

EPIDEMIOLOGY

Prevalence/Incidence and Geographical Distribution of KFD

The KFD is geographically confined to a few districts of Karnataka state in India. The affected districts are Chickmaglur, Dakshin Kannada, Shimoga, Uttar Kanada and Udupi Distt. Shimoga and Chickmaglur are worst affected. The worst year was 1983 when 2167 cases and 148 deaths were reported and since then the KFD is endemic in the state of Karnataka forest area.

KFD is a tick-borne infection and is localized to Karnataka only. KFD is now reported from adjoining states of Tamil Nadu, Maharashtra and Goa. Monkeys are recognized as amplifying hosts for KFD but monkeys die of KFD infection and cannot maintain virus in nature. Man is affected incidentally by tick bites in the forest area. Man is the dead end host of KFD. Severe infections may cause violent headache, high fever, nausea, coma and death.

Prevention: No specific treatment is available. Prevention requires avoidance fields and forests infested with ticks, use of repellents, use of impregnated clothing and removal of attached ticks.[1]

YELLOW FEVER

EPIDEMIOLOGY[2–4]

Yellow fever is an acute, viral infectious disease of short duration and varying severity, transmitted between humans by infected mosquitoes.

Distribution

The disease affects people of all ages and occurs in tropical areas, mainly in sub-Saharan Africa and Central and South

America. No case has been reported in Asia including India, although the mosquito vector is found in India.

Problem

An estimated 2,00,000 yellow fever cases with 30,000 deaths occur each year, almost all in sub-Saharan Africa and America. Over 508 million people in 46 countries are at risk of infection in these areas (33 African and 13 in South Central America Region).

Transmission

Yellow fever is primarily disease of monkeys and it maintains three cycles in nature.

1 ***Sylvatic or jungle cycle:*** The yellow fever virus mainly occurs in population of monkeys in dense forests and gallery forests in Africa and South and Central America. It is transmitted from monkey-to-monkey by forest dwelling mosquitoes (*Aedes* species in Africa, Haemagogus and Sabethes in South and Central Africa). Jungle or Sylvan yellow fever is enzootic in Africa.

2 ***Rural cycle:*** These mosquitoes occasionally bite humans when they enter forests and may thus transmit the virus from monkey reservoir to the human population. In Africa monkeys sometimes in jungle leave the forest in search of banana plantations and may then infect the local species which in turn infect humans living or working on plantations.

3 ***Urban cycle:*** People infected in or near forests can carry the virus to rural or urban areas where *Aedes aegypti* or related mosquitoes can pick it up and transmit it among the human population. Such situation can result in serious epidemics and many deaths. Man-to-man cycle in urban and rural areas is maintained by *Aedes aegypti* mosquitoes.

In America, urban outbreaks used to be very severe but have not occurred since 1954. However, the risk remains and cases are reported each year among people working in forests. In Africa, urban and rural outbreaks are occasionally reported from areas near forests and may cause thousands of deaths. People working in forests also become infected regularly. Urban yellow fever outbreaks are still reported from Africa.

Occurrence

It is endemic disease in Africa, South and Central America and it can occur in epidemic proportion in these areas.

Endemic zone in Africa: Angola, Zambia, Tanzania, Zaire, Rwanda, Burundi, Kenya, Somalia, Ethiopia, Sudan (part) Central African Republic, Congo, Cameroon, Equatorial Guinea, Nigeria, Sao Tome and Principe. Togo Benin, Ghana, Burkina Faso, Liberia, Sierra Lone, Guinea Bissau, Senegal, Gambia, Côtd'Ivoire, Mali (part) Niger (part), Liberia, and Chad (part).

Endemic zone in South and Central America: Brazil, Bolivia, Peru, Equador, Colombia, Panama, Venezuella, Guyana, Suriname, and French Guana.

Case Fatality

The case fatality rate in endemic region is under 5% but, may reach 50% among non-indigenous groups. *Aedes aegypti* mosquitoes transmit yellow fever in urban and certain rural areas and other Aedes mosquitoes transmit the infection from monkey to man in Africa. In the forest of South America, transmission is by Haemagogus mosquitoes. The blood of patient is infective for mosquitoes before the onset of fever and for the first 3–5 days of illness. It is highly communicable where many susceptible persons and abundant vector mosquitoes coexist.

There is evidence in some areas of endemicity that the virus is maintained in mosquitoes population through transovarial transmission in the absence of vertebrate reservoir.

Incubation period: It is 3–6 days.

Clinical Features

Many infections are mild. Typical attacks have a sudden onset with fever, headache, backache, prostration, nausea and vomiting. As the disease progresses, the pulse weakens and albuminuria and anuria may occur. Haemorrhage and jaundice follow the period of fever and vomiting.

In 15% of patients it can lead to shock (bleeding from mouth, nose, eyes and/or stomach), and kidneys and liver failure. Persons recovering from yellow fever have lifelong immunity against reinfection.

There is no specific drug treatment effective against the yellow fever virus, but with supportive care most patients can survive.

Epidemic can be controlled by vaccinating all persons living in affected areas, by space spraying with insecticides against adult mosquitoes and by appropriate larval control measures. Non-immunized person can reduce the risk of infection by protecting themselves from mosquito bite with protective clothing, repellents and screens to prevent day time biting.

Prevention and Control

Surveillance: Yellow fever is international notifiable disease by WHO hence, regular surveillance helps to keep a track and control this disease by controlling environments.

Vector surveillance: Vector surveillance is being done to keep the vector density low (*Aedes aegypti* index being kept below 1). Ships and aircrafts coming from endemic areas are made free of mosquitoes by appropriate measures.

Valid vaccine certificate: As per international health regulations, yellow fever vaccine certificate is mandatory for persons coming from endemic areas to India or other areas where disease is absent. Similarly, persons going from

India or areas free of yellow fever to endemic areas should have valid yellow fever vaccination certificate.

Prevention

Yellow fever is best prevented by immunization which is recommended for all persons working in or visiting forests where yellow fever occurs. Immunization is also indicated for people in urban or rural areas at risk.

Vaccination

Yellow fever vaccine is a live attenuated virus vaccine which contains the viable attenuated yellow fever 17D strain virus. Adults and children 6 months of age and older can be vaccinated against yellow fever in endemic areas. A single dose by subcutaneous route confers immunity for 10 long years. The validity of vaccination starts after 10 days of primary vaccination and on the day of booster. It is valid for 10 years.

Dose: A single dose of 0.5 ml, for all ages confers immunity after 7 days of administration. Yellow fever vaccine has very high efficacy, the antibodies may persist for 30–35 years but revaccination within 10 years is still required by the international health regulations for travel to and fro endemic areas.

Storage: 0°+8°C. Long-term storage should preferably be at –15° to –25°C.

Contraindication: It is contraindicated in infants below 4 months and pregnant women. If pregnant women must travel to areas where the risk of yellow fever is high, vaccination should be given after 6 months of pregnancy.

Quarantine: If a person entering the receptive area without valid vaccine certificate or before the vaccine certificate becomes valid, that person is a 'suspect' and is quarantined for 6 days under mosquito free conditions and his movements are restricted.

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WATERBORNE DISEASES (WBD)

8

Waterborne diseases are dirty water diseases, those caused by water that has been contaminated by humans, animals and chemical wastes.

EPIDEMIOLOGY OF DIARRHEAL DISEASES

Acute watery diarrhoea is a killer disease in young children. The diarrhoea is a preventable disease.

Definition

Diarrhoea is passage of loose, liquid or watery stools (stool has more water than faecal matter). In many regions, acute watery diarrhoea is defined as passage of three or more loose watery stools in 24 hours with or without dehydration. However, it is the recent change in consistency and character of stools rather than the number of stools is more important. Passage of even one watery stool in young child constitutes diarrhoea. Mother knows best what is normal or abnormal stool for her child. The normally frequent or semi-solid stool of a breastfed baby is not diarrhoea.

Epidemiology of Acute Watery Diarrhoea

What Causes Diarrhoea?

One-third to half of acute watery diarrhoeas are caused by bacteria, one-third are due to viruses and in remaining the causative organisms cannot be pin-pointed. In India most acute watery diarrhoeas in children are caused by Rotavirus and Enterotoxigenic *Escherichia coli*. Shigellae group of organisms invade mucosal cell of intestine and cause necrosis resulting in passage of blood and mucus in stool (dysentery).

E. coli produce enterotoxins which causes increased secretions of small intestine without any apparent damage to mucosal cells.

Dehydration

Acute watery diarrhoea leads to excess loss of water and electrolytes from the body, i.e. dehydration, which may become severe and cause death in young children.

Age group affected: Infant and young children are most affected. Diarrhoea is a major disease in young children and caused 6.4% of deaths in under five children in India killing 62000 children per annum in 2015–17 (Fig. 8.12). However, diarrhoea kills 13.9% of 1–4 years children per annum (Fig. 8.11)

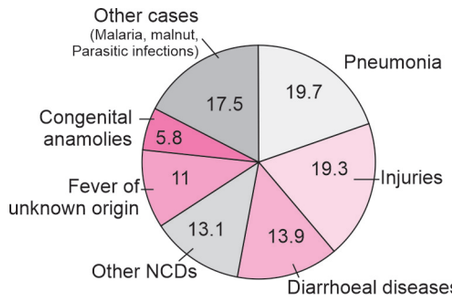


Fig. 8.11: Major causes of death for age 1–4 years (in %) in India: 2015–17 (SRS)

Risk Factors

Bottle-feeding, unclean hands, unsafe water, contaminated food, open defection, malnutrition in young children, low birth weight babies are the major risk factors in diarrhoea.

Distribution

Diarrhoea is widespread mostly in rural and urban slum areas with poor sanitation.

Common Beliefs and Practices[1,2]

People may have wrong beliefs and misconceptions and harmful practices in relation to diarrhoea such as bottle feeding, stopping feeding during diarrhoea, imposing dietary restrictions, use of injections and antibiotics, associating diarrhoeas with teething, heat or change in seasons, heavy and light foods. As many as 80% of practitioners who know that antibiotics are harmful yet 80% of them prescribe antibiotics in acute watery diarrhoeas. Practice or use of ORS is limited to 54% and yet to become universal.

Magnitude of Problem

Nearly 7% of under 5 children experienced diarrhoea in 2 weeks preceding survey (NFHS-5). Childhood diarrhoeal diseases continue to be major killer among under-five children in many states contributing 12% of under-five deaths in India. Over 13 million cases of acute diarrhoeal diseases are being reported every year in India (NHP 2018, 2019). Reported incidence decreased to 7.2 million in 2020 with 1606 deaths. A child under 5 years may experience 1–6 episodes of diarrhoea per year, each episode lasting reported for 3–7 days.

Diarrhoea A Killer Disease in Young Children

Young children between 6 and 12 months of age are affected severely with diarrhoea and account for high mortality as compared to older children and adults. Diarrhoea kills 62000 children every year (reported deaths) due to dehydration (loss of water and electrolytes from body—sodium chloride, potassium and carbonates). Most diarrhoeas—90% show no signs of dehydration, 10% of them show some dehydration and 1% may develop severe dehydration.

Classification of Diarrhoea

It is done on the basis of clinical syndromes. Diarrhoea is classified as follows:

Acute watery diarrhoea

Acute watery diarrhoea starts suddenly and is characterized by passage of loose watery stools, more of water and less of faecal matter.

Dysentery

This is diarrhoea with visible blood and mucus in the faeces. Shigellae group of organisms produce dysentery.

Persistent diarrhoea (PD)

Acute episode of watery diarrhoea or dysentery which lasts for more than 14 days is classified as persistent diarrhoea.

What is Oral Rehydration Therapy (ORT)?

ORT is the core of management of diarrhoea and is life saving. The term ORT includes:

- Oral rehydration salts solution (low osmolarity ORS as per WHO formula)
- Solution made from sugar and salt (SSS)
- Food-based solutions
- Home available fluids together with food (breastfeeding and normal feeding).

Other Oral Rehydration Therapy

i. Sugar salt solution

A mixture of sugar (sucrose) 40 g and 4 g of salt (sodium chloride) in one litre of water makes an excellent oral rehydration solution and effective replacement when ORS is not available. Mother can herself prepare this solution at home as and when diarrhoea strikes.

ii. Food-based solution

Time-tested home available food-based solutions are rice water, or rice conjee with salt, dal, or dal water with salt, butter milk with salt and some soups with salt. They are physiological sound as they contain acceptable concentration of starch and sodium.

iii. Home available fluids

Plain water, lemon water, soups and coconut water. These fluids are effective only in the presence of continued feeding which provides starch (ultimately glucose) and protein (ultimately amino acids) to promote absorption of sodium from gut. These fluids together with food provide ORT.

Oral Rehydration Salt (ORS): Reduced Osmolarity ORS[3]

ORS prevents and treats dehydration from diarrhoea irrespective of cause or age group affected. It is a balanced and the best mixture of glucose and electrolytes for use in treating and preventing dehydration, potassium depletion and base deficit due to diarrhoea. Glucose in ORS helps in transporting sodium and water across the intestinal membrane during diarrhoea. Glucose thus promotes/increases the absorption of sodium and water from the intestine.

Table 8.15: Composition of reduced osmolarity ORS*

Ingredient	*Weight (g)*
Sodium chloride	2.6
Glucose-anhydrous	13.5
Potassium chloride	1.5
Trisodium citrate, dihydrate	2.9

*To be used in one litre of potable water

Basis of ORS and Mechanism of Action

In most diarrhoeas, the absorptive capacity of gut is retained and nutrients such as glucose, amino acids and dipeptides tend to be absorbed in majority of cases. As glucose is absorbed in the gut, sodium is carried along and also gets absorbed, even though it is being actively lost in secretory diarrhoea due to the effect of enterotoxins. ORS helps absorption of glucose and sodium. Sodium also promotes absorption of water. This is the physiological basis of oral rehydration therapy.

The ORS packet supplied under the national programme has a light blue colour and has the national LOGO. If ORS from other sources are used, the packet should be checked to confirm that it has the right composition. Packets with a high glucose content (more than 20 g per litre), should not be used as these can lead to osmotic diarrhoea and worsen the condition of child. Packets containing colouring and sweetening agents like saccharine should also not be used.

Reduced osmolarity ORS with sodium 75, chloride 65, glucose anhydrous 75, potassium 20, citrate 10 mmol/litre with total osmolarity of 245 mmol/litre has been recommended by **WHO, UNICEF,** IAP and MOH and FW as universal ORS solution. This solution has improved efficacy for treatment of children with acute non-cholera diarrhoea (Table 8.15).

Classification of Dehydration

Deaths in acute diarrhoeal diseases are due to dehydration, i.e. loss of water and electrolytes—sodium chloride. potassium and bicarbonates. The dehydration can be assessed and classified as per Table 8.16:

i No dehydration
ii Some dehydration
iii Severe dehydration

Oral rehydration therapy is the core of management of acute watery diarrhoeas.

Management of Dehydration[4]

Diarrhoea with: No dehydration—90% cases.

A1. Treatment Plan A: Prevention of Dehydration—Treat Diarrhoea at Home

Policy guidelines: Children with diarrhoea with **no physical signs of dehydration** when brought to health facility by mother/caregivers should be educated at ORS corner/station to give ORS for replacement of ongoing losses to prevent dehydration (Table 8.17). Also use increased amount of culturally acceptable home available fluids (HAF). Show the mother how to mix ORS and how much ORS after each stool and give her enough ORS packets for 2 days. Such children can be managed at **home**. Home management principles are:

i Give extra fluids: As much as the child can take.
- Breastfeed frequently
- Give home available fluids

ii Continue feeding: Do not stop feeding. Continue breastfeeding and normal feeding—rice and dal porridge—*khichri*, wheat porridge are good foods.

iii Give zinc supplements: While ORS is the mainstay of therapy during acute diarrhoea, zinc is an adjunct to ORS, has an additional advantage in reducing duration and severity of diarrhoea.[5]

Table 8.16: Assessing severity of dehydration

Signs	*Classification of dehydration*	*Treatment plan*
Not enough signs to classify as some or severe dehydration	*No dehydration*	**Plan A**
Two of the following signs: • Restless, irritable • Drinks eagerly—thirsty • Sunken eye • Skin pinch goes back slowly	*Some dehydration*	**Plan B**
• Lethargic or unconscious • Unable to drink or drinking poorly • Sunken eye • Skin pinch goes back very slowly	*Severe dehydration*	**Plan C**

Table 8.17: Plan A ORS for prevention of dehydration*

Age	*Amount of ORS to be given after each liquid stool*	*Amount of ORS to provide for use at home*
• 2 month up to 24 months	50–100 ml	Give two packets of ORS to use at home
• 2 years up to 10 years	100–200 ml	
• 10 years or more	As much as wanted	

*ORS is appropriate for both prevention and treatment of dehydration if child is less than 6 months age breast feed frequently and longer plus ORS 5 tea spoons after each loose stool.

- 10 mg per day for children 2 months to 6 months and
- 20 mg per day for children 6 months and older for 14 days.

iv **When to return to facility:** Mother should report back to nearby health facility if the child does not get better in 5 days or immediately if the child develops any danger signs such as many watery stools, repeated vomiting, marked thirst, eating or drinking poorly, fever and blood in stool.

A2. Provision of Normal Daily Fluid Requirement

Normal daily fluid requirement should be continued, i.e. breastfeeding, milk—full strength animal milk or other fluids consumed by child and plain water should be continued, offer semisolid foods at frequent interval.

Treatment Plan B (Table 8.18)

For cases with physical signs of dehydration—start rehydration therapy.

Some Dehydration

Rehydration therapy

All cases with obvious signs of dehydration need to be treated by trained health workers (AWW/ASHA/ANM) or CHO trained in IMNCI or at health centre or hospital. The rehydration fluid therapy for dehydration at ORS-Zinc corner has three components.

i Correction of dehydration—existing water and electrolyte deficit, by rehydration therapy.

ii Replacement of ongoing losses due to continuing diarrhoea to prevent recurrence of dehydration (maintenance therapy).

iii Provision of normal daily fluid requirement.

1. Guidelines for Correcting Dehydration by Rehydration Therapy

- 75 ml/kg of ORS in first 4 hours. If weight is not known age can be used as shown in plan B. If child vomits, wait for 10 minutes, then restart ORS slowly.

Table 8.18: Plan B—for treating some dehydration with ORS. Approximate amount of ORS solution to be given in first 4 hours

Age	*Up to 4 months*	*4 months to 12 months*	*12 months to 2 years*	*2 years to 5 years*
Weight in kg	*<5 kg*	*5–<8 kg*	*8–<11 kg*	*11–16 kg*
• ORS in ml	200–400	400–600	600–800	800–1200
• Approximate local measures (glass or cup)	1–2	2–3	3–4	4–6

– Breastfeeding should be encouraged and continued during oral rehydration therapy
– Start semisolid foods soon after deficit replacement

- Reassess after 4 hours and classify dehydration

In most children dehydration gets corrected with ORS. Reassess the child after 4 hours and again classify the child for degree of dehydration and select appropriate plan. In case mother has to leave before 4 hours give her 2 packets of ORS (enough ORS) to complete rehydration at home. Explain 4 rules of home treatment

i Give extrafluids
ii Continue feeding
iii Give zinc supplements
iv Return in case of danger signs.
v Follow up in 5 days if not improving

2. Guidelines for Maintenance Fluid Therapy

Replacement of ongoing fluid losses (Table 8.19). This begins when signs of dehydration disappear usually within 4 hours. ORS in volumes equal to diarrhoea losses should be offered—approximately 10–20 ml per kg body weight for each liquid stool. ORS should be continued in this manner till diarrhoea stops. Plain water should be given in between. Continue breastfeeding.

Table 8.19: How much of ORS (or ORT) to give for replacement of ongoing stool losses to maintain hydration when body weight is not known

Age	*After each liquid stool offer*
≤6 months	Quarter glass or cup* (50 ml)
7 months to less than 2 years	Quarter to half glass or cup (50–100 ml)
2 years up to 10 years	Half to one glass or cup (100–200 ml)
Older children and adults	As much as desired

* Large tea cup

Counsel mother for continued feeding as given in plan A and when to return under plan A.

If the child continues to have some dehydration after 4 hours, ORS should be repeated for another 4 hours. Breastfeeding, milk and other feeds should be continued.

If mother has to leave before completing treatment of 4 hours, she should be given enough ORS packets (2 packets).

How Effective is ORT?

In some dehydration ORT is effective in 95–97% of cases.

Plan C: Treatment of **severe dehydration** with rapid intravenous rehydration (Table 8.20).

Table 8.20: Plan C—IV fluid therapy in severe dehydration

Age	*First give 30 ml/kg in*	*Then give 70 ml/kg in*	*Total 100 ml/kg*
<12 months	1 hour*	5 hours	6 hours
Older children	30 minutes*	$2\frac{1}{2}$ hours	3 hours

* Repeat once if radial pulse is still very weak or not detectable.

Severe dehydration is an emergency, hence it is to be treated promptly by intravenous therapy.

Plan C: Intravenous 100 ml/kg of Ringer's lactate or Hartmann's solution/normal saline (0.9% NaCl. Dextrose or plain glucose in not effective.

Reassess the child every 15–20 minute till a strong radial pulse is detectable and thereafter reassess the child every 1–2 hours. If hydration status is not improving give IV drip more rapidly. Also give ORS about 5 ml/kg/hour as soon as child can drink. Reassess infants after 6 hours and a child after 3 hours and classify dehydration and choose appropriate treatment plan—A, B or C.

If child is less than 2 months of age then ANM should give first dose of intramuscular Ampicillin/oral Amoxicillin and injection Gentamycin before referral.

If treatment facility is far away, rehydration therapy can be started with nasogastric tube or by mouth with ORS. Give 20 ml/kg/hour for 6 hours (total of 120 ml/kg). Reassess the child every 1–2 hours.

If child is 2 years or older and there is cholera in your area give antibiotic for cholera.

Nutritional Management in Acute Diarrhoea

Diarrhoea is an important nutritional leak, and it worsens the nutritional status. Recovery from diarrhoea is not simply cessation of liquid stool but achievement of **catch-up growth**.

- Children should be continued to be fed during acute diarrhoea; because feeding is physiologically sound and forms the component of ORT, helps prevents dehydration, and helps early recovery.
- Feeding along with home available fluids provides starch (ultimately glucose) and protein (ultimately amino acids); to promote sodium and water absorption from gut. These foods together with home available fluids constitute **oral rehydration therapy.**
- Breastfeeding should be continued uninterrupted.
- Staple foods should be enriched with fats/oils or sugar to provide more energy. *Khichri* with oil, rice with milk or curd, mashed potatoes with oil and lentil are good foods.
- Animal milk needs not to be diluted during any phase of diarrhoea. Milk cereal mixtures, e.g. *dalia* and milk and milk and rice mixture are good foods.
- Extra food should be given during recovery period, it helps in catch-up growth.

Children with SAM Give ORS For 4 hours in ORS-zinc corner. 5ml/kg/hour every 30 minutes for 2 hours and then 5 ml/kg/hour, ORS and starter diet alternate hours over 10 hours unless child is in shock.

Prevention of Acute Diarrhoeal Diseases

i *Exclusive breastfeeding (BF)*: Encourage universal exclusive breastfeeding up to 6 months of age and complementary breastfeeding up to 2 years of age. BF prevents diarrhoea and ensures adequate growth.

ii *Hand washing*:[6] Handwashing with soap and water reduces incidence of diarrhoea to the extent of 45%. Safe disposal of human excreta combined with hand hygiene could reduce the incidence of diarrhoeal deaths by 65%.[7]

iii *Clean food*: Eating clean food and freshly cooked food prevents diarrhoea.

iv Improved sanitation reduces diarrhoea morbidity by 32%. Improvement in drinking water quality by household water treatment with chlorine tablets can reduce diarrhoeal episodes between 35 and 39%.[8]

v *Immunization*: Measles immunization prevents measles induced diarrhoea.

vi *Vit. A prophylaxis in children*: It has a role in prevention of diarrhoea.

vii *Nutrition*: Improved nutrition of young children, with adequate food as per age reduces the chances of persistent diarrhoea. Improved nutrition prevents diarrhoea.

viii *Rotavirus vaccine*[9]: Rotaviruses are leading cause of severe dehydrating diarrhoea hospitalization in children <5 years globally and in India *rotavirus* diarrhoea kills 1,22,000 to 1,53,000 children every year mostly under 2 years of age. Live oral monovalent *Rotavirus* vaccine has been introduced in India in universal immunization programme as 3 doses schedule along with OPV 1, 2 and 3. Dose is 5 drops orally. Expansion of rotavirus vaccine to the entire nation in 2019 will prevent an estimated 40000 under five deaths per year. It prevents *Rotavirus* diarrhoeas and not other diarrhoeas in young children, hence prevention remains the mainstay.

NATIONAL DIARRHOEAL DISEASE CONTROL PROGRAMME (NDDCP)

WHO diarrhoeal diseases control programme was launched in 1978. In India National Cholera Control Programme was renamed national diarrhoeal disease control programme and in view of recommendations of WHO India launched NDDCP in 1981. The short-term objective was to reduce mortality by use of ORS. Now

NDDCP is an integral part of integrated management of childhood illness (IMCI) and integrated plan of action for pneumonia and diarrhoea.

Strategies of NDDCP

- Ensure standard case management of acute watery diarrhoeal disease, dysentery and persistent diarrhoea.
- Promote standard case management practices among private practitioners through Indian Medical Association and Indian Paediatric Association and Indian Association of PSM.
- Improve maternal knowledge on home management of diarrhoea and recognition of danger signs for seeking immediate medical care.

Intensified Diarrhoea Control Fortnights (IDCF) 2014 to June 2022

Goal: To combat diarrhoea mortality in children with ultimate aim of **Zero Child Deaths** due to childhood diarrhoea across all states and UTs of India.

Strategy

Intensified diarrhoeal control fortnight is being implemented as a campaign in the month of June–July since 2014 for reducing deaths due to diarrhoea across all states.

- Strategy is to reach all children under 5 years of age with one packet of ORS, to be used when diarrhoea begins.
- Campaign activities during fortnight provide an opportunity to generate awareness on prevention of diarrhoea in young children by use of home available fluids and ORS, prevention of dehydration, promotion of breastfeeding and improving infant and young child feeding practices and demonstration on feeding and preparation and administration of ORS. ASHAs, AWWs and ANMs are used for advance distribution of ORS packets in homes and demonstration of use of ORS. ORS was prepositioned in houses of 80 million under five children and 3.5 Lakh ORS—zinc corners were established during 2021 campaign.

ORS use Rate

ORS has been the most important technological advance of the 20th century as this modality has saved million of lives of young children. Nearly 61% of children who suffered acute diarrhoea were treated with ORS or increased fluids with gruel (NFHS—2019–21), 47% of prescriptions on diarrhoea included ORS, while tonics, anti-diarrhoeal drugs and injections continued to be prescribed in the same proportion (UNICEF 2009).

Rational use of Drugs in Diarrhoea

Anti-diarrhoeals (anti-motility drugs, binding agents, stimulants, steroids and other drugs) have no place in the treatment of diarrhoea. Marketing of anti-diarrhoeals has been banned in India. Similarly antibiotics and antimicrobials can worsen the diarrhoea. Only small proportion of cases of diarrhoeal diseases like cholera and dysentery need specific antibiotics like doxycycline and tetracyclines in cholera and ciprofloxacin in dysentery.

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CHOLERA

EPIDEMIOLOGY OF CHOLERA

Cholera has re-emerged as a major infectious disease in the recent past. Cholera is one of the acute watery diarrhoeal diseases and accounts for fewer than 5% of all cases of acute diarrhoea. Cholera can be acute public health emergency, with the potential of rapid spread and cause many deaths.

Causative Organism

Vibrio cholerae 01 biotype El-tor, Serotype Ogawa or 0139 is the causative organism for cholera.

Pattern of Occurrence and Global Burden

Cholera occurs in endemic, epidemic and pandemic forms. World has witnessed seven pandemics of cholera from 1817 to 1961. Pandemic of 1817 killed 19.7 million persons

globally and 80 Lakh persons in India. *Vibrio Cholerae* 0139 Bengal emerged as a new strain in 1992 isolated from Calcutta and Bangladesh may be the beginning of eighth pandemic. The real global burden is unknown. In 47 endemic countries 2.8 million cholera cases and 91,000 deaths occur every year.

Slow progress in providing access to safe water and sanitation to underserved populations, limitations of surveillance systems for early detection of cholera outbreaks, and lack of access to timely and appropriate healthcare have contributed to this burden of diseases. Other factors contributing to make cholera a public health priority are the emergence in 1992 of new strains of *V. Cholerae* (0139) more virulent and causing more severe clinical manifestations, the increased antimicrobial resistance, climate change and rapid and unplanned urbanization. Children under five bear the greatest burden of cholera and account for about half of the estimated cholera deaths.

Situation of Cholera in India

During 2016, only 718 cases and 3 deaths and during 2018 only 624 cases and 6 deaths and in 2020 over 2300 cases were reported with 3 deaths. Many outbreaks/epidemics have been reported in India from 1975 to 2021 due to contamination of water supplies. Cholera is endemic in many states particularly in West Bengal and Chennai in Tamil Nadu.

In India, case fatality which was 49% in 1950 has come down to less than 1% due to better case management with ORS.

Transmission

Even before the cholera organism was discovered, the transmission of cholera through contaminated water was described in 1853 by John Snow's pioneering epidemiological investigations. Cholera is transmitted/spreads through contaminated water and food with foecal matter.

Incubation Period

Average incubation period is 2–3 days. For the purpose of International Health Regulation incubation period is 5 days for quarantine.

Carriers

In more than 90% of cases cholera is mild and therefore difficult to distinguish from other types of acute diarrhoeal disease. Asymptomatic carriers of disease are common.

Typical Case

In majority of cases there is sudden onset of profuse, painless and effortless watery diarrhoea (rice water stools) and vomiting, resulting in loss of a large amount of fluids and salt from the body. Patient develops severe dehydration and circulatory collapse may follow quickly if treatment is delayed.

Cholera Case Definition

- **In an area where disease is not known to be present:** Severe dehydration or death from acute watery diarrhoea in patient aged 5 years or more.
- **In an area where cholera is endemic:** Acute watery diarrhoea with or without vomiting in a patient aged 5 years or more.
- **In an area where there is a cholera epidemic:** Acute watery diarrhoea with or without vomiting in any patient.

Syndromic Surveillance of Cholera and Notification

Under IDSP syndromic surveillance—loose water stools of less than 2 weeks duration with no dehydration, some dehydration and severe dehydration are being reported from all health facilities once a week on every Monday. The purpose is to detect outbreaks at the earliest and ensure effective response by rapid response teams. Laboratory confirmed cases are also reported. Cholera outbreak is suspected if:

a. A patient older than 5 years develops severe dehydration or dies from acute watery diarrhoea or
b. There is a sudden increase in daily number of patients with acute watery diarrhoea, especially patients who pass the 'rice water' stools typical of cholera.

Notification

Under International Health Regulation cholera is a notifiable disease. All countries are required to notify the occurrence of cholera to WHO within 24 hours.

Clinical Management

Clinical management of cholera is essentially the same as far acute watery diarrhoea. Nearly 80–90% of patients can be treated with oral rehydration salts (ORS), without intravenous therapy. For severe dehydration, IV Ringer lactate solution is used.

Antibiotics

In severe dehydration of cholera oral antibiotics can reduce the volume and shorten the duration of diarrhoea and hospital stay. For adults patients, doxycycline is preferred antibiotic because only a single dose is needed. Tetracycline is effective in children. Norfloxacin is another antibiotic of choice in cholera.

Methods of Prevention and Control of Cholera

- Safe drinking water supply.
- Sanitary disposal of human excreta (use sanitary latrines)
- Handwashing before eating and after defection
- Clean food and clean utensils
- Education of people and involvement of community
- Improvements in water supply and sanitation can reduce cholera morbidity by 80–100%.

- Standard case management practices with ORS and antibiotics.

Regular chlorination of water, and ensuring residual chlorine, destroys *Vibrio cholerae* organisms. Sanitary disposal of human excreta prevents contamination of water and food. Handwashing prevents diarrhoeal diseases including cholera.[1, 2]

Recommended chlorine levels in water distribution systems in areas affected by cholera	
The minimum levels of free residual chlorine necessary for safe water are:	
• At all sampling points in a piped water system	0.5 mg/L
• At standposts in system with standposts	1.0 mg/L
• In tankers trucks, at filling	2.0 mg/L
Active monitoring is required to ensure that these minimum levels of chlorine are maintained.	

Making Water Safe by Chlorination

Make a stock solution of chlorine (1% concentration by weight of available chlorine). Add to 1 litre of water:

Product (percent concentration by weight of available chlorine)	*Amount*
Calcium hypochlorite (70%)	15 g
or	
Bleaching powder or chlorinated lime (30%)	33 g
or	
Sodium hypochlorite (5%)	250 ml
or	
Sodium hypochlorite (10%)	110 ml

Store the stock solution in cool place in a closed container that does not admit light. The stock solution loses effectiveness with time and must be used no later than one month after it has been made.

Use the stock solution to make water safe. Add stock solution to water and ensure proper mixing.

Quantity of stock solution added to water	
Stock solution	*Quantity of water*
0.6 ml or 3 drops	1 litre
6 ml	10 litres
60 ml	1000 litres

Allow the chlorinated water to stand for at least 30 minutes before using it.

For effective disinfection, there should be a residual concentration of free chlorine of ≥0.5 mg/L after at least 30 minutes of contact time at pH<8.0. Chlorine residual should be maintained throughout the distribution system. At the point of delivery the minimum residual concentration of free chlorine should be 0.2 mg/L.

If the water is turbid (not clear, with a lot of suspended solid matter), then

- Filter it before chlorination or
- Boil it vigorously instead of treating it by chlorination.

Role of Mass Chemoprophylaxis and Vaccination[2]

Mass chemoprophylaxis has no role in controlling outbreaks. Selective chemoprophylaxis for household contacts may be helpful.

Vaccination

Cholera vaccination is not recommended for control of cholera. Vaccination campaigns for control of cholera are wasteful of scarce resources. Now certificate of cholera vaccination is not required under International Health Regulations.

Epidemic Disease Act, 1897—to be Replaced by Public Health Act of 2022

The Act provides powers to health authorities to close ice factories prohibit sale and storage of ice candies and cut vegetables. These measures seldom control outbreak/epidemic of cholera. This 125 years old epidemic disease Act is being replaced by Public Health (prevention, control and management of epidemics, bioterrorism and disasters).

Competency addressed: The student should be able to:
CM 8.4: Describe the principles and enumerate the measures to control disease epidemic.

Management of Outbreaks of Cholera

- Early recognition reporting and rapid response for case management with standard treatment protocols at local level.
- Making water safe by regular chlorination or by boiling
- Promote hand washing and food hygiene

Long-term Measures

- Provide safe water and sanitary latrines
- Ensure regular monitoring of water supply system for coliform count and residual chlorine
- Educate people for prevention of cholera

Laboratory Investigations

Lab investigations are done to confirm cholera. Rectal swabs are collected and transported in Cary Blair transport medium. During the outbreak collect samples from first ten cases meeting the case definition to confirm diagnosis.

Laboratory confirmation of all cases with acute watery diarrhoea is not required. Samples are sent to nearest district laboratory/state/medical college laboratory.

Control of Outbreaks

The mainstay of control measures during ongoing epidemics should remain:

i Immediately providing appropriate treatment to patients with cholera—antibiotics, ORS/I/V Ringer lactate.

ii Stop using contaminated source till such time it is declared safe.

iii Chlorination of water sources. Use/supply alternate source of safe drinking water to people.

iv Observe personal hygiene—handwashing with soap and water before eating and after defection and food safety.

v Forbid use of contaminated water sources.

Long-term Measures

- To improve water and sanitation and hygiene (WASH): Safe drinking water and use of latrines for safe excreta disposal.
- Educating people: Mobilization and community participation.

Surveillance

Surveillance for microbiologically confirmed cases of cholera be instituted and integrated into already existing systems of IDSP to measure the burden of cholera and monitor seasonality and impact of vaccination and other interventions in high risk population.

Ending Cholera—a Global Roadmap to 2030

Global Task Force on Cholera Control (GTFCC) by WHO

Goal

To reduce cholera deaths by 90% (eliminate cholera by 2030 in 20 high endemic countries) with focus on 47 endemic countries of the world.

Multisectoral strategies/interventions

a Water, sanitation and hygiene (WASH) a long-term measure and food safety.

b Intersectoral coordination—between health, engineering, local bodies and administration

c Healthcare system strengthening—by enhanced readiness for cholera outbreaks.

d Effective routine surveillance and reporting for action.

e Use of oral cholera vaccine (OCV) as an adjunct to WASH.

f Enhancing communication and engaging community.

Oral Cholera Vaccine (OCV)

Use of Oral Vaccine in Cholera Outbreaks

World Health Assembly in May 2011 adopted resolution for implementation of an integrated and comprehensive approach to cholera control which may include the use of oral cholera vaccine (OCV) "where appropriate in conjunction with other recommended prevention and control methods and not as substitute for such methods."

Two OCVs are currently prequalified by WHO: Dukoral® and Shanchol™. Overall both oral vaccines are killed whole cell vaccines that provide protection of >50% for at least 2 years in endemic population, induce an immune response relatively quickly (7–10 days after 2nd dose) and have a good safety profile. Both vaccines have a two doses regimen 1 and 6 weeks apart (3 doses for Dukoral® in children 2–5 years of age) and require a cold chain.

Doses: For Dukoral® 3 doses given orally 1–6 weeks apart. Booster dose after 6 months. Each dose is of 3 ml.

When to Consider the Use of OCV

These vaccines should be used in conjunction with other prevention and control strategies in areas where disease is **endemic** and should be considered in areas at risk for **outbreaks**.

Vaccination should not disrupt the provision of other high priority health interventions to control and prevent cholera outbreak.[3, 4]

Target Groups

Where resources are limited OCV should be targeted at high risk children aged more than 1 year (Shanchol™) or ≥2 years (Dukoral®). Vaccination of entire population is not warranted. Rather vaccination should be targeted at high risk areas and population groups such as pre-school and school-aged children.

Coverage Levels

Vaccination should cover as many people as possible who are eligible to receive the vaccine and should be conducted as quickly as possible.

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VIRAL HEPATITIS

EPIDEMIOLOGY

Viral hepatitis is an immense public health problem in India. Acute infection with a hepatitis virus may result in conditions ranging from sub-clinical disease to self-limited symptomatic disease to fulminant hepatic failure. Adults with hepatitis A or B are usually symptomatic. Persons with acute hepatitis C may be either symptomatic or asymptomatic.

Causative Organisms

The 'Hepatitis viruses' (ABCDE) are diverse group of viruses and affect 'liver'—the target organ and give rise to hepatitis or inflammation of the liver.

Case Definition

Suspect

Viral hepatitis is an acute illness which causes yellow colouring of eyes and skin, and dark urine.

Presumptive/Clinically Confirmed

Acute onset, fever of short duration followed by jaundice, malaise, anorexia, hepatomegaly and abdominal tenderness in the right upper quadrant. Increase in serum alanine aminotransferase (ALT >10 times) and serum bilirubin more than 2.5 mg% and epidemiological link or outbreak in the area of residence of a case.

HEPATITIS A

EPIDEMIOLOGY

Transmission

Hepatitis A and E are RNA viruses widely distributed. Enteric hepatitis viruses are transmitted primarily by faecal—oral route: Explosive epidemics of HAV and particularly of HEV usually result from faecal contamination of drinking water or food. Hepatitis A and E virus are important cause of acute viral hepatitis and acute liver failure.

Occurrence

Hepatitis A and E occur in endemic and epidemic fashion. Endemicity means sporadic cases continue to occur throughout the year in cities/areas where water supply is unsafe and continues to be contaminated with faecal matter. **Epidemics** occur when water supply becomes too bad and large number of cases are reported and clustering of cases in a locality or an area is a common feature.

Distribution

Hepatitis A has the highest global burden at over 5.5 billion. Worldwide, the global public health impact of enteric hepatitis virus infections is immense. Approximately 15 million cases of clinical hepatitis are reported each year.

Problem in India

HAV is responsible for 10 to 30% of acute hepatitis cases and 5–15% of acute liver failure cases in India. It is highly endemic in India. Around 1–1.5 lakh cases of viral hepatitis due to all viruses per annum are being reported in India (NHP 2021). Different studies in India have shown HAV sero-prevalence to be between 38 and 92% in different age groups. The actual occurrence or incidence may be much higher because of under-reporting and poor surveillance system in the country.

Of the four enteric hepatitis viruses currently recognized, HAV has the longest and best known history. Initially HAV was known as the 'infectious' or 'epidemic' hepatitis virus because of its typical association with epidemics caused by contaminated water and food worldwide.

Like many picornaviruses, HAV tends to cause infection that is mild or without clinical symptoms in children. The incidence of infection is closely linked with hygiene and sanitation conditions and most people in India and other developing countries contract infection during early childhood period. Typical clinical symptoms of infection are seen in *adults*. Most *adults* show signs and symptoms. **There is no carrier state in HAV**.

Lab diagnosis: In acute hepatitis with clinical jaundice, the serum bilirubin levels are above 2.5 mg/dl and serum alanine aminotransferase (ALT) is more than 10 times upper limit of normal.

Morbidity

Hepatitis A is an outbreak prone disease. Patient feels ill and confined to bed up to 6 weeks or so and severity of illness depends upon nutritional status and immunodeficiencies and the general state of health. In India general health and nutritional status is low hence severity of illness is more in poor people. Common symptoms are low grade fever, anorexia, nausea and vomiting, fatigue, malaise, artharalgia, myalgia, headache may precede onset of Jaundice. There is no specific antibiotic or treatment for HAV.

Mortality

Mortality is generally very very low, i.e. 0.1%.

Immunity

One attack confers lifelong immunity. In adult population in developing countries and communities, immunity to HAV may exceed 95% in contrast to developed countries where level of immunity may be less than 50%.

Resistance

The HAV is highly infectious and can cause **explosive epidemics** when present in water and food. In addition, it

is relatively resistant to unfavourable environmental conditions, including water treatment and disinfection process. Normal doses of chlorination do not destroy HAV. 0.5 mg/litre of residual chlorine ensures safety against HAV.

Incubation Period and Household Infection

Incubation period of hepatitis A may vary from 15 to 45 days with a mean of 30 days. The virus is present in the blood in relatively low number for about 7–14 days with a peak before the onset of clinical symptoms. Faecal–oral transmission of HAV is the result of personal contact or consumption of faecally polluted water or food. If one member of a household contacts an infection from contaminated water or food or from contact with an infected individual outside the home, can infect other members of household by **personal contacts.** Household infection rate of up to 95% have been recorded.

Vaccine Against HAV

WHO considers that in countries where hepatitis A is highly endemic exposure to HAV is almost universal before the age of 10 years, in such countries clinical hepatitis is usually a minor public health problem and large scale immunization efforts against this disease may not be undertaken. Hence, universal immunization of hepatitis A is not recommended as yet. Currently, 4 inactivated vaccines against HAV are internationally available. All 4 vaccines are safe and effective with long lasting protection. None of the vaccines are licensed for children less than 1 year of age. The HAV vaccines are given parenterally as two doses series 6–18 months apart.

Prevention Strategy

The HAV vaccines may be used to protect individuals with high-risk situations but the principal barriers to transmission of enteric hepatitis virus are safe drinking water supplies and good standards of sanitation and of personal and food hygiene. Safe water supplies and sanitation will remove or eliminate other dangerous diseases/infections as well (like typhoid fever, cholera and diarrhoeal diseases).

HEPATITIS E

EPIDEMIOLOGY

Hepatitis E virus is RNA virus belong to hepevirus. This virus was confirmed in 1970s and early 1980. Infection with this virus was initially referred to as enterically transmitted (or epidemic) non-A, non-B hepatitis (NANB). It eventually transpired that HEV had for many years been mistaken for HAV because the two viruses share same basic clinical and epidemiological properties. Hepatitis E is an outbreak prone disease and responsible for 10–40% of acute hepatitis and 15–45% of acute liver failure.

Transmission

Primarily by the faecal–oral route and often associated with waterborne and food-borne outbreaks. However, HEV tends to occur more often in young adults, many of whom are already immune to HAV. Person-to-person transmissions is uncommon. **There is no carrier state in HEV**.

Incubation Period

It ranges from 2 weeks to 10 weeks; mean incubation period is 40 days.

The clinical course of hepatitis E is similar to that of hepatitis A. More than 50% of HEV infections remain anicteric. In moderate to severe cases, the onset is usually sudden with fever, marked loss of appetite, feeling of general ill health and upper abdominal discomfort, nausea and/vomiting and averson of food followed within a few days, by jaundice. Fever usually disappears by the time jaundice appears. Liver function tests include a rise in serum alanine aminotransferase—ALT >10 times of upper limit and serum bilirubin to more than 2.5 mg%. Jaundice persists for 1–6 weeks.

Animal Reservoir

HEV is zoonotic member. Virus has been detected in animal excreta (cows, pigs, goats and even in rodents). *Animals serve* as *reservoir* of HEV and many human infections may originate from water sources polluted by animal waste. This underlines the need to protect water resources and supplies from pollution by *animal wastes*. In the past the animal wastes were not considered to be of particular importance with regard to viruses.

Distribution

Both HAV and HEV are associated with poor standards of hygiene and sanitation. However, geographical distribution of HEV is distinct and restricted. Globally 20 million infections of HEV occur per annum.

Mortality

In contrast to hepatitis A, which rarely causes complications and mortality. HEV causes fulminant hepatitis and high fatality in pregnant women (case fatality as high as 10–25%). Case fatality ranges from 0.1 to 4%.

Outbreaks of Hepatitis E in India

HEV is the most common cause of acute fulminant hepatitis in adults in parts of India, other parts of Asia and in Africa. Most of the outbreaks of viral hepatitis in India are caused by hepatitis E virus, hence there are limitation of use of hepatitis A vaccine. Large outbreaks

associated with sewage contaminated drinking water include one in 1954 involving approximately 40,000 cases in Delhi, India. One in 1986–1988 with more than 1,00,000 cases in the Xinjian Uighar region of China and one in 1991 with 79,000 cases in Kanpur, India. Several outbreaks between 1989 and 1999 in Andhra Pradesh, Madhya Pradesh, Delhi, Ahmedabad, Rajasthan have been investigated by NICD and all these were due to HEV. All these outbreaks occurred in areas having evidence of contaminated pipe water supply irrespective of presence or absence of sewer lines. Only single case occurred in most of the affected households. The majority of cases (80%) were 15 years and above. Males contributed almost three-fourths of cases. Outbreaks occurred mostly in rainy season. Outbreaks subsided in a few weeks once the leakages were identified and corrected.

Prevention and Control[1]

Since transmission of hepatitis A and E is faecal–oral, the measures of personal hygiene and environmental sanitation that apply to control of enteric infections are the basis for control of hepatitis A and E.

Ensure safe water supply. Hepatitis A and E viruses are not destroyed by chlorination in usual doses. Ensuring high level of residual chlorine at least 0.5 ppm in the system is effective against viruses. The virus is killed by boiling of water. This is temporary alternate arrangement of safe water supply during the outbreaks; till such time the source of contamination is removed.

***Vaccine*:** Hepatitis E vaccine is available in China but not in India so for.

Anticipatory Actions

- Ensure water quality monitoring on regular basis in addition to sanitary surveys and inspections by health agencies and suppliers.
- Syndromic surveillance under IDSP and disease surveillance through health facilities and institutions: Surveillance data on acute diarrhoeal diseases, typhoid fever and jaundice can provide clue of impending outbreaks well in advance for appropriate and timely actions.
- People participation and education of community on all aspects of prevention of hepatitis by their own action is essential. Multiple channels should be used to disseminate messages.

HEPATITIS B—A SILENT KILLER

EPIDEMIOLOGY

World Scenario

Hepatitis B is a disease of the liver caused by virus—the hepatitis B virus (HBV); a DNA virus, it used to be called as serum hepatitis virus. It belongs to the family of hepadnaviruses. Globally it is estimated that 325 million people are living with chronic hepatitis B and C. Hepatitis B is a silent killer, taking the lives of 500,000 to 700,000 people each year globally.

Carrier State in Viral Hepatitis

Over 95% of the people are able to clear the virus from their blood. In those who have mild disease with hepatitis B, some patients do not get rid of virus after acute infection. They become lifelong carriers of hepatitis B virus. Those who are infected when young may carry infection for the rest of their life; often without knowing it.

Acute HBV infections: About 70% of patients with acute HBV infections have sub-clinical or anicteric hepatitis. About 10% of infants and up to 30% of adults infected by HBV, develop icteric hepatitis a short-term illness (acute hepatitis B). Symptoms include loss of appetite, weakness, nausea, vomiting, abdominal pain, jaundice, dark urine and joint pain. Case fatality rate is 1–2%.

Chronic HBV infections: The rate of progression from acute to chronic hepatitis B in immunocompetent persons is determined primarily by age at infection. The risk of development of chronic infection is 90% following perinatal transmission (up to 6 months of age) but decreases to 20–50% between 6 months to 5 years and less than 5% in adults acquired infection. Persistence of hepatitis B surface antigen (HBsAg) for more than **6 months** is defined as **chronic hepatitis B**. Chronic carriers can infect others and are themselves at risks of serious liver disease in life including cirrhosis and liver cancer. It is estimated that in about 15–25% of such carriers, there is a risk of liver cirrhosis or cancer, 20 years or more after the primary infection. Most of the carriers are those who become infected in early childhood as children have very mild form of illness. In India, the available data indicate that the country has intermediate endemicity of hepatitis B, with prevalence of hepatitis B surface antigen (HBsAg) ranges between 1.1 and 12%. Around 40 million carriers (Chronically infected) of hepatitis B exist in India. Of 27 million infant born every year in India one million run the lifetime risk of developing chronic HBV infection. The hepatitis B vaccine, as part of the universal immunization programme would prevent these chronic infections.

The chronic carrier rate of HBV in adults varies widely in different parts of the country and among different sections of society, from less than 1% to over 15%. On an average, the carrier rate in pregnant women is 2–4%. Annually 27 million babies are born in India. Thus, about half to one million infants are born to women who are chronic virus carriers. The probability of vertical transmission is only about 30%. In other words, some 1,66,000–3,33,000 neonates are likely to be infected.

Among them about 90% are likely to become chronic carriers, thus adding 1,49,000 to 2,99,000 to the carrier pool annually. Therefore, prevention of MTCT is an essential component of Hepatitis B vaccination in National Immunization Programme.

Detection of Carriers

A simple blood test called Australia antigen test (HbsAg) will help determine whether one is infected with hepatitis B virus or not.

Problem—Endemicity

Hepatitis B is a major public health problem, worldwide.

- Highly endemic areas are those where hepatitis B surface antigen (HBsAg) prevalence is 8% or more.[2]
- Medium endemicity means prevalence between 2% and 7%. India falls in this zone of prevalence. Average prevalence is 3–4% in India.
- Low endemicity means prevalence less than 2%.

Incubation Period

Incubation period is 30 to 180 days, median incubation period is lower than 100 days.

Mode of Transmission

The virus is found in infected blood and other body fluids such as saliva, semen, vaginal secretions, wound exudates, etc. Man is the only known reservoir of this virus. The virus is transmitted from one person to another by infected blood or body fluids by unsafe blood transfusion, **unsafe** injections and unsafe sexual intercourse with sexual partners. There are four major modes of transmission:

Vertical: Perinatal transmission from infected pregnant women to child at birth is most common.

Horizontal: Occasionally between person-to-person (accidental contact with infected blood and other body fluids) by needle stick injuries or other injuries.

Parenteral/percutaneous: During transfusion of infected blood and through infected needles.

Sexual: Between sexual partners.

In fact, hepatitis B virus is 100 times more infectious than HIV/AIDS virus and only 0.00004 ml of contaminated blood is sufficient to transmit this virus. Unlike HIV, HBV is able to remain active on surfaces (e.g. table tops, razor blades, bloodstains, etc.) for about a week without losing infectivity.

At risk individuals: Persons who indulge in unsafe sex and have multiple sex partners, infants born to hepatitis B infected mothers, professional blood donors, persons who receive repeated blood transfusion (thalassaemics and haemophilics) injecting drug users and persons exposed to needle stick injuries like doctors, dentists, nurses and paramedicals are at greater risk of HBV infection.

Majority of infants and children infected with hepatitis B do not show any sign and symptoms of hepatitis B infection. These asymptomatic children can transmit the hepatitis B virus to other healthy children and at later age the asymptomatic child may develop liver cirrhosis and liver cancer.

Outbreaks

Reported outbreaks due to hepatitis B are rare and have been linked to **unsafe injections** by use of unsterilized needles and one needle and syringe is used for multiple injections. NICD investigated outbreaks of hepatitis B in Mehsana (Gujarat), Sirsa (Haryana) and Sri Ganganagar (Rajasthan) in the year 1997. These outbreaks were due to use of unsterilized needles and syringes by private practitioners. Outbreak of hepatitis B in January 2009 in Modasa town in district Sabarkantha of Gujarat state affected 500 persons resulting in 93 deaths—case fatality rate of 18.6%, due to **unsafe injections.** Thus, there is an imperative need of **safe injection** by rolling out of reuse prevention (RUP) syringes.

Prevention by Hepatitis B Vaccine

A safe and effective vaccine against hepatitis B has been available since 1982.

Objective

The primary objective of routine infant hepatitis B immunization is to prevent the early childhood infection which result in chronic liver disease later in life. By preventing chronic HBV infection this strategy also serves to reduce major reservoir for transmission of new infection.

Immunization Strategies[2]

Routine Infant Immunization

Prevention of perinatal HBV transmission: In order to prevent HBV transmission from mother to infant, the first dose of hepatitis B vaccine needs to be given as soon as possible after birth (preferably within 24 hours after birth). In countries where a high proportion of chronic infections are acquired perinatally (e.g. SE Asia), a birth dose should be given to infants when feasible. It is usually most feasible to give hepatitis B vaccine when infants are born in hospitals. Effort should be made in these countries to give hepatitis B as soon as possible after delivery to infants delivered at home.

What is the 'birth dose' of hepatitis B?

This refers to the dose given within 24 hours of birth. A child vaccinated with hepatitis B after more than 24 hours

of birth is not considered to have received the birth dose.

Why is the birth dose of hepatitis B vaccine given only within 24 hours of birth?

The birth dose of hepatitis B vaccine is effective in preventing perinatal transmission of hepatitis B only if given within the first 24 hours. Increase coverage of birth dose to over 90%.

Why is hepatitis B vaccine given only till 1 year of age?

Hepatitis B vaccine is given till 1 year of age because infections during first year of age have a 90% chance of becoming chronic as compared to 20–60% during 1–5 years and 5% after 5 years. Persons with chronic infection have 15–25% risk of dying prematurely due to HBV-related liver cirrhosis and cancer.

National technical advisory group on immunization (NTAGI): In India recommends 1st dose at birth for institutional deliveries followed by dose 2 at 6 weeks and dose 3 at 14 weeks along with DPT.[3]

For those not receiving a birth dose, three doses at 6,10 and 14 weeks are given along with DPT or as pentavalent vaccine.

Administration of hepatitis B vaccine to pregnant woman with HBV provides no benefit either to mother or the body.

Catch-up immunization: For children and adolescents—3 doses on demand and on payment. Here the ideal schedule is one month between dose 1 and 2 and 3–5 months between dose 2 and 3. Third dose gives protection of 20–25 years.

In countries with lower HBV endemicity, a higher proportion of chronic infection may be acquired among older children, adolescents and adults. Catch-up-immunization for these groups may be considered (WHO).

Vaccination is essential for all students and staff of healthcare, including medical, nursing, dental, laboratory and related paramedical disciplines in order to prevent nosocomial transmission to and from healthcare workers. Those already infected with HBV do not benefit from HBV vaccine.

Administration: Hepatitis B vaccine is given by intramuscular injection in the anterolateral aspect of the thigh (infants) or deltoid muscle (older children). It can safely be given at the same time as other vaccines. Sterile autodisable (AD) injection devices are recommended.

Dose: For infants 0.5 ml (10 µg of hepatitis B surface antigen protein). For older children and adults 1 ml (20 µg of hepatitis B surface antigen protein).

The hepatitis B vaccine is the *First vaccine against a cancer* (primary liver cancer).

Treatment of Chronic Hepatitis B

With antiviral drugs tenofovir 300 mg, entecavir 0.5 mg and Tenofovir alafenamide 25 mg daily for lifelong generally.

HEPATITIS C—THE SILENT KILLER

EPIDEMIOLOGY

Globally there were 495000 estimated deaths in 2015 and 37000 deaths in India due to HCV. WHO estimates that 3% of world population is infected with HCV and around 170 million individuals are chronic carriers at risk of developing liver cirrhosis and liver cancer. Over 50% of cases are asymptomatic. HCV is the most common cause of chronic hepatitis. India has an HCV prevalence rate of 0.09 to 15% in general population. India has 6–12 million people chronically infected with HCV.

Modes of Transmission

Hepatitis C is usually transmitted through infected syringes and needles and transfusion of infected blood. About 50% of cases are related to injecting drug users who share needles. Risk of sexual transmission is low. It is reported to be more common in HIV-positive persons particularly in MSM. The risk of transmission from mothers to her child occurs in 4–8% of births to women with HCV infection and 10.8 to 25% of births to women with HIV and HCV co-infection. In developing countries, it is estimated that up to 1,60,000 HIV, 4.7 million hepatitis C and 16 million hepatitis B infections each year are attributable to **unsafe injections**.[2] In February 2012 in Ratia block of Fatehabad district in Haryana, 1584 persons tested positive for hepatitis C. Punjab has highest prevalence of Hepatitis C.

Salient Features of HCV Infection

- Hepatitis C along with hepatitis B and alcohol are the top three global causes of liver cirrhosis and liver cancer.
- HCV causes both acute and chronic hepatitis.
- More than 50% likelihood of chronicity, leading to cirrhosis in >20%
- No symptoms in 50% of cases
- Undetected up to 10 years

Prevention and Management

There is no vaccine to prevent HCV infection. Safe blood, safe injection, and safe sex prevent HCV and HBV.

Treatment of Hepatitis C (refer to Table 8.21)

Chromic infections with HCV are silent. Spontaneous clearance of acute HCV infection occurs within 6 months of infections in 15 to 45% of infected individuals in the absence of treatment. Almost all the remaining 55% persons will harbour HCV for rest of their lives (if not

Table 8.21: Treatment of hepatitis C with directly acting antivirals (DAAs)

Categories of patient	*Regimen oral daily*	*Duration*
1. Patient without cirrhosis (uncomplicated)	Sofosbuvir 400 mg and Daclatasvir 60 mg	12 weeks
2. Patient with cirrhosis compensated (child-Pugh A)	Sofosbuvir 400 mg + Velpatasvir 100 mg	12 weeks
3 Patient with cirrhosis decompensated (child-pugh B and C)**	Sofosbuvir 400 mg + Velpatasvir 100 mg and Ribavirin (600–1200 mg)**	12 weeks
** Refer to Model Treatment Centre	In Ribavirin intolerant patients Sofosbuvir 400 mg + Velpatasvir 100 mg	24 weeks

treated and are considered to have chronic HCV infection) of those with chronic HCV infection, the risk of cirrhosis of liver is 15–30% within 20 years. The risk of hepatocellular carcinoma (HCC) in persons with cirrhosis is 2–4% per year.

The availability of highly effective DAAs has, however, changed the HCV treatment outcomes and paradigms leading to hope of elimination of this infection as public health threat by the year 2030. Treating HCV infected persons with DAA prevents decompensated cirrhosis and HCC. Treating all persons with HCV along with preventive measures will ultimately eliminate HCV infection in India.

NATIONAL VIRAL HEPATITIS CONTROL PROGRAMME (NVHCP)

National viral hepatitis control programme was rolled out on the occasion of world hepatitis day on 28th July 2018. Under the umbrella of National Health Mission.[4]

India is committed to progressively move towards elimination of viral hepatitis B and C and control other virus-induced hepatitis. This is in line with our global commitment towards achieving sustainable development goal (SDG) 3; target 3.3 which aims to "By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water borne diseases and other communicable diseases".

National Guidelines

Haryana model of "Jeevan Rekha" free of cost test and treatment for hepatitis C by November 2018 has been adopted in the country.

To begin with, 16 model treatment centres will be established at district hospitals in different states to provide treatment for cases of hepatitis C, in addition to training of doctors and technical staff. Oral drugs for treatment of hepatitis C became available in India in 2015 and patient no longer requires to get injection.

National Centre for Disease Control at Delhi is the nodal centre for national programme for control of viral hepatitis.

AIM[4]

1 Combat hepatitis and achieve countrywide elimination of hepatitis C by 2030.
2 Achieve significant reduction in the infected population, morbidity and mortality associated with hepatitis B and C, viz. cirrhosis and hepatocellular carcinoma (liver cancer).
3 Reduce the risk, morbidity and mortality due to hepatitis A and E.

Key Objectives

1 Enhance community awareness on hepatitis and lay stress on preventive measures among general population especially high-risk groups and in hotspots.
2 Provide early diagnosis and management of viral hepatitis at all levels of healthcare.
3 Develop standard diagnostic and treatment protocols for management of viral hepatitis and its complications.
4 Strengthen the existing infrastructure facilities, build capacities of existing human resource and raise additional human resources, where required, for providing comprehensive services for management of viral hepatitis and its complications in all districts of the country.
5 Develop linkages with the existing national programmes towards awareness, prevention, diagnosis and treatment for viral hepatitis.
6 Develop a web-based "Viral Hepatitis Information and Management System" to maintain a registry of persons affected with viral hepatitis and its sequelae.

Components

The key components include

1 **Preventive component:** This remains the cornerstone of the NVHCP. It will include
   a Awareness generation
   b Immunization of hepatitis B (birth dose, high risk groups, healthcare workers)
   c Safety of blood and blood products

d Injection safety, safe sociocultural practices
e Safe drinking water, hygiene and sanitary toilets.

2 Diagnosis and treatment—A New Initiative

a Screening of pregnant women for HBsAg to be done in areas where institutional deliveries are <80% to ensure their referral for institution delivery for birth dose hepatitis B vaccination.
b Free of charge screening, diagnosis and **treatment** for both hepatitis B and C would be made available at all levels of healthcare in phased manner.
c Provision of linkages, including with private sector and not for profit institutions, for diagnosis and treatment.
d Engagement with community/peer support to enhance and ensure adherence to treatment and demand generation.

3 Monitoring and evaluation, surveillance and research: Effective linkages to the surveillance system and operational research would be undertaken through department of health research (DHR). Standardised monitoring and evaluation framework would be developed and an online web-based system established.

4 Training and capacity building: This would be a continuous process and will be supported by NCDC, Institute of liver and biliary sciences (ILBS) and state tertiary care institutes and coordinated by NVHCP. The hepatitis induction and update programs for all level of healthcare workers would be made available using both, the traditional cascade model of training through master trainers and various platforms available for enabling electronic, e-learning and e-courses.

National Programme for Viral Hepatitis Surveillance

Surveillance of hepatitis B and C has been integrated with HIV sentinel surveillance to know the disease burden.

Objectives of surveillance

- Detection of outbreaks and timely response.
- Description of trends in type specific acute hepatitis and identification of risk factors.
- Estimation of chronically infected persons, burden of chronic infections and incidence of hepatic cell carcinoma (HCC) and cirrhosis.
- To measure the exact burden of viral hepatitis ABCDE by network of 10 laboratories.

Programme Management

National, state and district level viral hepatitis control management units have been set up for implementation of programme and service delivery.

Collaboration with existing programmes: The NVHCP is collaborating its activities:

i With UIP to increase coverage of birth dose of hepatitis B to achieve 90% coverage of 3 doses of hepatitis B vaccine in infants.
ii With NACP to promote voluntary blood donation to the level of 80% and above and prevention of hepatitis B and C in high-risk groups and integration surveillance of biomarkers of hepatitis B and C with HIV sentinel surveillance and harm reduction in key population/core high-risk groups.
iii 100% of injection devices are safely engineered in India (Roll out of reuse prevention syringes). Safe injections handbook and guidelines are in place.
iv With IDSP for surveillance and effective outbreak response of hepatitis A and E.
v With FSSAI to promote safe food.
vi Swachh Bharat Abhiyan—Mission for safe drinking water and sanitation programme.

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GUINEA WORM DISEASE (ERADICATED FROM INDIA)

Guinea worm or dracunculiasis has been eradicated from India. Guinea worm is caused by the nematode: *Dracunculus medinensis*. Adult worms live in subcutaneous tissues of man. Disease cycle is maintained through intermediate host: Cyclops. Cyclops live in water and embryos develop in the body of cyclops. When unsafe water is consumed by human beings, the cyclops are ingested and further stages of worm develop in man. The female adult guinea worm which measures 60–100 cm in length emerges through skin, causing incapacitating chronic swelling and ulcer in lower limbs or back of the body, when these parts come in contact with water the gravid female liberates thousands of embryos in water. Cyclops ingest these embryos and the cycle is maintained. The disease mostly occurs in rural areas with inadequate safe drinking water and peaks are observed during the summer season when there is scarcity of water. The disease causes incapacitation to the individual, who is unable to perform his regular work, resulting in economic and production loss to the patient and family.

NATIONAL GUINEA WORM ERADICATION PROGRAMME

National Guinea Worm Eradication Programme (GWEP) was started in 1983–84 as a centrally sponsored programme.

Strategies[1, 2]

i To provide safe water to geographical areas having guinea worm infestation on priority basis.
ii Surveillance of guinea worm cases through house-to-house search programme.
iii Management of guinea worm cases.

Active Surveillance

Every year during the months of April, May/June and November/December, three active search operations were undertaken with a view to identify guinea worm affected villages, detection of guinea worm cases and their management, study the epidemiological situation of guinea worm disease, identify unsafe water sources and study the safe drinking water requirements and the trend of the guinea worm disease.

Vector Control

Temephos was considered as the safest, with long residual effect and was comparatively economical to use against the control of other vector-borne diseases including onchocerciasis, filariasis, dengue fever and malaria. As a cyclopsicide 1% and 2% sand granule formulations of **temephos** have been extensively evaluated and found to be safe in India. In India, the task force on GWEP decided to use 50% emulcifiable concentrate (EC) temephos in place of 2% sand granule.

Frequency: Temephos eight times a year and use of fine nylonmesh/double layered cloth strainers by the community to filter cyclops in all the affected villages. Initially temephos first application was done in Feb/March and then repeated twice at an interval of 6 weeks. Another application was done in 2nd and 3rd week of September. Subsequently temephos was applied every month.

Provision and Maintenance of Safe Drinking Water Supplies

It was done in mission mode, high priority was given to endemic areas affected with guinea worm disease.

Management of Guinea Worm Patients

No specific drug is available against dracunculiasis, worm extraction is the only remedy to be done at nearest primary health centre or community health centre by trained professionals.

During the year 1984, when the GWEP was launched there were 40,000 cases of guinea worm disease spread over in 12840 villages of 89 districts of 7 endemic states (Rajasthan, Madhya Pradesh, Chhattisgarh, Karnataka, Maharashtra, AP and Gujarat). During 1996, 9 guinea worm cases were recorded in three villages of Jodhpur district (Rajasthan), all of which were adequately contained. Last case was reported from village Aau in July, 1996.[3,4]

Impressive gains were made over the period of 13 years of implementation of the programme. India reported 'Zero' case in 1997. A National Commission for Certification of Guinea Worm Eradication was set-up by the Ministry of Health and Family Welfare in 1998. WHO team for eradication of guinea worm disease, visited the country from 9.11.99 to 25.11.99 to validate the zero guinea worm disease status for eradication in India and hence India was certified for eradication of guinea worm disease in 2000.[5]

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ENTERIC FEVERS—NEGLECTED TROPICAL DISEASE

EPIDEMIOLOGY

Enteric fevers of which typhoid fever (caused by *Salmonella enterica* serovar *typhi*), constitutes an overwhelming majority is an old problem that still persists. Paratyphoid fever can be caused by any of three variations or biotypes of *S. enteritidis paratyphi* A, B, C. It is similar in its symptoms to typhoid fever but tends to be milder, with much lower case-fatality rate. Typhoid fever is a major hazard to public health in India and rated as the fifth most common communicable disease in the country. Typhoid fever—a widespread disease is a *Salmonella typhi* septicemia related to the presence of the capsule Vi antigen. It results in high morbidity and mortality in developing countries. In industrialized countries, 80% of cases of typhoid fever are contracted by persons travelling in endemic zones. The difficult diagnosis and the emergence of strains multi-resistant to antibiotics effectively delay the setting up of effective treatment and increase the number of complications, the mortality rate and the cost of treatment. Typhoid fever is still a serious disease.

Mode of Infection

The reservoir: The reservoir of bacteria is strictly human (man). No animal reservoir is known. The agent responsible can, however, survive several months in soil or water.

Dissemination of bacteria is by infected subject: They are excreted in large quantities in patient's stools, and also in their vomit and urine, or are excreted in a more sporadic way in the stools of **chronic carriers,** veritable reservoirs of the pathogenic agent that can harbour bacteria in their gallbladder for months or even years. These **chronic carriers** are an important source of infection, maintaining the endemic, even epidemic state of certain geographical regions.

Transmission: There is no animal reservoir in typhoid fever. Typhoid fever is an oro–faecally transmitted disease. In 90% of cases, infection is indirect, by ingestion of water or food contaminated with excreta from infected subjects. This mode of transmission plays a major role in the spread of disease in India and other developing countries in which it is highly endemic and where sanitary systems are often inadequate and also where there are many houseflies from defecation ground and kitchen, which act as mechanical vectors for transmission of disease.

Transmission also occurs **directly** in the family or contacts of a patient or chronic carriers (Fig. 8.12).

Incubation Period

It ranges between 5 and 21 days.

Following ingestion the bacterium may reach reticuloendothelial system and multiply intracellularly within macrophages, a property that seems dependent on the presence of the Vi antigen. After 5–21 days of incubation the patient experience fatigue, headache, abdominal pain and fever. Constipation usually occurs in older children and adults, whereas diarrhoea occurs in younger children. Severe form of typhoid fever may entail cerebral dysfunction, delirium, shock, occasional intestinal perforation, and haemorrhages. Immunocompromised individuals suffering from achlorhydria are susceptible to lower infectious doses of *S. typhi* and are at increased risk of severe diseases. Regardless of treatment or risk factors, the overall fatality rate is about 4%. Approximately 1–4% of the patients continue to harbour *S. typhi* in their intestinal tract and gallbladder for months or years (chronic carriers). Definitive diagnosis of typhoid fever requires isolation of *S. typhi* from blood, intestinal secretions and bone marrow by culture. Only 50–70% of blood cultures are positive. Chronic carriers show high antibody titre to Vi antigen.

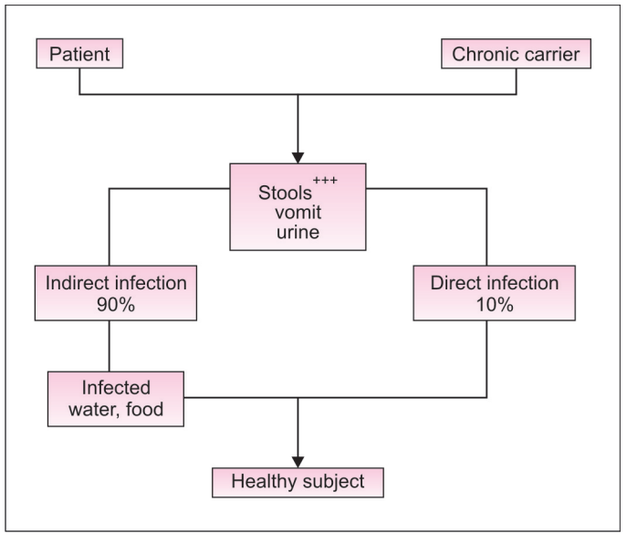


Fig. 8.12: Modes of infection of typhoid fever (enteric fevers)

Carrier: If *S. typhi* organisms persist in stools or urine for >1 year after onset of disease, a person is known as **chronic carrier.**

Population Affected

In endemic country like India, young subjects are most affected—children over five, adolescents and young adults with a peak incidence between 8 and 13 years of age. It is an important cause of absenteeism from school or work. In aged subjects, typhoid fever is less frequent but much more severe and the proportion of chronic carriers increases with age. The occurrence of typhoid fever in children under 2 years of age is rare.

Taking into consideration the increasing amount of travel to developing countries, the risk of infection for travellers is becoming greater. 80% of cases of industrialized countries are brought in by travellers.

Military personnel, food sector employees, laboratory and hospital personnel are other populations at risk. Persons in close contact with a chronic carrier are at most risk.

Geographical Distribution

Typhoid fever is widespread and remains a serious disease. Typhoid fever is ubiquitous disease. It is endemic in different regions of the globe. WHO conservatively estimates the annual global incidence of typhoid fever at 20 million episodes and 1,40,000 deaths. In some developing countries of Asia and Africa, the annual incidence may reach 1% with case fatality rate as high as 10%. About 70% of all deaths due to typhoid fever occur in Asia.

Problem in India

Disease Burden—Based on Notification

India is a high burden country for typhoid fever and faces the highest burden of antimicrobial resistance.

All medical institutions in India are required to report cases and deaths of typhoid (enteric fever) every month to respective state and states report consolidated data to Central Bureau of Health Intelligence (CBHI).

There is inadequate and incomplete information of typhoid fever in India and these reports come from hospitals and dispensaries. Hence, it does not depict the true picture of the problem. Over 2.3 to 2.4 million cases and over 300 deaths were reported per annum in 2018 and 2019.[1] Over 1 million cases and 126 deaths were reported in 2020.

Study conducted in India in 1997 provides community based prevalence of typhoid in urban slums of Delhi.

Typhoid fever cases were seen in all age groups up to 40 years giving an overall incidence of 9.92 per 1000 person per year. The incidence was 27.28 per thousand in children <5 years of age and 6.63 per thousand in those older than 5 years. The above figures were based on the blood culture positive cases of typhoid fever. This may be an underestimate as culture is not positive in all cases (Table 8.22).

Table 8.22: Incidence of culture confirmed typhoid fever in Delhi (by active surveillance) and other studies

Year	*Author*	*Disease incidence per 1000 per year*		
		Overall	*<5 years*	*>5 years*
1971	Chuttani et al. (Delhi slums) 6248 population	9.60	10.49	9.29 (5–17 yrs)
1997	AIIMS study group (Delhi slums) 8000 population	9.92	27.28	6.63 (5–40 yrs)
2020	Cao, et al.	360 per lakh is national incidence		

Source: Waterborne diseases: The continuing challenge Ranbaxy Science Foundation in India 1997 and Cao, et al. JID 2021: 224 (Suppl 5)

There was no change in overall incidence in the last 26 years between 1971 and 1997. It means that the disease is being perpetuated and factors and conditions responsible for it have not changed much over the years.[2, 3]

At this rate, there would be 8.5 million culture positive cases of typhoid in India per year. The actual load may be much higher given that the culture positive cases vary between 50% and 70%. Of these, a guess estimate of 0.73 million cases will need hospitalization and 17000 will die every year.

Paratyphoid fever caused by *S. paratyphi* A constituted almost one-fourth of the total cases of enteric fever. In contrast to typhoid fever, which was more prevalent in children under 5 years, majority of paratyphoid fever cases occurred in those older than 5 years.

The estimated prevalence across all hospital studies of laboratory confirmed typhoid and paratyphoid was 9.7% and 0.9% respectively (John et all systemic review and meta-analysis).

Problem: Highest Incidence in 2–4 Years Children

There was no disease during the first year of life, the incidence during the second and third year of life was 24.8 and 51.8 per 1000 person, years respectively, which has an epidemiological implication of prevention of typhoid with immunization. Incidence in school age groups is not known precisely. Typhoid fever in children below 3 years is not a mild disease.[2–6] But hospital-based studies reveal peak incidence of typhoid between 5 and 12 years of age.

Geographic Pattern of Typhoid Fever in India Published in 2021 in Jid Reveals

An estimated national incidence of typhoid fever in India (in children between 6 months and 15 years) was 360 cases per 100, 000 person years. Thus there is substantial decline from 992 cases per 100, 000 person-year in 1996 (63% decline in incidence) due to improved water supply and sanitation programme. Study of 2021 estimates 4.5 million cases and 8930 deaths per annum with substantial geographic variation.[7] Typhoid Conjugate vaccines recommended by WHO to prevent typhoid fever in children is an interim strategy. Long term measures of improved water. Supply and sanitation remain the sheet anchor for prevention of water borne diseases including typhoid fever.

Urban–Rural Distribution

It is believed that the incidence of typhoid fever is less in rural areas but there is no scientific evidence. Urban slums are worst affected because of poor sanitation and water contamination.

Case Fatality

Case fatality of typhoid fever has been reported as 10%, which can be reduced to 1% with appropriate antibiotic therapy. Case fatality is low in paratyphoid A, B and C fevers.

Communicability

People can transmit the disease as long as bacteria remain in their system. Most people are infectious prior to and during the first week of convalescence. About 10% of untreated patients will discharge bacteria for up to 3 months; 2–5% of untreated patients will become permanent carriers.

One notorious carrier was Mary Mallon or **Typhoid Mary** who was a cook and asymptomatic chronic carrier of *Salmonella typhi*, infected dozens of people in New York city.

Problem of Drug Resistance in Typhoid Fever

Widespread multidrug resistance in typhoid fever has been reported in India, Bangladesh, and other parts of the world.

The basic drugs (firstline drugs) like chloramphenicol, ampicillin and cotrimoxazole have become blunt and are not effective against typhoid fever. Resistance to the extent of over 80% has been reported by 1991. In Great Britain in 1991, 25% of isolated strains were resistant to chlor-

amphenicol (100%), trimethoprim (87%) and ampicillin (85%).

Even ciprofloxacin and erythromycin are becoming less effective, which at present is the drug of choice for typhoid fever. Amikacin and Gentamicin are still very effective against typhoid fever. The cost of treatment is quite high apart from man-days lost due to morbidity.

In Jan 2022, The Recent 'Lancet Microbe' study observed antimicrobial resistant *Salmonella typhi* to commonly used drugs like ciprofloxacin and erythromycin has intercontinental spread.

Prevention and Control

I Safe disposal of human excreta and safe water supply and personal hygiene are effective methods of prevention for waterborne diseases including typhoid fever. These measures can reduce morbidity due to typhoid fever by 80–100% (WHO 1992).

We have the programme of national water supply and sanitation but the coverage is low because of escalating cost and rising population.

II Personal hygiene measures which include washing hands before eating and after defecation with soap and water cuts down the incidence of waterborne diseases to at least one-third. Similarly, eating clean food and safe storage of drinking water should be promoted. Dipping hands into pitcher to draw water is a dangerous practice as it contaminates water. Avoid use of ice and ice candy as also controlling food vendors in schools (avoiding eating exposed food and fruits) and control by parents, and teachers can be helpful measures to cut down the transmission.

Immunization is no substitute or replacement for safe water, sanitation and hygienic practices. It remains an interim measure or intervention to prevent disease in individuals. The efficacy of all vaccines available is limited.

Immunization

Interestingly when India adopted expanded programme of immunization in 1978, typhoid vaccination was included in its programme. It was targeted at 5–6 years children and dose of 0.5 ml in two occasions was given by subcutaneous route. Subsequently, this was discontinued because of severe reactions and low level of efficacy ranging from 50 to 73% and its acceptability was low.

Policy Guidelines in India (Recommendations)

1 To make available whole cell, acetone killed and dried typhoid vaccine (monovalent AKD) to be supplied on demand. This will remain inexpensive choice for wide use and its efficacy has been rated high. Its side effects are not serious and no worse than that of DPT. Moreover, it can be given in infancy.

2 Provide Vi vaccine single dose at an age between 2 and 5 years in all public sector vaccination clinics in all urban communities. Such children may be given one repeat dose after 3–5 years.

3 As part of any typhoid outbreak control, use oral typhoid vaccine in the age group 6–40 years.

1. WHO Recommended Typhoid Vaccines

Three WHO prequalified typhoid vaccines are currently available[8–9]

Newer Vaccines Against Typhoid

1. The Vi capsular polysaccharide vaccine: This vaccine is composed of purified polysaccharide from *S. typhi*. It is administered as single subcutaneously or intramuscularly, dose is 0.5 ml (which contains 25 microgram of Vi antigen). The dose is same for children and adults. There is no contraindication to vaccine except for pregnancy. The vaccine confers immunity after 7 days of injection. **The vaccine is not effective under 2 years of age**. Vi vaccine offers protection for a period of 3 years. Hence, revaccination is recommended after every 3 years. Efficacy of this vaccine is at least 60% in hyperendemic region, in Nepal trial it was 77%. This vaccine is recommended for children above 2 years of age and adults and other population groups.

This vaccine is poorly immunogenic in children below 2 years of age.

Storage: Temperature +2° to +8°C.

Adverse Reactions

None, because of its purity, mild pain at injection site, redness or local induration in 1% of cases.

2. Ty21a Vaccine

This is a live attenuated strain of *S. typhi*. It is live oral vaccine against typhoid. The vaccine is usually administered orally as enteric-coated capsules and is registered for use from 6 years of age.

Vaccine is indicated for children 2 years and above and adults. One capsule is administered 2 days apart, and 3 doses are recommended on day 1, 3 and 5. When the vaccine is given in 3 doses 2 days apart, protective immunity is achieved 7 days after the last dose.

Protection lasts for a period of 3 years. It has shown protective efficacy of 62%. In disease endemic areas, a booster dose is recommended every 3 years.

A liquid formulation of the Ty21a can be taken by the children as young as 2 years of age and has proved more immunogenic than capsular formulation (WHO).

Storage: Temperature +2° to +8°C.

3. Typhoid Conjugate vaccines (TCV)

TCV is capsular polysaccharide (VI) covalently linked to a protein conjugate of tetanus toxoid, diphtheria toxoid (Vi-TT). TCV generates robust immune response in children less than 2 years. In 2018 WHO position paper

and recommendations of strategic Advisory Group of Experts (SAGE) recommended single dose of Vi-TT for children less than 2 year either along with initial measles Rubella Vaccine at 9-12 months of age or with the second dose of measles Rubella at 16–24 months.

Vi-TT thus can be introduced into routine immunization programme under UIP based on local endemicity level of typhoid disease.

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ZOONOTIC DISEASES

RABIES (A NEGLECTED TROPICAL DISEASE)

Epidemiology of Rabies

Rabies is 100% fatal but a preventable disease. It is primarily a zoonotic disease transmitted between animals, man is involved incidently.

Causative organism: Rabies is caused by rabies virus (RABV) from Rhabdoviridae family—*Lyssavirus* genus which is a bullet shape virus. It is very fragile virus rapidly destroyed by savlon, dettol and povidone iodine.

Distribution

Worldwide distributed responsible for 59000 human deaths and over 3.7 million DALY Lost every year. However, New Zealand, Australia and Japan are free of human rabies.

Indian Scenario

Rabies is endemic in India reported from all states and UTs except Lakshadeep and Andaman and Nicobar Islands. Rabies continues to be a public health problem, killing every year an estimated 20000 people in India, 45% of the victims are children below 14 years of age. India with 62 million street dogs population recorded 16 million street dog bites between 2019 and 2022.

Reservoirs

Dogs and cats in India are principal reservoirs. Dogs being responsible for 95% and cats 2% of the bites. Monkeys, cattle, horses, sheeps, pigs, jackals and moongoses are other animals to name a few for 1%. Bites by domestic rats, mice, squirrels, hare and rabbits do not ordinarily require PEP treatment. Bites by all wild and forest animals should be treated as category III bites.[1,2]

Transmission

The virus is excreted in the saliva of rabid animals like-dog. Infection is transmitted to humans by bites and scratches of rabid animals, by licks on broken skin and by licks on intact mucous membranes.

Man-to-man transmission: Man-to-man transmission has never been well documented, other than the few cases resulting from organ (cornea) transplant. However, people exposed to secretion of a patient with rabies may be offered postexposure prophylaxis (PEP) as precautionary measure.

Incubation Period (IP)

In humans incubation period varies from 2 weeks to 6 years. On an average it is 30–90 days after the bite. IP is shorter in case the bite site is closer to brain such as face, hand, and neck.

Contagion index: Bite on face has 100% and on legs 2%.

Symptoms/Signs of Rabies in Human Beings

Hydrophobia is characteristic symptom/sign of rabies in man. It is due to hyperexcitability and contraction of muscles of pharynx, larynx and oesophagus. The swallowing of mouthful of water or even the sight of water, glass of water or sound of running water is enough to trigger hydrophobic reaction. The person dies in 1–5 days due to respiratory paralysis and cardiac arrest.

Paralytic rabies: In paralytic form of rabies there is a flaccid Landry's ascending paralysis and person dies in 7–10 days. The symptoms are less characteristic, patient may die before the diagnosis, usually there is no hydrophobia in this type of rabies.

Rabies in Dogs

Incubation period in dog is from 10 days to 2 months and sometimes more. In prodromal phase dog behaves abnormally—hides in dark corners and becomes restless. Excitability is enhanced and dog becomes dangerously aggressive with a tendency to bite objects, animals and

man including its own master. Often it bites itself. Salivation is profuse, generalized convulsions are seen at terminal phase. In dumb form of rabies there is progressive paralysis of muscles of head and neck and difficulty in swallowing. The death results due to general paralysis in 5–6 days.

REVISED NATIONAL GUIDELINES ON RABIES PROPHYLAXIS (2019)[3–5]

Because of long incubation period, which is typical of most cases of human rabies, it is possible to institute prophylactic postexposure treatment. In countries like India, where rabies is endemic, the animal bite management should not depend on laboratory results. The treatment should be started immediately as per recommended guidelines.[1]

Approach to Postexposure Prophylaxis (PEP)

The postexposure treatment is a three-pronged approach. All three carry equal importance and should be done simultaneously as per category of exposure.

i *Management of animal bite wound(s)*

ii *Passive immunization with:* Rabies immunoglobulins (RIG)

iii *Active immunization with:* Rabies vaccine.

Management of Animal Bite/Wound(s)

Wound(s) toilet: Since the rabies virus (RABV) enters the human body through a bite or scratch and virus multiplies locally, it becomes imperative to remove as much saliva, and thereby the virus from the wound by an efficient wound toilet that should not involve additional trauma. Since the rabies virus can persist and even multiply at the site of bite for a long time, *wound toilet* must be performed even if the patient reports late.

1 Prompt and gentle thorough washing with soap or detergent and flushing the wound(s) with running water for approximately 15 minutes and copious amount of water. If soap and detergent are not available, wash with running water. Avoid direct touching of wound with bare hands. Wound washing is crucial step.

2 After thorough washing and drying the wound, any one of the available virucidal chemical agents should be applied. Savlon (in appropriate recommended dilution), dettol (in appropriate recommended dilution), povidone-iodine, alcohol, etc. are appropriate.

3 Local infiltration of RIG in category III exposure to neutralize the locally present virus.

4 The application of mud soil, chillies, oil, etc. is unnecessary and damaging. In case soil, chillies, oil, etc. have been applied over wound, enough gentle washing with soap or detergent to remove the extraneous material should be done followed by flushing with enough amount of water immediately.

5 Suturing of wound should be avoided as far as possible. If unavoidable, minimum loose sutures should be applied after adequate local treatment along with proper infiltration of anti-rabies serum (RIG).

6 Cauterization of wound is no longer recommended as it leaves a very bad scar; and does not confer any additional advantage over washing the wound with soap and water.

7 Injection tetanus toxoid should be given to the individual. To prevent sepsis suitable antibiotic may be recommended.

RABIES IMMUNOGLOBULIN

Local infiltration of Rabies Immunoglobulin in category III bites is life saving. The anti-rabies serum/RIG provides passive immunity in the form of ready-made antibodies before it is physiologically possible for the victim to produce his/her own antibodies following anti-rabies vaccination. RIG has the property of binding with the RABV, thereby resulting in neutralization and loss of infectivity of the virus. Therefore, RIG should be administered to all patients with category III exposure.

Indications

1 All category III animal bite exposures cases

2 Exposures to all wild animals should be treated as category III exposure.

In immuno compromised individuals such as HIV/AIDS patients, patients on immunosuppressive therapy (steroids/cancer chemotherapy) congenital agammaglabulinemia RIG should be administered both Category II and III exposure.

Two Types of RIGs are Available

- **Equine rabies immunoglobulin (ERIG):** ERIG is of heterologous origin produced by hyper-immunisation of horses. Currently manufactured ERIGs have highly purified Fab 2' fragments and the occurrence of adverse events have significantly reduced. These are produced in India in public and private sectors. Since ERIG is of heterologous origin, it carries a small risk of anaphylactic reaction (1/150,000).

  A skin test prior to administering ERIG is not required because testing does not accurately predict adverse reactions, and ERIG should be given irrespective of the result of the test. The treating physician should be prepared to manage anaphylaxis which, although rare, could occur during any stage of administration, even when the skin test is negative. However, some manufacturers of ERIG still recommend performing a skin test.

- **Human rabies immunoglobulin (HRIG):** HRIG is of homologous origin and is relatively free from the side effects encountered in serum of heterologous origin. Because of longer half-life, HRIG is given at half the dose of ERIG.

DOSAGES OF RABIES IMMUNOGLOBULIN

Generic Name	*Dose*
ERIG	40IU per kg body weight
HRIG	20IU per kg body weight

ADMINISTRATION OF RIG

- The RIG should be brought to room temperature (25°C to 30°C) before administering to the patient.
- The role of RIG is to provide neutralizing antibodies at the site of exposure before patients starts producing their own antibodies as a result of vaccination. Therefore, RIG should be administered to all patients with category III exposure, except those who have previously received complete PrEP or PEP.
- RIG is administered only once, preferably at or as soon as possible after initiation of postexposure vaccination. It is not indicated **beyond the seventh day** after the first dose of rabies vaccine, regardless of whether the doses were received on days 3 and 7, because an active antibody response to the rabies vaccine has already started, and this would represent a wastage of RIG.
- The maximum dose of HRIG is 20 IU/kg of body weight, while that of ERIG is 40 IU/kg of body weight. There is no minimum dose.
- The entire immunoglobulin dose, or as much as **anatomically possible** (but avoiding possible compartment syndrome), should be **infiltrated carefully** into or as close as possible to the wound(s) or exposure sites. Evidence suggests that injecting the remaining RIG volume intramuscularly at a distance from the wound provides little or no additional protection against rabies as compared with infiltration of the wound(s) along.
- If however, there is a high likelihood that there are additional small wounds (e.g. if a child does not report all wounds), injection of the remaining RIG volume intramuscularly as close as possible to the presumed exposure site, to the degree that is anatomically feasible, is indicated. The same applies to mucosal exposure with no wound, and rinsing with RIG can be considered. In the case of suspected exposure to RABV via aerosols, an intramuscular injection of RIG is still recommended.
- Tip of the finger(s), toe(s), ear lobe(s) or bites on the nose or around the eye can be safely injected with RIG provided the injection is not done with excessive pressure, which can cause compression syndrome. RIG should never be administered in the same syringe or at the same anatomical site where the vaccine was administered.
- As for all immunizations, animal bite victim should be kept under observation for at least 15–20 minutes after administration of ERIG and there is not need to admit the patient.

TOLERANCE AND SIDE EFFECTS AFTER RIG INFILTRATIONS

- There may be transient tenderness at the injection site and a brief rise in body temperature that does not require any treatment. Anaphylactic reactions are extremely rare. **RIG must never be given intravenously**.
- Serum sickness is rare and occurs usually 7 to 10 days after injection of ERIG, but it has not been reported after treatment with HRIG.
- A full course of Rabies vaccine should follow thorough wound cleansing and passive immunization.

Local Infiltration of Rabies Immunoglobulins (RIG)

In category III bites, rabies immunoglobulin is lifesaving.

POST EXPOSURE PROPHYLAXIS

DECISION TO TREAT

In a rabies endemic country like India, where there is sustained dog-to-dog transmission, every animal bite is suspected as a potentially rabid animal bite, and treatment should be started immediately after exposure. Post-exposure prophylaxis needs to be considered in the following conditions:

- Bites by all warm-blooded animals.
- **Exposure to wild animals:** Exposures to all wild animals should be treated as Category III exposure.
- **Rodent Bites:** Exposure to domestic rodents, hare and rabbits do not ordinarily require PEP. However, rodent bites in forest areas necessitate institution of PEP.
- **Exposure to bats:** Bat rabies has not been conclusively proven in India and hence, at present, exposure to bats does not warrant PEP.
- **Human-to-human transmission:** The risk of human-to-human transmission is minimal and there are no well-documented cases, other than the few cases resulting from infected organ/tissue (cornea) transplant. However, people who have been exposed closely to the secretions of a patient with rabies may be offered PEP as a precautionary measure. Organ/tissue (cornea) for transplantation should not be collected from suspected/confirmed rabies or rabies-like encephalitis cases.

OBSERVATION OF BITING DOG/CAT

The PEP should be started immediately after the exposure. The observation period of 10 days is valid for dogs and cats only. The natural history of rabies in mammals other than dogs and cats is not fully understood and therefore the 10 day observation period is not applicable in such animals.

The treatment may be modified if the suspected dog or cat involved in the incident is healthy after a 10 day observation period and PEP can be converted to pre-exposure prophylaxis (PrEP) by skipping the vaccine dose on day 14 and administering it on day 28 while using **IM regimen** (Essen Schedule).

While using **ID route** of administration complete course of vaccination should be given irrespective of the status of animal.

VACCINATION STATUS OF BITING ANIMAL

Animals vaccinated against rabies do not suffer and transmit the disease. However, animal vaccine failures may occur because of improper administration, inadequate doses, poor quality of the vaccine or poor health status of the animal. Thus, the history of rabies vaccination in an animal does not guarantee that the biting animal is not rabid.

Therefore, in the absence of laboratory documentation of immunization (antibody titre), it cannot be presumed that a vaccinated dog is actually protected, given the variable efficacy of various anti-rabies vaccines in animals or health status of animals. Hence, irrespective of the vaccination status of the biting animal, the PEP should be given.

PROVOKED VERSUS UNPROVOKED BITE

A bite by a provoked animal does not mean that the animal is not rabid. Therefore, a provoked dog bite should also be managed as exposure and PEP should be started immediately.

CONTRAINDICATIONS AND PRECAUTIONS

As rabies is a nearly 100% fatal disease, **there is no contraindication to PEP**. Pregnancy, lactation, infancy, old age and concurrent illness are not the contraindication for Rabies PEP in the event of an exposure. Moreover, rabies vaccine does not have any adverse effect on pregnant woman, course of pregnancy, foetus or lactating mother. Hence, complete PEP should be given depending on the category of exposure.

People taking chloroquine for malaria treatment or prophylaxis may have a reduced response to Intradermal (ID) Rabies vaccination. These patients should receive the rabies vaccine by **Intramuscular (IM)** route.

As with all other immunizations, vaccinated persons should be kept under medical supervision for at least **15-20 minutes** following vaccination. Previous reaction to any component of a vaccine is a contraindication to the use of the same vaccine for PEP or PrEP.

The long and variable incubation period, which is typical of most human rabies cases, provides a window of opportunity to initiate PEP and protect the individual. This must be started at the earliest to ensure that the individual is immunized or protected before the rabies virus reaches the nervous system. However, people who present for treatment even months or years after a possible rabies exposure should be evaluated and treated as if the event had occurred recently.

Risk assessment of potential rabies exposure can be complex and confusing. When in doubt PEP should be initiated and the attending physician should consult a specialist at anti-rabies clinics (ARC).

The categorization of animal bite wound depend on the type of exposure is as under (Table 8.23).

Rabies Vaccines for Active Immunization

Neural Tissue Vaccines (NTV): An Obituary

In the past, BPL inactivated sheep brain vaccine (Simple type) was in use. NTVs have been effective, but they contain less antigen, daily injection for 10–14 days followed by boosters are required to produce a protective level of antibody.

WHO has strongly recommended *discontinuation of* the use of reactogenic *nerve tissue derived vaccines* and their complete replacement with safe and potent cell

Table 8.23: Type of contact, exposure and recommended postexposure prophylaxis (PEP) 2019

Category of exposure	*Type of exposure*	*Recommended postexposure prophylaxis* (PEP)
I	• Touching or feeding of animals • Licks on **intact skin** • Contact of **intact skin with** secretions/excretions of rabid animal/human case	• No PEP, if reliable case history is available • Wash exposed area with water and soap and apply antiseptic
II	• Nibbling of uncovered skin • Minor scratches or abrasions **without bleeding**	• Wound management • Rabies vaccine
III	• Single or multiple **transdermal** bites or scratches, licks on **broken skin** • Contamination of **mucous membrane** with saliva (i.e. licks)	• Wound management • Rabies immunoglobulin • Rabies vaccine

Note: Bites by **wild animals** and all bites in **forest areas** should be considered as category III exposures and treated accordingly.

culture vaccines. Now the production and use of NTV has been discontinued by the Government of India since December, 2004.

Vaccines for Intramuscular (IM) Regimen

1. Cell Culture Vaccines (CCVs)

CCVs available in India:

i Human diploid cell vaccine (HDCV), 1 ml

ii Purified chick embryo cell vaccine (PCECV), 1 ml

iii Purified verocell rabies vaccine (PVRV), 0.5 ml

2. Purified Duck Embryo Vaccine (PDEV)

Intramuscular regimen for post exposure prophylaxis-essen regimen (1-1-1-1-1):

Five dose intramuscular schedule—the course for post-exposure prophylaxis consists of intramuscular administration of five injections, one dose each given on days 0, 3, 7, 14 and 28. Day 0 indicates the date of administration of the first dose of vaccine (Fig. 8.13A).

Switching the route of administration from IM to ID or vice versa and switch over from one type of modern Rabies Vaccines to the other during PEP is not recommended as a routine. However whenever this is absolutely required as per WHO recommendation PEP need not be re-started and the regimen should be continued/resumed as per the new vaccine/route of administration

Changes in rabies vaccine product and/or the route of administration during the same PEP course are acceptable, if unavoidable to ensure PEP course completion.

PEP for immune-compromised persons requires wound management, local infiltration of RIG followed by complete course of anti-rabies vaccination by intramuscular route in both category II and III exposures and need of additional doses of vaccine after testing anti-rabies antibody.

Dose: 1 ml for HDCV, PCECV, PDEV, and 0.5 ml for PVRV irrespective of age of person. The dose of PVRV by Pasteur Institute of India, Coonoor is 1 ml per injection.

Indications

All cases of animal bites (categories II and III) irrespective of severity of exposure, require the same number of injections and dose per injection. The category III requires administration of rabies immunoglobulins.

Site of Injection

The deltoid region is ideal for the inoculation of these vaccines. Gluteal region is not recommended because the fat present in this region retards the absorption of antigen and hence impairs the generation of optimal immune response. Intramuscular schedule—the most widely used WHO Essen Regimen on day 0, 3, 7, 14 and 28 (1–1–1–1–1). In case of infants and young children anterolateral part of thigh is the preferred site.

Abbreviated Multisite IM Regimen

In the abbreviated multisite schedule (Zagreb schedule), the '2–1–1' regimen, one dose (of HDCV or PCECV or PVRV or PDEV) is given in the right arm and one dose in the left arm (IM) on day 0 and one dose given IM in the deltoid region on days 7 and 21.

Cost of Postexposure Treatment

Presently many types of cell culture vaccines are available in India. The costs of various CCVs are as given: HDCV costs ₹3280, PCEC cost ₹1075 and PVRV cost ₹1155 if regular five dose intramuscular schedule is followed. Most of these cases also require administration of rabies immunoglobulins, which adds to the cost.

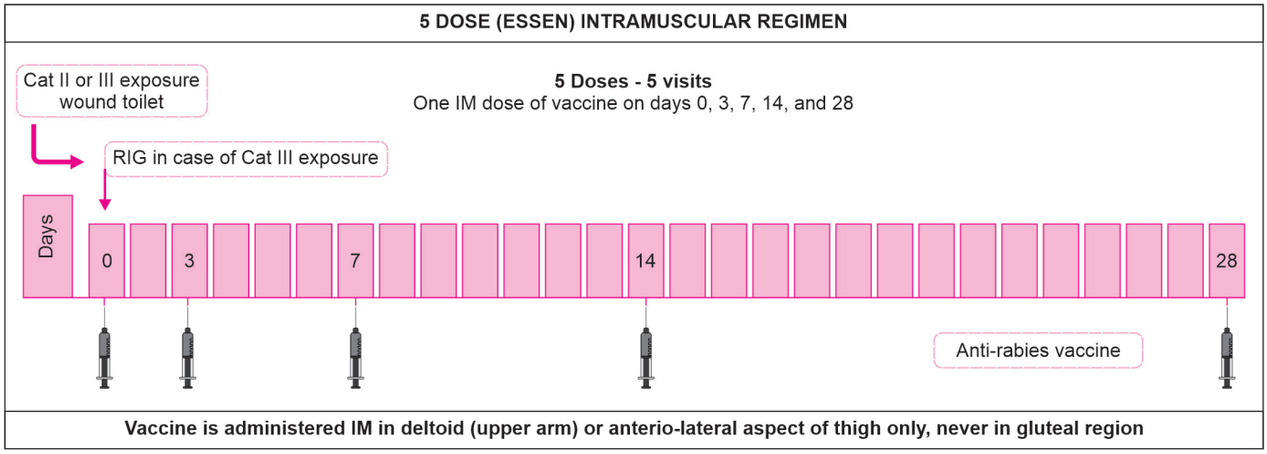


Fig. 8.13A: ESSEN intramuscular regimen

Intradermal (ID) Regimens[3]

To reduce the cost of postexposure treatment with CCVs, WHO has recommended intradermal regimens with CCVs. Intradermal regimens are cost-effective and it has been evaluated by WHO and recommended in Thailand. The updated Thai Red Cross schedule (TRC) is ('2–2–2–0–2'): One dose of vaccine in a volume of 0.1 ml is given intradermally at two different lymphatic damage sites, usually the left and right upper arm, on days 0, 3, 7 and 28.

Updated Thai Red Cross schedule (2–2–2–0–2) has been adopted in India.

Vaccines for intradermal route: Only approved safe and efficacious CCVs are to be used-PVRV (Verorab, Abhayrab, Indirab and Pasteur Institute of Coonoor) and PCECV (Rabipur and Vaxirab N).

Intra-dermal (ID) Route

National Rabies Control Program Strongly advocates of intradermal route of Rabies vaccine. The use of the ID route leads to considerable saving in the total amount of vaccine needed to complete PrEP or PEP, thereby reducing the cost of active immunization.

However, Intradermal administration is not the preferred route of Rabies vaccine administration **for immune-compromised individuals or individuals receiving Chloroquine, Hydroxychloroquine or long-term conrticosteroid or other immunosuppressive therapy**.

As the volume of an ID vaccine dose is lesser than that of an IM dose, the intradermal route is especially suitable for treating many patients at the same centre or where attendance of animal bite cases is more. However entire vial content should be utilized within 6 hours after reconstitution of the vaccine.

Only the Rabies Vaccine (lyophilized vaccine along with the diluent of specified volume) approved by DCGI for ID administration should be used for ID route. The vaccine package leaflet should include a statement indicating the potency as well as innunogenicity and route of administration for PEP and PrEP.

Regimen for postexposure prophylaxis-updated Thai Red Cross Schedule (2-2-2-0-2) (Fig. 8.13B).

This involves the injection of 0.1 ml of reconstituted vaccine per ID site and on two sites per visit (one on each deltoid area, an inch above the insertion of deltoid muscle) on days 0, 3, 7 and 28. Day 0 is the date of administration of the first dose of Rabies Vaccine.

Storage and Transportation

Though cell culture vaccines are marketed in freeze dried (lyophilized) form, which is more tolerant to higher temperature, yet it is recommended that these vaccines should be kept and transported at a temperature range of +2° to 8°C. Freezing does not damage the vaccine, but there are chances of breaking of ampoule containing the diluent.

Reconstitution

The lyophilized vaccine should be reconstituted with the diluent provided with the vaccine immediately prior to use. However, in case of unforeseen delay it should not be used after 6–8 hours of reconstitution.

Potency: The potency is the capacity of the vaccine to induce immune response. For modern vaccine, it is more than 2.5 IU per IM dose.

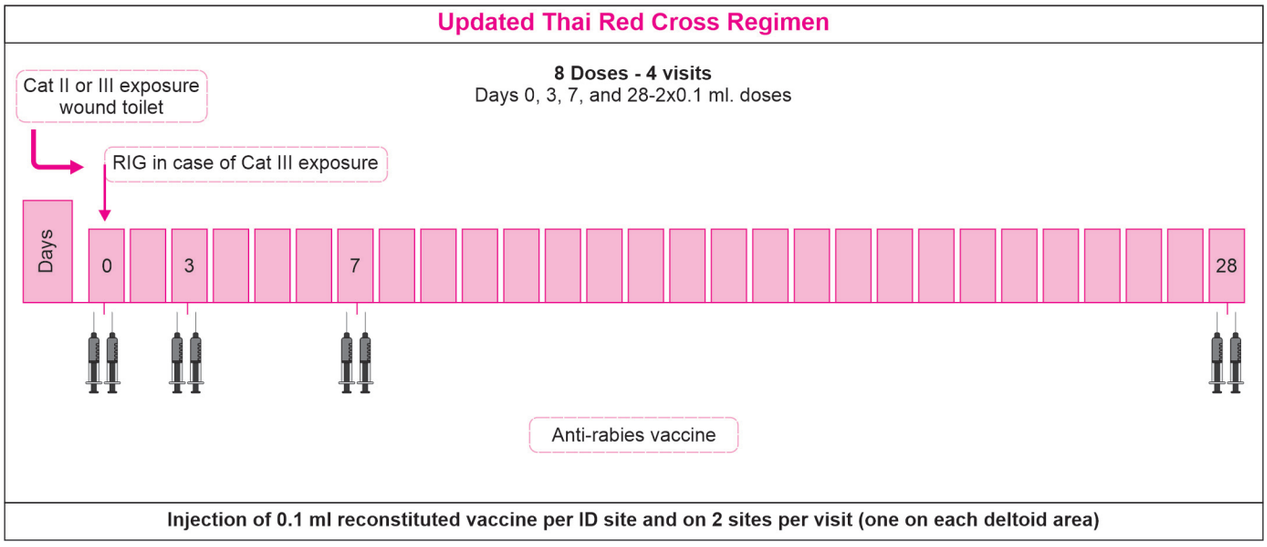


Fig. 8.13B: Updated Thai red cross regimen (2–2–2–0–2)

This involves the injection of 0.1 ml of reconstituted vaccine per ID site and on two sites per visit (one on each deltoid area, an inch above the insertion of deltoid muscle) on days 0, 3, 7 and 28. Day 0 is the date of administration of the first dose of rabies vaccine.

Protective Level of Antirabies Antibody

Humoral antibodies are believed to play an important role in protection against rabies. Anti-rabies neutralizing antibody titre of 0.5 IU/ml or more in serum is considered as protective. This level is achieved in most healthy individuals by day 14 of PEP. Antibody tests, viz. Rapid Fluorescent Focus Inhibition Test (RFFIT), Mouse Neutralization Test (MNT) can be done to know the level of antibody.

Adverse Events Following CCVs

The cell culture vaccines are widely accepted as least reactogenic rabies vaccines available today. The general adverse reaction includes sore arm, headache, malaise, nausea, fever and localized oedema at the site of injection. Only symptomatic treatment is advocated.

Switch Over from One Vaccine to Other

Shifting from one brand of CCV to other brand also should not be encouraged in routine practice as however under unavoidable circumstances, available brand/type may be used to complete the PEP.

Managing Re-exposure Following Postexposure Treatment with CCVs

Several studies have indicated that persons who have previously received complete pre- or post-exposure prophylaxis will elicit an **anamnestic** response (enhanced reaction of body immune system to one or more booster doses of rabies vaccine) even if the initial dose of vaccination was administered several years previously.

If a re-exposed person who can document previously received full pre-exposure/postexposure prophylaxis (anytime in the past either pre-exposure 3 doses or postexposure 5 doses) with a potent cell culture vaccine, should be given only two booster doses, intramuscularly or intradermally on days 0 and 3 but no rabies immunoglobulin is necessary in them (WHO 2002). If a repeat exposure occurs within 3 months of completion PEP, only adequate wound treatment is required neither vaccine nor RIG are needed (WHO—2018).

Pre-exposure Prophylaxis (PrEP)

It is indicated for high-risk groups—like laboratory staff handling the virus and infected material, clinicians and paramedicals attending to hydrophobia cases, veterinarians, animal handlers and catchers, wildlife wardens, quarantine officers, and travellers from rabies free areas to rabies endemic areas. IAP recommends PrEP in children. This may be considered on voluntary basis.

Pre-exposure immunization should be three full IM or ID doses of CCVs given on days 0, 7 and either day 21 or 28.

Laboratory staff and others at high continuing risk of exposure should have their neutralizing antibody titres checked every 6 months during the initial 2 years and thereafter every 2 years. If it is less than 0.5 IU/ml, a booster dose of vaccine should be given. Such individuals on getting exposure to rabies virus after successful pre-exposure immunization require only two booster injections of vaccine given on days 0 and 3 without any antirabies serum (RIG).

Management of Animal Bite Exposure in Pregnant Women and Lactating Mothers

Pregnancy and lactation are no contraindications for rabies vaccination. Postexposure prophylaxis against rabies takes preference over any other consideration since it is life-saving procedure. Moreover, antirabies vaccine does not have any adverse effect on foetus, mother to be and the course of pregnancy. Hence, complete postexposure treatment should be given depending upon the category of exposure.

Pre-exposure Immunization in Animals

Pre-exposure immunization of pet animals against rabies is recommended.

Single dose: The vaccine is prepared as 20% suspension of brain from sheep infected with modified rabies virus. The virus in the brain suspension is inactivated with phenol or b-propiolactone (BPL). It is only used for pre-exposure immunization.

Veterinary antirabies vaccine multiple dose: This vaccine is also prepared from sheep brain infected with modified rabies virus. Modern cell line inactivated vaccines in India for animals are available. For dogs and cats, the primary schedule of 2 injections at 2 months age with one month interval and a booster every year is recommended. Oral vaccine for dogs offers a new approach.

NATIONAL RABIES CONTROL PROGRAMME (NRCP)

The Government of India has initiated the National Rabies Control Programme in 12th Five Year Plan which has both human and animal components. National centre for disease control is the nodal centre for human component. Ministry of Environment and Forest is the Nodal Ministry for animal component. The animal component is being tested in Haryana and Chennai.

Objectives of NRCP

The main objective is to reduce the disease incidence and deaths due to rabies.[1]

The main strategies for control programme are:

i Capacity building training of health and veterinary professionals.

ii Implementing use of intradermal route of vaccine.

iii Strengthening surveillance of animal bites and human bites.
iv Population survey of dogs.
v Mass vaccination of dogs.
vi Dog population management.
vii IEC activities—increase awareness about rabies
viii Strengthening of laboratory diagnosis of rabies.
ix Collaboration with veterinary and animal husbandry.

NATIONAL PROGRAMME FOR CONTROL OF RABIES IN DOGS

National Action Plan for Dog mediated Rabies Elimination from India by 2030 released in Sept 2021 by NCDC.

Canine rabies can be eliminated. Canine rabies control programme should incorporate three basic elements:

(a) Epidemiological surveillance, (b) mass vaccination and (c) dog population control

a. Epidemiological Surveillance

Rabies should be made notifiable disease within national health and veterinary systems. Rabies surveillance is inadequate. Both clinically and laboratory confirmed cases and persons seeking and receiving postexposure prophylaxis should be regularly reported to capture burden and trends of problem.

b. Canine Mass Parenteral Vaccination Campaigns

i. Mass canine vaccination campaigns have been most effective measure for controlling canine rabies. At least 70% of the dog population in each community should be vaccinated in areas where canine rabies is endemic. Registration and permanent identification of vaccinated dogs is recommended.
ii. *Supplementary measures:* Oral vaccination of dogs offers a new approach that may improve vaccination coverage of stray dogs in rural and urban slum areas.

Although the preferred vaccine for dog immunization should be parenteral (inactivated cell culture vaccine), oral vaccine should be used whenever there is higher population of inaccessible dogs.

c. Dog Population Management and Animal Birth Control (ABC) Programmes (Rules 2023)

Three practical methods of dog population management are recognized—movement restriction, habitat control and reproduction (sterilization of dogs). Attempt to control dog population through culling without alteration of habitat have generally been unsuccessful. Based on 1990 WHO guidelines, ABC programmes have been launched in several countries and the results have been encouraging, with a reported reduction in the size of the street dogs population and the number of human rabies cases (only after 70% of street dogs are sterilized).

Since dogs are the major reservoir of rabies transmission in India, hence their population must be controlled. The latest report of the state of homeless index of India states that there are about 62 million street dogs population in India.

The dog destruction used to be one of the pivotal activities at the primary health centre in India. Sanitary inspectors used to destroy dogs in rural areas after obtaining the requisition from village *panchayats*. Now culling of stray dogs has been banned since 2001.

- Sterilization of dogs and monkeys has been attempted to reduce their population.

Various organizations are currently involved in control activities without any intersectoral coordination. Existing rabies control activities are being carried out by Municipal Corporations/Committees, in their respective areas.

Health Education (IEC Activities)

Health education of public on prevention and control of rabies and management of bites and their response to bite at local level is crucial to save lives. This should be attempted through primary healthcare infrastructure besides mass-media as also formal and non-formal education channels.

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PLAGUE

EPIDEMIOLOGY

Plague is primarily a zoonosis, being a disease of rodents and man is affected incidentally.

Plague is an acute communicable disease caused by *Yersinia pestis* and transmitted to man by the bite of infected rat flea. It remains a major life-threatening infection of human beings and animals.

Occurrence

Plague recognized no boundaries and used to occur in pandemic form, in epidemics and it has become endemic in some parts of the world. It has caused millions of deaths. The first pandemic occurred in 543 AD in Egypt during the reign of Emperor Justinian and it killed about 100 million people. The second pandemic started in 1345 and it killed 25 million people and third pandemic started in 1845 and it killed 10.25 million people. More than 12 million people died in India from 1898 to 1950s. The incidence has declined considerably due to improvement in living conditions.[1, 2]

Indian Scenario

Nearly 12.5 million people died in India in the last pandemic which started way back in the year 1894 as recorded deaths in India from 1898 provides this evidence. After 1966, the plague re-emerged in India in 1994 after a gap of 28 years when cases were reported from village Mamla in Maharashtra.[1]

Natural foci of plague are known to exist in parts of Andhra Pradesh, Gujarat, Himachal Pradesh, Karnataka and Tamil Nadu. The reasons are environmental degradation because of emerging urban slums, deforestation, increase in population of rodents in slums besides rising population. 'Charminar' at Hyderabad was built to commemorate elimination of plague epidemic in the city.

Outbreak of Plague in 1994 Case Study

On 30th September 1993, a devastating earthquake struck in parts of Osmanabad and Latur district of Maharashtra. The affected population was rehabilitated in temporary shelters 1–3 km away from affected areas. People of Mamla village in Beed district of Maharashtra abandoned their homes and resettled in temporary shelters. Lots of grains were rushed to the area and probably these environments brought rodents closer to human beings. After a period of one year, the rodent population got built up and cases of bubonic plague were reported from Mamla village. In August 1994, the *R. rattus* population overshot its equilibrium density and eventually led to an epizootic in rats (rat-to-rat transmission of plague by rat flea and leading to death of rats). On 5th August 1994, the inhabitants of village Mamla experienced heavy flea nuisance and rat falls (deaths) were reported. Subsequently, a number of cases clinically resembling bubonic plague were reported from Mamla village and from surrounding villages.[3–5] Afterwards during the third week of September 1994, 876 suspected cases of pneumonic plague were reported and 54 people died in Surat (Gujarat). Recently in 2002, 16 cases and 4 deaths of pneumonic plague were reported from Hat Koti village of Shimla district in Himachal Pradesh. The cases were confirmed by NICD Delhi.[6] *Yersinia pestis* strains were isolated from human and rodent specimens and molecular characterization showed that biotype of the Surat strain was different from the existing 16 biotypes of *Y. pestis*. Three cases of plague occurred in a village in Uttaranchal in 2004. This case study explains risk factors for occurrence of plague.

Epidemiology of Plague in India

Causative Agent

The causative organism of plague is bacteria *Yersinia pestis* which was previously called *Pasteurella pestis*. It is a small gram-negative, straight oval bacillus of size 1.5 mm × 0.7 mm. The bacillus has rounded ends and convex sides, arranged singly in short chains or in small groups. High degree of pleomorphism is seen in smears from buboes and culture grown on 3% of salt agar. The organism manifests typical bipolar staining (safety pin appearance).

The organism may remain viable for several weeks in water, moist soils and grains. However, it is killed by several hours of exposure to sunlight.

Reservoir

At least 220 species of rodents which inhabit mountains, plains, deserts, cultivated fields and forests both temperate and tropical climate are known to be infected with plague bacillus. The major natural vertebrate reservoir of plague includes field or wild rodents (*Tatera indica*) including ground squirrels which play an important role as reservoir of *Y. pestis*.

Mode of Transmission

Plague is primarily a disease of rodents in which man is incidentally involved. The principal mode of transmission is bite by infected flea. There are at least 5 basic types of transmission cycles in plague:

1. Domestic rats or commensal rats → rat fleas → man. This is the basic cycle in epidemic bubonic plague.
2. Jungle rat (***Tatera indica***) or wild rodents → wild rodent fleas or direct contact → man. The disease is transmitted from rodent to rodent via wild rodent fleas or contaminated soil. Man acquires infection from infectious wild rodent fleas or by direct contact with infected rodents.
3. Wild-rodents, peri-domestic rodents, commensal rodents → wild rodent fleas, peri-domestic rodent fleas, commensal rodent fleas → man. Plague foci impinge upon the habitats of peri-domestic or commensal rodents. Interaction of the rodents and their fleas convey the infection to man.
4. Man → man (through human flea: *Pulex irritans*). This variety may be encountered in certain areas.
5. Man → man (via respiratory route). This results when a primary case of bubonic plague develops secondary

pneumonic plague and infects contacts via respiratory route.

Incubation Period (IP)

Bubonic plague: 2–6 days

Pneumonic plague: 2–4 days or even shorter.

Under International Health Regulations IP is 6 days.

Pathogenesis

Rats (and other rodents) are natural reservoir of plague. The disease is maintained between rodents by the bite of infected fleas. On being bitten by an infected flea, bacteria are introduced into man. The initial response is that of lymphadenitis in those lymph nodes which receive drainage from the site of flea bite. The enlarged lymph node is called bubo and the disease as bubonic plague. If untreated this progresses to septicaemic phase in which the organisms get disseminated to various organs of the body including meninges. Involvement of lungs causes pneumonia which is of special significance since aerosolized droplets of sputum may cause primary pneumonia in another individual.

Bubonic Plague

This is the commonest form characterized by high fever, toxaemia and painful enlargement of lymph glands which are called buboes. Bubo appears on second and third day. Buboes may appear in groin or in the axillary or cervical region depending upon the site of bite and entry of organism. The glands gradually become soft and suppurate and there is marked haemorrhagic tendency with variable septicaemia. Fever usually subsides after 10 days, bubo may burst. Mortality is 25–30% in untreated cases.

Pneumonic Plague

It is due to droplet infection. It is a severe form of disease with high fever and cough with blood tinged tenacious sputum. The disease is highly contagious resulting in explosive outbreaks. Recovery is rare and death occurs in 2–4 days.

Septicaemic Plague

This is a variant of bubonic plague, where there is overwhelming septicemia or over-running the lymph nodes. Consequently, lymph node enlargement is not prominent but the patient is highly toxic. This form also results in very high mortality.

Pestis Minor

It is an ambulant plague, a mild form of disease with fever and buboes which may suppurate. Symptoms are very mild.

Cutaneous Plague

There is pustule, eschar, carbuncle, erythema gangrenosum usually with bubo.

Meningeal Plague

Partially or untreated patients of bubonic plague may progress to meningeal stage, seen commonly in children whose presentation are typical of bacterial meningitis.

Case Fatality

If not treated in time, more than 50% cases of bubonic plague and almost all cases of pneumonic plague die.

WHO Case Definition of Plague

Suspect Plague

Compatible clinical and epidemiological features and suspicious organisms seen or isolated from clinical specimens.

Presumptive Plague (Probable Case)

- *Y. pestis* F1 antigen detected in clinical materials by direct fluorescent antibody testing, or by some other standardized antigen detection method; or
- Isolate from a clinical specimen demonstrates biochemical reactions consistent with *Y. pestis* or PCR positivity; or
- A single serum specimen is found positive for diagnostic levels of antibodies to *Y. pestis* F1 antigen, not explainable on the basis of prior infection or immunization.
- Epidemiological link with a confirmed case.

Confirmed Plague

- Isolate identified as *Y. pestis* by phage lysis or cultures; or
- A significant (equal or more than fourfold) change in antibody titre to F1 antigen in paired serum specimens.

Prevention and Control

Case Management

The response of plague to antibiotic treatment is dramatic and rapid. The drugs which are effective against plague include tetracycline, chloramphenicol, cotrimoxazole, sulphonamide and streptomycin.

Tetracycline

During first 48 hours, 4–6 g should be administered daily. Intravenous therapy is essential in severely ill-patients as in pneumonic plague. Treatment is to be continued for 10 days or at least 3–4 days after the fever has disappeared in dose of 15 mg/kg body weight every 6 hours. Oral dose for adult is 500 mg every 6 hourly. Tetracycline is contraindicated in children below 7 years, pregnant women and patients with renal failure, in such cases cotrimoxazole should be administered.

Chloramphenicol

Patients with meningitis require a drug that can penetrate the meninges. In such patients, chloramphenicol should be administered intravenously, with a loading dose of 25 mg/kg followed by 60 mg/kg in four divided doses daily till patient improves.

Streptomycin

0.5 g every 4 hours for 2 days followed by 0.5 g every 6 hours until clinical improvement occurs. This drug is associated with ototoxicity.

Cotrimoxazole

For children less than 5 years of age one teaspoonful of syrup of cotrimoxazole every 12 hours is indicated, children between 5 and 10 years 1 tablet every 12 hours is recommended. Pregnant women require administration of 2 tablets every 12 hours (single strength) and one tablet of double strength every 12 hours. The above mentioned chemotherapeutic agents are effective when given alone. Relapses are exceedingly rare. There is no rationale for using multiple drugs.

Chemoprophylaxis

Chemoprophylaxis is recommended for exposed persons, exposure to bites of rodent fleas during an outbreak or to tissues or fluids of infected animals or coming in contact with suspected case or to pet animal with suspected plague pneumonia.

WHO guidelines for chemoprophylaxis are shown in Table 8.24.

Chemoprophylaxis for general population is not recommended.[6]

During the outbreak of plague at Surat there was large scale exodus of population from Surat to other states (as natives left Surat in panic and migrated to their homes in different states). All people started consuming tetracycline and this drug disappeared from the market. A panic was created and administration wanted to isolate and quarantine the migrants in the camps which appeared to be a futile and impractical exercise. People were most comfortable in their homes and were educated to report to nearby facility if they observed any symptom compatible with plague. Sale of masks picked up tremendously and everyone on the roadside was wearing mask particularly in metropolis.

Table 8.24: Chemoprophylaxis for plague

Drugs	*Dosage*	*Interval (hours)*	*Route of administration*
Tetracycline			
• Adults	1–2 g/day	6–12	Orally
• Children	25–50 mg/kg/day	6–12	Orally
Doxycycline			
• Adults	100–200 mg/day	12–24	Orally
• Children ≥9 yrs	100–200 mg/day	12–24	Orally
Sulfamethoxazole/ Trimethoprim			
• Adults	1.6 g/day*	12	Orally
• Children ≥2 mths	100–200 mg/day*	12	Orally

* Sulfamethoxazole component

Immunoprophylaxis

A formalin killed plague vaccine is produced in limited quantity by Haffkine Institute, Mumbai. It contains 2000 million organisms per ml.

Dosage

Adult: 0.5 ml given subcutaneously followed by second dose of 1 ml after 7–14 days. Boosters are given every 6 months. Immunity appears after 5–7 days of inoculation and lasts for about 6 months. Repeated boosters induce higher incidence of adverse reactions.

Vaccination is recommended for only high-risk groups of individuals, i.e. medical and public health workers who are dealing with patients of plague or who investigate plague outbreaks and laboratory workers who handle plague cultures or plague infected material. In local outbreaks of plague, vaccination is of no use. Moreover, the vaccinated person who has been exposed to definite risk of infection must be given prophylactic antibiotics, even if his serum is known to contain antibodies against plague bacterium.

All persons exposed to patients with suspected pneumonic plague should receive antibiotics regardless of their immunization status.

Vector Control[7]

The rat fleas are the natural vectors of plague. In India, the most important species involved in disease transmission are *Xenopsylla cheopis*, *X. astia* and *X. brasiliensis*, the most common being *X. cheopis*. Both male and female fleas feed on blood.

Blocked Flea

Yersinia pestis rapidly multiplies in the gut of flea, the speed of multiplication and the enormous number of bacilli may block the lumen of the gut. The blocked flea makes repeated attempts to take the blood meal and each time it attempts to bite, it inoculates large number of plague bacilli in the body of vertebrate host. The extrinsic incubation period of plague bacilli in fleas has been reported to be 5–31 days with an average of 21 days.

Vector Control Measures

Application of insecticidal dusting powder is effective to control the flea population. The rodents pick up the dust on their feet and carry it to their nest and subsequently the insecticide is distributed over its body through constant preening.

Dust Formulation

Five per cent malathion dust powder (1 part of 25% WP malathion and 4 parts of chalk powder or inert material).

Insecticidal dust applied on runways and burrows are more effective in controlling fleas. The insecticidal dust should be blown into the opening of burrows and patch of 1 cm thick is left around it. In indoor situations, patches of dust should also be applied to rat runways, which are usually found along the wall. 15–30 cm wide patches of dust should be placed at several points along runways.

Residual Insecticidal Spray

In the absence of insecticide dust formulation, residual insecticide may be sprayed for flea control.

Rodent Control

Mass destruction of rats by baiting, and trapping should be done during inter-epidemic period. During epidemic situation, the rodent control activities should be discouraged because of killing of a large number of rodents may result in large number of fleas leaving their dead hosts and give rise to further increase in plague cases as the flea may attack the human population. Flea control must be done before killing rats.

Environmental Control

Improvement in sanitation, proper disposal of waste, proper storage of grains and foodstuffs, rat proofing of dwelling units, and plugging of rodent burrows with concrete are useful.

Plague Surveillance

Serosurveillance

i Monitoring the presence of antibodies to plague antigen in wild rodents collected from the identified foci of plague.

ii Monitoring of antibodies to plague antigen in canine is better alternative. Dogs from the villages, considered at potential risk, act as sentinels since they are likely to be exposed to infection, if infected wild rodents and/or fleas have reached human population.

iii Presence of antibodies to plague in humans in the villages at high-risk should be considered a signal for high alert.

Plague antibodies decline rapidly after vaccination or illness and are usually not detectable after a period of 6–8 months.

Warning Signals for High Alert

Commensal rodents are highly susceptible to plague. Rat fall (dead rats found in the village) is a sign of *high alert and trigger* for immediate action/investigation. A system must be in place to receive information about rat fall immediately if this occur. Local people and health workers in high-risk areas identified, should notify rat fall urgently. Health facilities must report immediately any case of fever with painful lymphadenitis (or severe pain in the groin or axilla) for immediate investigation and follow-up.

Geographical areas for surveillance: Erstwhile known foci of plague, rodent serology positive for plague antibody recorded and suspected human case(s) of plague be reported.

Collection of Rat Fleas

Rat fleas are collected to determine the species, rat flea index and susceptibility to insecticides.

The flea index or flea population density is calculated by dividing the number of fleas by the total number of rodents surveyed. For example:

Flea index = No. of fleas/No. of rodents

A flea index of 1 or above should be treated as high-risk factor and an early warning signal of risk of potential outbreak.

Similarly, species index is also calculated, e.g. *Xenopsylla cheopis* index is *X. cheopis* per rat.

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BRUCELLOSIS—NEGLECTED TROPICAL DISEASE[1]

EPIDEMIOLOGY, PREVENTION AND CONTROL

Distribution: Worldwide. This is occupational zoonotic disease. This disease seriously affects the live stock of India. Data on this bacterial zoonotic disease among

human beings is incomplete. The causative organisms are *Brucella melitensis*, *B. abortus*, *B. suis* and *B. canis*.

Reservoir and Source

The animals that serve as common reservoir include goats, sheep, cattle, buffaloes and swine.

The modes of transmission to man are by ingestion, contact, inhalation and accidental inoculation.

Ingestion

Usual vehicles of infection are:

- Untreated food products or raw milk from infected animals.
- Raw vegetables contaminated by infected animal's urine or faeces.
- Viscera, bone marrow, and lymph nodes and muscle tissue from infected carcasses which may retain brucellae for more than a month after slaughter and much longer in chilled meat.
- Contamination of water supplies by animal excreta.

Contact

Contact with brucellae in vaginal discharges, fetuses, placentae, urine, manure, carcasses and salvaged animals causes a large proportion of human cases. The skin and mucus membranes including the conjunctiva provide the portal of entry. Contact route of transmission is important in veterinarians and farmers.

Inhalation

Brucellosis infection can occur by inhalation of infected dried material of animal origin such as dust from sheep wool, railways, trucks, and lorries that have transported infected animals.

Human Brucellosis

Acute and subacute brucellosis is accompanied by fever and bacteraemia. Some patients develop an acute illness of limited duration followed by apparent recovery, others have prolonged fever followed by frequent relapses. Chronic illness may persist for number of years.

Prevention and Control

- Pasteurization of milk (heating milk at 73°C for 15 seconds and then suddenly chilling it, followed by bottling) or else boiling of milk.
- Destruction of diseased animals.
- Safe disposal of animals suffering from brucellosis or their products such as caracasses.
- Personal protection measures in slaughter houses.

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HYDATID DISEASE—A NEGLECTED TROPICAL DISEASE

EPIDEMIOLOGY

Echinococcosis: Echinococcosis is a zoonotic infection caused by adult and larval stages (metacestodes) of the cestode genus *Echinococcus* (Family Taenidae). The hydatidosis or hydatid disease is restricted to infection with metacestodes, while echinococcosis is applied to both adult and larval infections.

Hosts: Echinococcosis requires two hosts for completion of their life cycles. Definitive host is carnivorous animal usually dog. Sexual cycle is completed in definitive host and eggs are passed in the faeces. Intermediate host is represented by wide range of mammals including man. After their ingestion, cestode eggs hatch to release embryos (oncosphere) in small intestine. Penetration through the mucosa leads to bloodborne distribution to liver, lungs, kidneys, spleen, muscles, brain and other organs, via circulation. These embryos develop into hydatid cyst. Although most primary infection in humans consists of a single cyst, 20–40% of patients may have multiple cysts or multiple organ involvement. The liver is the most common site for hydatid cysts followed by lungs (50%) and less frequently in other organs like brain, kidneys, heart, and bones.

Signs and symptoms depend upon the size and anatomical site of the cyst. Common signs are liver enlargement. Rate of growth of hydatid cysts are highly variable and range from 1 to 5 cm in diameter per year. In humans, the cyst may attain volume of many litres and contain many thousands of protoscolices. Rupture of the cyst may precipitate allergic reactions.

Although disease may not progress or may resolve spontaneously, the risks of anaphylactic reactions, dissemination following rupture, and relentless growth which renders therapy more difficult or impossible provides a strong argument for early therapy. Surgical removal of hydatid cyst remains the most effective treatment. Surgical removal should be followed by injection of a protoscolicidal agent at the site (hypertonic saline or silver nitrate) and complete removal of endocyst.

Diagnosis and surgical removal of intact cysts before the onset of complications result in high cure rates with low surgical mortality (1–4%). In contrast, secondary or recurrent disease often requires repeated surgical intervention with mortality reaching 20%.

If the cyst is at inaccessible site or if it ruptures or if widespread metastasis has occurred treatment with mebendazole or albendazole may be attempted. Liver cysts respond to treatment very well but cysts at other site respond poorly. Mebendazole (50–150 mg/kg of body weight per day, as a single dose for 3 months) or albendazole (10–15 mg/kg per day, in divided oral doses for 1 month) are recommended, many patients require repeated courses.

Prevention and Control

Preventive measures include personal hygiene, strict dietary regulation of pet dogs to prevent ingestion of sheep offal and avoidance of dogs that are not so regulated. Prophylactic treatment of dogs with praziquantel at intervals just short of *pre-patent period*—before completion of sexual cycle (e.g. 45–50 days) prevents egg excretion in dogs so treated.

The principal objective of control of cystic hydatid disease consists of reducing parasite prevalence in definitive and intermediate hosts to level below those necessary for continued transmission. Essential measures include health education, control of livestock slaughtering in abattoirs and on farms, safe disposal of infected viscera, dog control, and periodic diagnostic testing and mass treatment of dogs with praziquantel. The results achieved by control programme in New Zealand, Tasmania, Cyprus, Falkland, Island, Argentina and Chile have been spectacular. Marked reduction in prevalence of cysts in sheep following the initiation of control methods, as well as in the number of new diagnosed human cases, indicate that the fundamental requirements for effective control are now tried and proved.

TAENIASIS AND CYSTICERCOSIS—NEGLECTED TROPICAL DISEASES

Taeniasis and cysticercosis are diseases caused by the adult and larval stages of cestodes or tapeworm parasites, *Taenia saginata* and *Taenia solium* in their definitive host (human) and intermediate hosts (cattle, pigs, humans) both species are meat-borne parasites that localize as adults in the intestines of human host. These intestinal infections, termed taeniasis, normally produce only mild symptoms. Eggs passed in the faeces of human carriers can cause further disease if ingested by cattle pigs or humans. In these intermediate hosts, the eggs develop to the larval (*Cysticercus*) stage and the disease is termed cysticercosis. The larval stage of *T. saginata* infects cattle, whereas *T. solium* can infect both pigs and humans. Larvae invade mainly skeletal muscles. *T. solium* larvae frequently invade the central nervous system of humans, and is consequently, a serious public health problem (occurrence of epilepsy).

EPIDEMIOLOGY

Transmission

Animals to human: *T. saginata* and *T. solium* are transmitted to humans through the ingestion of raw or inadequately cooked beef or pork.

Human to animals: Human being can contaminate the environments with large number of tapeworm eggs (2,50,000 to >5,00,000 eggs per day per individual). Indiscriminate open defecation, use of raw sewage for farming can contaminate grazing fields and farms and animals can acquire infections easily. *Taenia* eggs can survive for long and can survive many sewage treatment processes.

Human to human: Autoinfection of humans can occur with *T. solium* eggs transmitted directly from anus to mouth or transmission can occur between individuals through contaminated hands or food. Humans most commonly become infected like pigs through ingestion of *T. solium* eggs contaminating the environments (i.e. drinking water contaminated by raw or inadequately treated sewage or eating vegetables fertilized with raw sewage).

Diagnosis: By stool examination, by biopsy and by radiology and serology.

Treatment

Taeniasis

Niclosamide (reported efficacy between 85 and 95%); and praziquantel (95% efficacy with single dose of 10 mg per kg body weight) are effective for human taeniasis. Praziquantel has the advantage of minimum side effects and it effectively removes scolex.

Cysticercosis

Praziquantel has been shown to be effective in humans for *T. solium* cysticerci. Previously, the only treatment available was the surgical removal of cysts. Traditional supportive therapy includes anti-seizure and steroid medication and decompression for hydrocephalus.

Prevention and Control

Preventive measures consist of:

i Safe disposal of human excreta by sanitary latrines.
ii Treatment of sewage.
iii Proper cooking of meat.
iv Inspection of pork.
v Treatment of infection.
vi Health education.

TOXOPLASMOSIS

Toxoplasmosis is one of the important parasitic zoonoses.

The causative agent is *Toxoplasma gondii*. It is an obligatory intracellular parasite. The organism exists in different forms such as *tachyzoites* is a rapidly dividing form (which can cross placenta and infect foetus) and *cyst* form.

The life cycle consists of two phases:

- Asexual stages which occur in intermediate and definitive host,
- Sexual stage, which occurs in definitive host.

EPIDEMIOLOGY AND TRANSMISSION

Toxoplasma infection is widespread globally hence it is a global problem.

Modes of transmission:

i Congenital infection in person occurs when mother acquires infection during pregnancy and it is

transmitted from mother to foetus through placenta by trachyzoites.

ii Postnatally toxoplasmosis infection can be acquired by ingestion of food contaminated by mature oocysts present in soil or from under-cooked meat containing tissue cysts (*Toxoplasma* infection being common in many animals like cattle, sheep, rabbits and pigs used for food). Tachyzoites are usually not infective when ingested as these are destroyed by acid in the stomach.

iii In nature, the infection is maintained by members of the felidae when they prey on infected rodents and other infected animals.

Cats and other members of felidae family are the key animals in the epidemiology of postnatal toxoplasmosis. Oocyst formation is greatest in domestic cats. Cats can pass million of oocysts in their stool sample and oocysts can survive in the moist environment for months and even years. Flies and cockroaches can spread oocysts mechanically.

Clinical Features

Infection may lead to abortions and miscarriage or still-birth or birth of baby with manifestations of acute toxoplasmosis. In the benign form, the disease may manifest in infancy, childhood or even adult life. Infection in first trimester are associated with more severe lesions. Two types of congenital infections have been described. In the generalized form anaemia, jaundice, hepatosplenomegaly, lymphadenitis and retinochoroiditis are common. In the neurological form, the tetrad of hydrocephalus, retinochoroiditis, convulsions and intracranial calcification are well recognized.

Acquired infection in man is less severe and can present with varied clinical picture. Lymphadenopathy is the commonest manifestation and may be accompanied with fever, malaise and rash. It is also a common cause of chorioretinitis. Acute generalized toxoplasmosis with involvement of brain may result, especially in persons undergoing immunosuppressive therapy. As many as 70–80% of patients with AIDS have been diagnosed as having toxoplasmic encephalitis.

Laboratory Diagnosis

It is by isolation of organism and by serum antibody test (qualitative and quantitative tests).

TORCH Test

Toxoplasma, others, rubella, *Cytomegalovirus* and herpes (TORCH). This 'acronym' is used to denote an insult to the foetus caused by varied categories of organisms, resulting in multiple organ damage occurring in the same way and presenting as similar manifestations. Earlier only syphilis was considered to fill in the space of 'o' (other infections) now many agents are considered to this slot like varicella, tuberculosis, gonococci, parvo-coxsackie, HIV and hepatitis B virus. This test can detect multiple antibodies against organisms mentioned above and is helpful in diagnosis of specific infection in pregnant women for appropriate action.

Treatment

Sulfonamides and pyrimethamines are two drugs widely used for therapy of toxoplasmosis. These drugs have synergistic effect. Spiramycine is used in pregnant women as it does not cross placental barriers.

Prevention and Control

Since man is infected by toxoplasmosis from tissue cysts in meat, the oocysts in soil and tachyzoites transplacentally. The preventive measures include:

i Proper cooking of meat and observing hygienic practices such as washing hands who handle raw meat.

ii Elimination of stray cats. Cats usually get infected by ingestion of raw meat of wild birds, and rodents. Pet cats food should be regulated. Cats shedding oocysts should be treated.

iii Routine serological check-up in antenatal clinics and treatment of infected mothers would be valuable step in protecting the foetus.

LEPTOSPIROSIS

PROGRAMME FOR PREVENTION AND CONTROL OF LEPTOSPIROSIS—NATIONAL GUIDELINES 2015

Programme on prevention and control of leptospiroris has been initiated by Government of India with the following objectives:[1]

i Reduction of morbidity and mortality due to leptospirosis.

ii Strengthening diagnostic laboratories.

iii Strengthening patient care management.

iv Development of trained manpower.

v Creating awareness

vi Sensitization of animal husbandry and agriculture personnel.

Leptospirosis is an *emerging* public health problem. Leptospirosis is a zoonotic bacterial disease caused by *Leptospira interrogans* and *Leptospira biflexa* and clinically manifested by fever of sudden onset, headache, chills, severe myalgia (calfs and thighs) and conjunctival suffusion. Jaundice and haemorrhagic manifestations are present in typical cases. Deaths are predominantly due to hepatic and renal failure; vascular abnormalities with haemorrhage, acute respiratory distress syndrome, or cardiac arrhythmias from myocarditis.

EPIDEMIOLOGY

Causative organism: Leptospirosis is caused by. *Leptospira interrogans* which has 23 serotypes and more than 200 serovars. It affects the humans and animals.

Reservoir of Infection

Rodents, several domestic (cattle, swine, sheep, and goat) and wild animals (foxes and rabbits) form reservoir of infection. They excrete leptospires in urine and may contaminate the environment, viz. water, soil, mud, vegetation, food and fomites. While domestic animals may act as carriers for several months (temporary carrier), rodents usually remain carriers throughout their life (permanent carriers). Leptospires can survive for prolonged period in the environment.

MODE OF TRANSMISSION

Humans contract the infection by direct exposure to the infected animals or to an environment contaminated with urine, blood or tissue of infected animals. The Leptospirosis is transmitted through inflamed or broken skin, intact mucous membrane (buccal cavity, nose) or conjunctiva. Rare cases of congenital infection have been reported.

Period of Communicability

Direct transmission from person to person is absent or extremely rare. Leptospires may be excreted in the urine usually for months following illness, but it has been observed in humans as long as 11 months. In reservoir species, excretion is lifelong.

Distribution

Leptospirosis occurs worldwide but is most common in tropical and subtropical areas with high rainfall. The disease is found mainly wherever humans come in contact with the urine of infected animals or urine polluted environments. In India the outbreaks of leptospirosis have been reported from coastal districts of Gujarat, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, and Andamans, Goa and Odisha from time to time (NICD and WHO in 2006 and 2018).

Incidence

Precise incidence is not known. According to currently available reports, incidence ranges from approximately 0.1 to 1 per 1,00,000 in humid tropics. During outbreaks, the incidence may reach over 100 per 1,00,000.[1] Data of some outbreaks investigated by NICD are presented in Table 8.25. In 2019, 15 outbreaks of leptospirosis were reported.

High-risk Groups

Leptospirosis is considered primarily an occupational disease. For example, agriculture, dairy, fish farming, forestry boating, mining, military exercises, working in slaughter house, sewers, laboratories and handling animals increase the risk of infections to leptospires.

Following rains and flood, the incidence increases, moist conditions favour it most besides water logging and salinity.

Table 8.25: Outbreaks, reported cases, and deaths in Gujarat and Kerala due to leptospirosis

Year	*No. of cases*	*Deaths*	*CFR%*
1994	158	12	7.6
1995	14	2	14.3
1996	40	9	22.5
1997	657	76	11.6
1998	537	42	7.8
1999	365	31	8.5
2000	112	12	10.7
2011	600	104	17.0
2018 Kerala Jan to Aug	520	28	5.4

Source: NICD CD Alert 2000 and personal communication.

Incubation period: It ranges from 2 to 30 days, average is 5–14 days.

Age: Most of the cases occur in adults (20–30 years) due to exposure of adults to contaminated materials. Adult males are more exposed than females.

Clinical Manifestations—two types of leptospirosis

a. **Anicteric leptospirosis:** While most of the infections (90%) remain subclinical and anicteric, mild or moderate which are not easily recognized as leptospirosis. These patients have fever, headache conjunctival suffusion, myalgia but no jaundice.

b. **Icteric leptospirosis:** Illness may be very severe and fatal in some of the cases (5–10%).

The disease has a sudden onset with fever, headache, conjunctival suffusion and myalgia, especially in calf muscles; severe manifestations include hepatic involvement (jaundice, hepatic failure), renal involvement (oliguria, renal failure), pulmonary involvement (cough, chest pain, breathlessness, haemoptysis), cardiac involvement (myocarditis), meningitis, encephalitis and haemorrhagic manifestations. The more severe form of disease with severe liver and kidney involvement is known as **Weil's syndrome**.

Mortality

Mortality is high (>20%) unless the treatment (antibiotics, penicillin, tetracycline) is started early. Infecting serovars, animal species involved, and general condition of the host determine the severity of illness. The disease is more severe in old and immunocompromised or those having pre-existing liver and kidney problems. More than 90% of deaths are due to pulmonary alveolar haemorrhages.

Diagnosis

Clinical diagnosis is not easy except during the outbreaks. A high degree of suspicion and use of laboratory is essential to diagnose the disease. The typical motility of leptospires in the clinical sample under the dark ground illumination in a clinical compatible case may be helpful for an experienced laboratory person. Diagnosis is confirmed by:

1. Seroconversion or a fourfold or greater rise in titre in paired serum samples in the presence of compatible clinical illness is a major criteria for definitive diagnosis of recent leptospirosis infection.
2. Microscopic agglutination test (MAT) is considered the gold standard or cornerstone of serodiagnosis because of unsurpassed diagnostic specificity in comparison with other currently available tests.
3. Isolation of organism from blood or CSF during the first week of illness and from the urine after the 10th day of illness.
4. PCR test.

Prevention and Control

Prevalence of leptospires infection in rodents and animals (carriers) and favourable environments make the control of leptospirosis most difficult. Following measures are helpful.

1. ***Health education and personal protection:*** The main preventive measure is to create awareness about leptospirosis and its prevention through mass media and interpersonal communication and print material. Hygienic measures such as avoidance of direct and indirect human contact with animal urine, and contaminated water.
2. ***Personal protective measures:*** Protective clothing, boots, gloves and aprons for all people involved in high-risk activities are advisable. Apply betadine ointment on cuts and abrasions before entering fields and after exit.
3. ***Chemoprophylaxis:*** Doxycycline has been shown to be effective in preventing leptospirosis in exposed personnel when administered 200 mg orally once a week for 6 weeks during the period of high exposure. However, prolonged and mass chemoprophylaxis is not recommended.
4. ***Rodent control:*** Rodents are major reservoir of infection. *Rattus rattus* (house rat), *Rattus norvegicus* (Norway rat) lesser bandicoot and larger bandicoot are reservoirs in India. Rodents are important from both the economic and public health point of view. Denying access to food by proper disposal of garbage and storage of food in rat proof containers and buildings is the most effective way to remove the rodents from the domestic environments.

   Trapping and administration of acute and chronic poisons may be useful in some settings. Experts from department of agriculture and animal husbandry should be fully involved to control rodents.
5. ***Control of environment:*** Mapping of water bodies for proper drainage system. Recognize potentially contaminated water and soil and drain such water if possible on regular basis.[6]
6. ***Case management:*** Treatment of cases and supportive therapy with appropriate antibiotic-like—doxycycline 100 mg twice a day for 7 days, pregnant women and lactating mothers should be given capsule ampicillin 500 mg every 6 hours. Children less than 8 years—30–50 mg per kg per day for 7 days.
7. ***Surveillance:*** A well-established laboratory-based surveillance system supplemented by sero-survey in men and animals to understand the epidemiology of leptospirosis should be in place.
8. ***Vaccination:*** A safe human vaccine, which is effective in field situation for wider use is not available at present. However, immunization of people has been carried out against occupational exposure to specific serovars in Japan, China, Italy, Spain and France, etc. Immunization of farm and pet animals prevents illness but not necessarily infection and renal shedding.

ANTHRAX

EPIDEMIOLOGY

Anthrax is an acute infectious disease of herbivorus animals caused by *Bacillus anthracis*. Anthrax is also called malignant pustule, malignant oedema, woolsorter's disease, or Ragpickers' disease. The main source of human infection is direct or indirect contact with an infected animal or contaminated animal product. It is a zoonotic disease.

The causative organism (*Bacillus anthracis*) is a Gram-positive encapsulated, non-motile rod. The organism rapidly grows in sheep blood agar aerobically and is non-haemolytic under these conditions.

Spread

The disease spreads among grazing animals (cattle, sheeps goats) through contaminated soil, feed, and among carnivorous animals through contaminated meat, bone meal and other feeds and in wildlife from feeding on carcasses of animal died of anthrax. Outbreaks of anthrax have been reported from Karnataka (1999 and 2001), Odisha (2003 and 2005) and West Bengal (2000). Human anthrax outbreaks during 2008 were reported from Odisha, Andhra Pradesh and West Bengal (WHO, SEARO).

The spores are resistant to adverse environmental conditions and disinfection, and can remain viable in the contaminated soil for many years.

Mortality

The mortality rate of untreated cutaneous anthrax may be 20% pulmonary and intestinal anthrax results in death in 25 to 60% of cases.

Types of Anthrax[2, 3]

Cutaneous, intestinal, and pulmonary anthrax can occur in human beings.

Cutaneous Anthrax

Cutaneous anthrax occurs when the bacteria enter a cut or abrasion on skin while handling infected animals or their contaminated products such as wool, hides, leather or hair. The incubation period for cutaneous anthrax is usually 1–7 days. The lesion which is on the exposed parts of the body such as face, neck and arms, is first noted as small pruritic papule that resemble an insect bite. Within 1–2 days, it develops into a vesicle.

Occasionally, the papule becomes surrounded by a ring of vesicles, which then coalesce to form a large vesicle around 2–3 cm in diameter. Approximately 5–7 days after the onset, the vesicle ruptures, revealing a painless ulcer with a characteristic black necrotic area in the centre. Effective therapy reduces oedema and systemic symptoms but does not change the evolution of skin lesion.

Occasionally, more severe form of cutaneous anthrax may occur with extensive local oedema, induration and toxaemia. The infection may also spread to bloodstream with overwhelming septicaemia.

Intestinal Anthrax

The intestinal anthrax is characterized by nausea, loss of appetite, vomiting, fever, abdominal pain, vomiting of blood and severe diarrhoea. In severe forms, general toxaemia with shock, sepsis and death may develop. Gastrointestinal anthrax is difficult to diagnose, as the symptoms are non-specific. However, history of ingesting meat of a sick-animal and cases of cutaneous anthrax in the area may support diagnosis.

Pulmonary Anthrax

The initial symptoms of pulmonary anthrax resemble a common cold, which quickly progresses to severe breathing problems and shock. Diagnosis is difficult but pulmonary anthrax should be suspected if there is history of exposure to aerosol that contains *B. anthracis*. Respiratory secretions may contain the bacilli but these are not present in the sputum.

Laboratory Confirmation

Laboratory confirmation is made by the demonstration of *B. anthracis* from blood, vesicular fluid, cerebrospinal fluid, pleural fluid and peritoneal fluid by direct polychrome methylene blue stained smears or by culture or inoculation of mice, guinea pigs or rabbits. Diagnosis can be confirmed by PCR. NICD must be notified immediately if anthrax is suspected.

Antibiotics are effective if the disease is recognized early and the full-recommended dose and course of antibiotic is completed. Death can occur if the antibiotic therapy is discontinued early. Penicillin, erythromycin, tetracycline, chloramphenicol, amoxycillin can be used as oral antibiotics, can be prescribed for mild forms of cutaneous anthrax, for severe cutaneous as well as pulmonary and gastrointestinal anthrax intravenous antibiotics in large doses are necessary.

Anthrax does not spread from person to person but discharges from lesions and other soiled articles from patients should be disinfected and incinerated. Hypochlorite is sporicidal but other disinfectants can also be used. Spores require steam sterilization, autoclaving or burning to assure complete destruction. The principal disinfecting agents for destruction of anthrax spores are formaldehyde, glutaldehyde (at pH 8.0–8.5), hydrogen peroxide and peracetic acid.

Prevention: If anthrax is suspected in animals the carcass should be immediately buried deep at site if possible, after covering it with anhydrous calcium oxide (quicklime).

Anthrax is important and exploited for *biological warfares* (bioterrorism) because it is highly fatal and when transmitted through inhalation is almost always fatal. Anthrax spores can remain viable for several decades and it is easy to weaponize and disseminate anthrax as an odourless and invisible aerosol.

REFERENCES

1 NCDC—Programme for prevention and control of Leptospirosis-national guidelines diagnosis, case management and control of Leptospirosis NCDC (DGHS) Delhi, 2015.

2 NICD. Anthrax. CD Alert. Monthly Newsletter on Communicable Diseases Sept 1999; 3(3).

3 NICD and WHO (2006). Guidelines for prevention and control of anthrax, Zoonosis division, NICD (DGHS), 22 Shamnath Marg, Delhi.

Q-FEVER

The causative organism is *Coxiella burnetii*.

Q-fever has been reported from all countries except America.

Mode of Transmission

C. burnetii organisms are generally transmitted when the host inhales infectious aerosols. They enter the host's cells by passive phagocytosis, preferentially infecting histocytes and Kupffer cells.

C. burnetii is carried by many species of tick and although ticks may serve as vector between animals, they

probably do not transmit the disease to humans. Humans are usually infected when they inhale aerosols generated by infected livestocks. Infection occurs most frequently in abattoirs, sheep research facilities, dairies and animal husbandry operations.

Incubation Period

It is 18–21 days.

Symptoms and Signs

Most common signs and symptoms are fever, headache, chills, myalgia, skin rashes hepatomegaly and hepatitis.

Laboratory Diagnosis

Weil-Felix test is helpful in establishing presumptive diagnosis. Sera of Q-fever fail to agglutinate 0X19, 0X2 and 0XK.

Prevention

Most outbreaks of Q-fever in various countries were associated with work-related exposure to sheep and their birth products. Therefore, preventive measures should be directed primarily at:

1. Avoiding exposure in institutions where sheeps are used for research.
2. Educating personnel in agriculture setting about disinfection and disposal of products of conception.
3. Vaccine made from killed organisms provides complete protection to high-risk individuals whose occupation expose them to infected sheep.

Treatment

Effective therapy with tetracycline and chloramphenicol shorten the duration and lessen the severity of the illness.

MAD COW DISEASE AND CREUTZFELDT-JAKOB DISEASE (CJD)[1]

Creutzfeldt-Jakob disease (CJD) is known to affect human beings since 1920s, it caught great public health attention in 1990s when a new variant of CJD (vCJD) emerged in Britain which was etiologically linked to bovine spongiform encephalopathy (BSE), popularly known as mad cow disease. Due to widespread use of cattle and cattle products and their import, the risk of vCJD exists in all parts of the world.

Transmissible Spongiform Encephalopathies (TSEs)

These are group of fatal neurodegenerative disorders which affect humans and certain animal species and produce characteristic neuropathological spongiform changes and deposition of amyloid protein (prion protein) in the grey matter of the brain. The exact nature of aetiological agent is not clear. Most scientists agree that it is self-replicating protein called prion protein and some think agent is virus like.

Creutzfeldt-Jakob Disease (CJD)

The CJD is first human TSE described in early 20s by HG Creutzfeldt and AM Jakob. CJD is a rare and fatal neurodegenerative disease with rapidly progressive dementia, myoclonus and characteristic EEG pattern. It occurs in sporadic, familial and iatrogenic CJD. A new variant of CJD has been described in 1996. The median duration of illness is 4.5 months.

New Variant CJD (vCJD)

A new variant Creutzfeldt-Jakob (vCJD) has been described in the UK and other parts of Europe. The first case was reported in UK in March 1996. Till June 2001, 105 cases of vCJD have been reported. vCJD has been strongly linked to exposure, probably through food, to the BSE. The fact that the France imported large amount of cattle products from UK perhaps explains the occurrence of cases in that country. In contrast to CJD, vCJD occurs in younger people (average age 29 years vs 65 years).

CJD in India: A total of 78 cases of CJD have been reported in India from 1968 to 2000.

Bovine Spongiform Encephalopathy (BSE)

BSE is transmissible neurodegenerative and fatal disease of cattle. It is also called mad cow disease. First case was reported in UK in 1986 and first case outside UK was reported in 1989. A total of 1,80,937 cases of BSE have been reported from UK till 2000.

Prevention and Control of CJD and vCJD

- A well-established surveillance system for CJD, vCJD and BSE.
- Ban on import of cattle and cattle products from BSE endemic countries.
- No part of product of any animal which has shown signs of a TSE should enter human or animal food chain.
- Avoid using, tissues, needle electrodes and surgical instruments contaminated by tissues from suspected cases.
- Steam autoclaving (1 hour at 132°C or higher) is highly effective method for disinfection. Chemical agents such as 5% sodium hypochlorite and 1N to 2N sodium hydroxide may not be completely effective. After 1 hour, they are best followed by steam autoclaving. Aldehydes are ineffective.

REFERENCE

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EPIDEMIOLOGY OF VACCINE PREVENTABLE DISEASES

MEASLES

Epidemiology

It is an acute highly contagious viral disease caused by the measles virus. It can cause death due to complications in the form of diarrhoea, pneumonia, or brain infections mostly in children less than 5 years of age.

Measles is such a common communicable disease in India that many communities have accepted it as a normal milestone of growing up.

Occurrence

It is endemic in densely populated areas while periodic outbreaks occur in less populated areas.

Incidence

The WHO estimated that over 40 million cases still occurs worldwide each year contributing to approximately 5,30,000 deaths in 2003. Twenty countries reported measles outbreaks in 2022. Over the years, the reported cases primarily from hospitals, the incidence has declined substantially due to improved coverage of measles immunization. In India 22,058 cases of measles and 33 deaths were reported in 2016 and in 2018 incidence was 21,037 cases and 31 deaths and in 2019 over 12,894 cases and 16 deaths were reported against 12081 in 2020 (Table 8.26).

In India, more than 50% of measles cases are currently reported in children less than 5 years of age indicating low coverage of measles immunization.

Case Fatality

Innumerable children suffer other infections like diarrhoea, acute respiratory infections, malnutrition and vitamin A deficiency as a result of measles. Case fatality is much more in malnourished children. Measles used to be one of the leading killers in young children.

WHO-UNICEF estimated 1,50,000 measles deaths in India during the year 2006. These have declined substantially now.

Age of Occurrence

The highest number of cases are observed among children under 2 years of age in the developing countries like India and at school entry in the more affluent countries with the greatest risk of complications and deaths occurring in infants. 90% of cases occur below 10 years of age.

Table 8.26: Trends in reported cases of measles

Year	*Reported number of cases*
1987	2,52,940
1985–1989 annual	1,79,000 average
2000	38,835
1990–93	80,766
2001	51,780
2002	38,927
2003	46,736
2004	51,546
2005	36,711
2007	41,144
2008	48,181
2009	56,188
2010	29,808
2011	33,634
2013	16,479
2014	23,348
2015	45,696
2016	22,058
2017	18,618
2018	21,037
2019	12,894
2020	12,081

Source: Central Bureau of Health Intelligence (CBHI, NHP)

Transmission

Transmission is from person to person by droplet spread from nasal or pharyngeal secretions. Measles is one of the most contagious diseases and highly infectious. Cases are infectious even before appearance of rash and up to 7 days after.

Incubation Period

The incubation period is between 7 and 18 days, usually 14 days. Measles is highly infectious and rarely will an unimmunized child escape from getting disease.

Symptoms

Measles is nearly always symptomatic. Diagnosis of measles is easy. The main characteristic features would be a cold, cough, running nose, fever 38°C or more. Eyes are pink or red watery and sensitive to light for 3–7 days followed by generalized rash—a characteristic blotchy rash maculo-papular (non-vesicular) appears beginning on the face and spreading all over the body, the rash lasts for 4–7 days and often ends with desquamation (peeling of skin). The pigmentation due to rash remains for 2 weeks or even longer. Koplik's spots (greyish white spots with

red borders) often appear on the inside of the cheek at about the same time the rash begins. These spots are diagnostic since they occur only in measles.

Post-measles Complications

Measles complications include diarrhoea, pneumonia, otitis media, malnutrition including acute deficiency of vitamin A, which may lead to keratomalacia and blindness. Therefore, measles cases should be given megadose of vitamin A solution as per age (Table 8.27). Occasionally, it may lead to encephalitis. Death strikes the malnourished especially where multiple cases crowd the home. In India, 2 to 3% children die generally following measles but in a measles epidemic, case fatality as high as 30 to 50% is reported. Delayed complications include high-risk of morbidity and mortality.

Table 8.27: Recommended vitamin A schedule for measles cases

Age	*Immediately on diagnosis of cases*	*Next day*
<6 months	50000 IU	50000 IU
6–12 months	100000 IU	100000 IU
12 months plus up to 5 years	200000 IU	200000 IU

Risk Factors

- Measles virus is transmitted through the air by respiratory droplets from infected children even before the rash is seen. Therefore, isolation of a case has no relevance in the control of disease.
- Measles is more rapidly transmitted in large families, crowded homes and urban slums.
- With high density of population, measles is apt to occur year round sometimes with seasonal peaks.
- Without immunization, nearly every child gets measles.
- Measles can occur at any age. In India due to overcrowding and increased contact among young children, effects are mostly seen before the second birthday of the child.
- Secondary cases in home tend to be more severe.
- Measles is severe among infants and malnourished children. Post-measles complications are also more common in these children.

Prevention

Natural disease gives permanent immunity. Infants born of mothers who have had the disease are usually immune for approximately the first 6–8 months. Prevention is by appropriate immunization.

Prevention by Immunization

Being a viral disease measles cannot be cured by antibiotics and therefore prevention is more important. Measles prevention should be priority. Preventing measles by immunization will have the multiple benefits of preventing other diseases, particularly diarrhoea, dysentery, malnutrition, blindness, pneumonia and acute respiratory infections.

Measles Vaccine

It is attenuated live measles virus vaccine. The vaccine stability has improved. Freezed dried live attenuated measles vaccine is available, which can be reconstituted by adding 2.5 ml of diluent. The vaccine is administered by subcutaneous injection in one dose of 0.5 ml at 9 months of age. If the child misses at this age ensure it at 10–12 months of age, i.e. before infancy or first birthday. Unimmunized children beyond age one and up to 5 years can also be given immunization. WHO currently recommend that two doses of measles vaccine should be the standard for all national immunization programmes. As of 2008, 192 of 193 member states of WHO use two doses of measles vaccine in their national immunization programme, India being the only exception.

There are two considerations when determining the minimal age to administer measles vaccine: age distribution of cases and deaths and the immunological response (maternal antibody interference). In India, where disease is common, the vaccine should be given at 9 months of age.

Immunization Strategy for India

In India, now measles vaccine is given as measles rubella vaccine (MR) through routine immunization—first dose at completed 9–12 months and second dose at 16–24 months of age. In case the child misses this opportunity, the child can be vaccinated at the first available opportunity up to 5 years of age.

Peak response of seroconversion occurs 6–8 weeks after vaccination. Seroconversion rate of measles vaccine varies from 85 to 95%. Outbreaks are generally due to accumulation of measles susceptible persons, including both unvaccinated children and those who were vaccinated but failed to seroconvert. Approximately 15% of children vaccinated at 9 months and 5–10% of those vaccinated at 12 months of age are not protected after vaccination. Previous coverage evaluation surveys have shown that mean national coverage with measles is around 74% with 85% vaccine effectiveness for vaccination at 9 months actual protection was offered to only 63% of annual birth cohorts (74% × 85% = 63%). In other words, 37% remained susceptible to measles. Accordingly, second opportunity for measles immunization is required in order to protect those children who have never been vaccinated as well as those who were vaccinated but did not develop immunity. Immunity conferred by measles vaccine has been shown to persist to at least 20 years and generally thought to be lifelong for most individuals.

Measles Vaccination during Epidemics/Outbreaks

There is no role of measles outbreak response immunization to stop the spread of measles during outbreaks. If children receive vaccine within 72 hours after exposure they may be protected but it is difficult to ensure. In India, mass measles vaccination during epidemics has not been considered useful.

Vaccine Efficacy

The term 'vaccine efficacy' refers to the ability of a vaccine to prevent disease when used in routine immunization services.

Efficacy of vaccine is an excellent indicator of the effectiveness of the immunization services.

For example, efficacy of measles vaccine is 85%. If immunization services with measles vaccine shows efficacy of less than 80%, it means there is a problem with the vaccine. This could be due to problem with the cold chain, the injection technique or the age at which the workers are immunizing the children and we must take action to correct it.

To calculate vaccine efficiency we will need to obtain following information from the health records:

i Size of study population (which is children 12–23 months of age).

ii The coverage of measles vaccine in children 12–23 months of age.

iii The number of cases of measles in immunized children 12–23 months of age.

iv The number of cases of measles in unimmunized children 12–23 months of age.

$$\text{Attack rate in immunized children} = \frac{\text{Number of cases in immunized children 12–23 months of age}}{\text{Number of immunized children 12–23 months of age}} \times 100$$

$$\text{Attack rate in unimmunized children} = \frac{\text{No. of cases in unimmunized children 12–23 months of age}}{\text{No. of unimmunized children 12–23 months of age}} \times 100$$

$$\text{Efficacy of vaccine} = \frac{\text{(Attack rate in unimmunized)} - \text{(Attack rate in immunized)}}{\text{Attack rate in unimmunized}} \times 100$$

Efficacy

The vaccine is usually 85% effective if administered below 12 months of age and more than 95% efficacy when given above 12 moths of age and provides long-lasting immunity.

Side Effects

A mild fever and rash lasting 1–3 days may occur in up to 15% of vaccines, 8 to 12 days after vaccination. Encephalitis has been reported following measles vaccination approximately at the rate of one case per million doses administered.

Storage

Exposure of the vaccine to high temperature and light before or after dilution may inactivate it. Long-term storage should preferably be at –15° to –25°C. Short-term storage should be maintained at 2° to 8°C. The freezed dried vaccine is stable for 1 to 4 weeks at room temperature. To avoid inactivating, the vaccine with hot diluent, the diluent should also be refrigerated at 2 to 8°C. After dilution, the vaccine must be kept at these temperatures and used within 4 hours. Discard the opened vials and leftover vaccine after the session and never store or use the opened vials for vaccination in the next session or next day, as it leads to contamination of vaccine.

Toxic Shock Syndrome

If the leftover vaccine is stored in the refrigerator or cold box, it may be contaminated with bacteria. Toxic shock syndrome (TSS) results following the administration of contaminated measles vaccine due to the use of unsterile syringes and needles used to draw the vaccine from the vial or reuse of measles vaccine vial for more than one session on the same or subsequent days. TSS occurs when the vial is contaminated with *Staphylococcus aureus*.

The symptoms of TSS are typical. Severe watery diarrhoea, vomiting and high fever are reported within a few hours of measles vaccine administration. There are usually more than one case as all children vaccinated from the contaminated vial will be affected. The disease progresses to hypotensive shock and death within 48 hours. Case fatality rates are high.

TSS is an emergency and no time should be lost in taking the child to district hospital, which can look after the severely ill children and provide supportive care.

If a child is brought first to PHC give ORS/home available fluids give broad-spectrum antibiotics, IV fluids, anti-pyretics, steroids and supportive therapy.

MEASLES MORTALITY REDUCTION—INDIA'S MULTI-YEAR STRATEGIC PLAN 2010–2017

Goals and Objectives

1 Reduce 90% measles mortality by 2013 when compared to 2000 estimates.
2 Achieving at least 90% coverage with measles vaccine.
3 Collection of good quality epidemiological data through active surveillance—integrated disease surveillance programme (IDSP) and outbreak

investigation and to use this information to guide further action.

4 **Elimination** of measles by 2020 India missed this deadline.

Key Strategies for Measles Mortality Reduction

- ***Strengthening of routine immunization:*** Achieving and maintaining high coverage (>90%) with first dose of measles vaccination in *every district*. Achieve high routine measles vaccination coverage of infants at 9–12 months of age, provide measles vaccine to children who missed routine immunization during infancy at the earliest contact until they are 5 years old.
- ***Surveillance of measles:*** India has established effective measles surveillance that provides information about number of cases and deaths by month, age and vaccination status of cases and deaths and conduct outbreak investigation supported by laboratory confirmation. The surveillance system for identification of measles outbreaks has been linked to AFP surveillance system.
- ***Case management:*** Improving management of measles cases, including vitamin A supplementation and adequate treatment of cases by integrated management of neonatal and childhood illness (IMNCI) strategy.
- ***Second opportunity:*** Based on evaluated measles immunization coverage and surveillance data, providing a second opportunity for measles immunization to appropriate age group of children either through a second routine dose of measles vaccine or through supplementary immunization activities (SIA).

Government of India has introduced a second dose of measles vaccine in the national immunization programme per below state specific strategies.

Measles Catch-up Campaigns in 2011[1]

India has conducted measles catch-up campaigns (a one time event targeting multiple cohorts in which susceptible children have accumulated) as part of global effort to reduce measles mortality and morbidity. Target group for this campaign was *9 months* to *<10 years* children irrespective of their previous measles vaccination status or measles infection. Estimated 134 million children were immunized in 14 states where coverage level of measles immunization was less than 80%.

Measles follow-up campaign: A periodic event (every 3–5 years according to the accumulation of susceptible) targeting children born after catch-up campaign to maintain low level of susceptibility. The periodicity depends upon routine immunization coverage. The target age group for immunization in these campaign should include all children aged over 9 months who were born after the previous mass immunization.

Measles Rubella (MR) Surveillance

MR case definition: Any person with fever and maculopapular rash. Measles is a 'tracer' of strength of the immunization system. When immunization coverage is low measles is fastest vaccine preventable disease to return.

Report all suspected cases/deaths of measles now or in the last 90 days. The epidemiological data thus collected will be reviewed for effective and rapid response to improve the programme.

For operational purposes, presence of measles outbreak should be verified if five or more than five clinically diagnosed cases of measles are identified in a block in a weak, or five or more than five clinically diagnosed cases of measles occur in an area bordering several blocks in a weak; or one or more than one death due to clinically diagnosed measles occurs in a block in a weak.

Measles Rubella (MR) Campaign Started in 2017

A wide age range MR campaign targeting children aged 9 months up to 15 years of age was conducted in a phased manner over a period of 2–3 years. Subsequently rubella vaccine has been introduced as MR vaccine in routine immunization as two doses, replacing the currently given measles vaccine 1 and 2 at 9–12 months and 16–24 months respectively. All the states have completed the campaign.[2,3]

Road Map to Measles and Rubella Elimination in India by 2023

Goal: Achieve and maintain elimination of measles and Rubella with interruption of transmission of indigenous measles and rubella viruses in all states and districts in India by 2023.

What is MR elimination? It is defined as absence of endemic measles and rubella virus transmission and CRS cases in a defined geographical area for >12 months. It is verified after it has been sustained for at least 36 months in the presence of high-quality surveillance system.

Strategic objectives: Vaccination coverage targets revised to 95%.

I Achieve and maintain high population immunity with at least 95% vaccination coverage of two doses of measles and rubella containing vaccine (MRCV) in every district of every state of India. Ensure that all children receive MRCV2 by 24 months of age and that missed doses are provided up to 5 years of age, with two doses given 4 weeks apart.

II Sustain a sensitive and timely case-based fever and rash and congenital rubella syndrome (CRS) surveillance. Target: Non measles and non rubella (NMNR) discard rate of ≥2 per lakh population and zero incidence of MR per million population.

III Ensure adequate outbreak preparedness and respond rapidly. Investigate cases within 48 hours of notification, conduct ORI within 2 weeks of confirmed outbreak.

IV Developing and maintain a proficient laboratory network.

ACTION PLAN

District shall be the unit for intervention. District should set a goal of 100% coverage with MRCV2 by 2 years of age and achieve at least 95% coverage by December 2022. In case the target is missed, achieve 95% coverage of MRCV2 by age 5 years for each child in each district.

CATEGORIZATION OF DISTRICTS

Based on MCV1 coverage of NFHS-5, building of susceptible cohort since 2017, the last MR campaign, and measles incidence, the districts have been categorized into:

- 183 low risk districts: MCV1 coverage ≥95% (NFHS-5).
- 386 medium risk districts: MCV1 coverage between 80 and 95% and with <40000 susceptible cohort.
- 164 high risk districts: MCV1 coverage less than or equal to 80% or MCV1 coverage between 80 and 95% with >40000 susceptible cohort.
- Very high-risk districts: Large and continuous outbreak affected districts.

MR VACCINATION STRATEGY FOR:

- Low risk districts: Focus on sustaining high coverage level through routine immunization in pockets with high immunity gap.
- Medium risk districts: Assess MRCV1 and MRCV2 coverage of children up to 5 years of age and ensure routine and or catch-up campaign to achieve 95% coverage.
- Very high- and high-risk districts: Prioritize catch up campaigns in very high-risk districts and catch-up campaign in high-risk districts covering all children till 5 years of age. One additional dose of MR vaccine is given. Achieve target of 95% coverage by September 2023.

RUBELLA

Most clinicians regarded it as milder form of measles and hence it was also known as German measles.

Causative organism: *Rubella virus* belongs to genus *Rubella* virus and family Togaviridae. *Rubella virus* is an RNA *virus*. Rubella occurs in two forms:

- Acquired rubella, and
- Congenital rubella syndrome (CRS).

MCV1 and MCV2 have now been replaced with MR vaccine at 9–12 months and at 16–24 months of age under UIP.

Acquired Rubella

It is widely distributed worldwide. The reservoir of infection is a case of rubella (clinical and subclinical cases) and there is no carrier stage. Majority of infections are asymptomatic. After an incubation period of 2–3 weeks the clinical symptoms/signs develop which include; coryza, sore throat, low grade fever and rash and lymphadenopathy. Acquired rubella is a mild disease and seldom leads to complications and encephalitis is very rare. *Rubella virus* has been suggested to be possible cause of chronic inflammatory joint disease. Natural infection is followed by a very high order of protection from reinfection.

Age

It is mainly a disease of children. Common age group affected is 3–10 years. Because of widespread vaccination programme in developed countries there is shift in age of occurrence beyond childhood period.

Transmission

It is a droplet infection, transmitted from person to person through droplets by coughing and sneezing.

Congenital Rubella Syndrome (CRS)

Rubella infection during pregnancy can lead to congenital malformation of foetus and child may be born with several congenital malformations; premature birth and low birth weights or even abortions. Infection during first trimester is more dangerous. The clinical features of congenital rubella include microcephaly, retinopathy, cataract, deafness, ductus arteriosus, ventricular septal defect, cryptorchidism, inguinal hernia, diabetes mellitus, hepatosplenomegaly, congenital cardiopathies, etc. These defects occur either as singly or multiple and the condition is described as 'congenital rubella syndrome' (CRS). The exact incidence is not known. It is estimated that 2 lakh babies are born with CRS each year in India. CRS surveillance is being conducted by ICMR.

Prevention: Introduction of Rubella Vaccine[2]

MMR (measles, mumps and rubella) vaccine is effective to prevent rubella and congenital rubella infection.

Women during child bearing age (pre-pregnancy period) can be protected against rubella by MMR vaccine. Vaccination during pregnancy is contraindicated. MMR routine child immunization is a preferred strategy. Before introducing MMR in India, we need reasonably reliable data on the presence of CRS in different parts of the country and on mumps and its sequelae. In addition, it needs to be demonstrated that MMR given at 9 months

of age will have efficacy equal to the dose given at 12–15 months.

The **rubella vaccine** was introduced in India in 2017, as measles rubella campaign targeting 9 months to 15 years age group. Now it has been introduced as MR vaccine as two doses replacing measles containing vaccine 1 and 2, at 9–12 months and 16–24 months of age under UIP.

MUMPS

Mumps virus belongs to family Paramyxoviridae. It is acute contagious disease of children and young adults. The reservoir of infection is always a case (clinical or sub-clinical). It spreads by droplet infection. The usual incubation period is 16–18 days. After entering the host, the virus multiplies and viraemia results.

The virus has affinity with several organs and it settles and multiplies in salivary glands especially parotid glands, testis, pancreas, ovaries, thyroid and meninges.

Age Group

It affects primarily children between 5 and 10 years age group. Approximately 85% of infections occur below 15 years of age. In developed countries because of massive MMR vaccination, the infection rate among 10–14 years and above has increased (shift in age of infection due to vaccination).

Clinical Features

It mainly affects salivary glands (parotid, submaxillary and sublingual glands). Bilateral painful swelling of parotid gland along with fever is common. The illness usually subsides after about 10 days time. The mortality rates are insignificant. Most infections subside. The mumps may lead to complications like orchitis, atrophy of affected testicle, sterility, oophoritis, pancreatitis, arthritis, myocarditis and renal dysfunction. Infection during pregnancy in first trimester may cause abortion. Most of the complications are not serious and precise incidence remain unknown.

The incidence of mumps and its complications is precisely not known in India. The mortality effects are probably more if mumps occur beyond 40 years of age. One attack confers lifelong immunity in 95% of individuals. Secondary attack rate in mumps is very high.

Prevention

Mumps can be prevented by MMR vaccine. The vaccine is prepared from Jery Lynn strain or from Leiningard or Urabe or Rubini strain. The efficacy of vaccine is very high, 95–99%.

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CHICKENPOX (VARICELLA)

Chickenpox is a communicable disease caused by varicella-zoster virus which is also responsible for herpes zoster. It is transmitted from person to person by direct contact through droplet infection. The disease is highly contagious with high secondary attack rate of over 90%.

Incubation period: Ranges from 10 to 21 days.

Epidemiology

Who get affected? It affects almost everyone. Children below 10 years of age are more susceptible. Crowded localities are most affected. Rashes appear on the first day of fever. The lesions occur in crops. Distribution of rash is centripetal. A single attack confers lifelong immunity. 75,288 cases and 99 deaths in 2017, and 67,927 cases and 50 deaths were reported in 2018 against 70,266 cases and 54 deaths in 2019.

Prevention

Live attenuated *varicella vaccine* is available. It is indicated against varicella in healthy subjects. From age 12 months to 12 years, a single dose of 0.5 ml by subcutaneous route, from 13 years and above, 2 doses with an interval of 6–10 weeks are given.

It is contraindicated in pregnant women. Varicella vaccine has not been introduced into the national immunization programme in India. The vaccine is very expensive but it is safe and effective. We need more epidemiological data on case fatality and complications and sequelae due to varicella in India.

PERTUSSIS (WHOOPING COUGH)

EPIDEMIOLOGY AND PREVENTION

It is an acute disease involving tracheobronchial tract. The disease is caused by bacterium *Bordetella pertussis*. Seasonal incidence does not have a consistent pattern in tropical climates.

Case Fatality Rate

CFR is approximately 1–3% in children under one year of age but may be higher in some areas. Mortality is especially high in infants under 6 months of age.

Transmission

It spreads primarily by droplet infection. Source of infection is a case of whooping cough. It is highly contagious during the early catarrhal stage, becoming negligible in about 3 weeks after the onset of paroxysmal stage.

Incubation Period

Range is 6–12 days and on an average incubation period is 7 days.

Clinical Signs

The catarrhal stage lasts for 1 to 2 weeks and is characterized by coryza, sneezing, fever and persistent cough. This is followed by the paroxysmal stage with repeated bouts of coughs that are succeeded by prolonged, sudden and inspiratory whoops. This stage lasts for 4–8 weeks. The whoop is rarely present in young infants.

The child vomits after severe bouts of coughing. Infectivity or communicability is very high during the early stages of the disease.

Complications

These include pneumonia, malnutrition and convulsions.

Disease Incidence

Every year in India, around 30,000 cases are being reported. The reporting of cases is incomplete because of weak surveillance programme. 38,493 cases were reported in the year 2010 against 60,385 cases in 2009 while 39,091 cases were reported in 2011. Similarly 37,011 cases and 7 deaths were reported in 2013 and 24,787 cases and 10 deaths in 2017 against 18,883 cases and 8 deaths in 2018 and over 14,543 cases and 24 deaths in 2019 against 11,985 cases and 50 deaths in 2020.

Susceptibles

It is estimated that around 80% of the children in an unimmunized population will contract the disease and 1–3% can die of disease or from its complications.

Prevention

Natural disease generally confers immunity. Effective prevention is through immunization against whooping cough.

Pertussis Vaccine

It is killed vaccine which consists of killed *Bordetella pertussis* bacteria and is usually available combined with tetanus and diphtheria toxoids adsorbed on aluminium phosphate. It is sensitive to freezing.

Administration

It is administered together with diphtheria and tetanus toxoid as a triple vaccine known as DPT. The DPT vaccine can be administered simultaneously with oral polio vaccine.

Immunization Schedule

Infant should have 3 doses prior to 12 months of age. The recommended age for first dose is 6 weeks. The minimum interval between two doses is 4 weeks.

Efficacy

The vaccine is 60–90% effective after 3 doses. There is marked fall-off in immunity 4 to 7 years after vaccination.

Side Effects

Fever, pain, swelling, redness, tenderness at local site are common. These subside after giving paracetamol. These must be explained to parents. In some cases, these are severe, such as convulsions, screaming attack, collapse and very exceptionally brain damage. Newer vaccines with fewer side effects are undergoing field trials.

Storage

The vaccine should be stored at 2° to 8°C and it should not be frozen.

TETANUS

EPIDEMIOLOGY AND PREVENTION

Tetanus is an acute neurological disease caused by toxins of the tetanus bacillus (*Clostridium tetani*). The spores of *Clostridium tetani* are present in animal excreta, which is indiscriminately disposed and it leads to widespread contamination of soil and dust. Tetanus is therefore common in agricultural regions.

Tetanus can occur in all age groups who are unprotected. It is epidemiologically important to distinguish neonatal tetanus in infants under 28 days from tetanus in all other age groups.

Mortality

Untreated neonatal tetanus may have nearly 100% fatality rate with adequate treatment the case fatality may be reduced to 50%. Thus, the case fatality is very high in tetanus neonatorum.

Transmission

The infection occurs when the wound gets contaminated with soil containing spores of *Clostridium tetani*. Neonatal

tetanus occurs when the delivery is septic or cord gets contaminated with dust or soil rich in tetanus spores. Post-delivery practices in some areas were bad as application of cow dung over cord or covering the cord with dirty linen makes the neonate vulnerable to tetanus. Aseptic delivery practices can prevent tetanus neonatorum.

Wound cleaning and aseptic dressing can also prevent occurrence of tetanus.

Incubation Period

The average incubation period is 7 days but it may range from 4 to 21 days.

TETANUS VACCINE

Tetanus toxoid is prepared from *Clostridium tetani* toxin. The toxoid comes in three formulations—tetanus toxoid (TT), DT with diphtheria toxoid or with pertussis and diphtheria (DPT). Adsorbed tetanus toxoid is better than plain tetanus toxoid. Vaccine is sensitive to freezing.

Administration

The vaccine may be administered simultaneously with polio vaccine as triple antigen (DPT). Pregnant women should be given two doses of TT, first dose early in pregnancy as early as possible and second dose 4 weeks after 1st dose. Children can have DPT at 6 weeks. Tetanus neonatorum can be prevented by immunizing all pregnant women.

Immunization Schedule for Pregnant Women

In India, since tetanus is common, it is necessary that women of reproductive age group and adolescent girls and boys are immunized with TT. Pregnant women should be immunized as early as possible during pregnancy. Two doses are given with a minimum interval of 4 weeks. A third dose in subsequent pregnancy or the following year offers protection for newborns for at least five additional years and a fourth dose protects for 10 years (UNICEF). If pregnant women have received 2 doses of TT within last three years, then only one booster dose is given. Ideally TT_2 or booster dose should be given before 36 weeks of pregnancy, however, it may be given even if more than 36 weeks have passed. It prevents maternal and neonatal tetanus.

Efficacy

The vaccine is highly effective and provides lasting protection.

Storage

The vaccine should not be frozen and should be stored at 2° to 8°C. Direct contact with ice should be avoided to avoid freezing.

In place of monovalent TT WHO recommends Td vaccine to boost diphtheria immunity in the population

Td vaccine contains tetanus toxoid and reduced amount of diphtheria toxoid. By 2020 monovalent TT will be phased out completely.

National immunization schedule has been revised since 2018–19. Now monovalent TT has been replaced by Td for pregnant women as also for adolescent at age 10 and 16 to boost diphtheria and tetanus immunity.

MATERNAL AND NEONATAL TETANUS ELIMINATED (MNTE)—WHAT IS ELIMINATION?

The definition of neonatal tetanus (NNT) elimination is a rate of less than one case per 10,000 live births in every district. Globally year 2010 was set as target year for NNT elimination. Since the tetanus spores are widespread in the environment. TT immunization and clean delivery practices must be continued indefinitely.

The strategies for elimination of NNT.

i ***Coverage:*** Ensure coverage of all pregnant women with two doses of Td and achieve high level of coverage over 90% through routine immunizations.

ii ***Safe deliveries:*** Ensure safe deliveries. 100% of deliveries should be attended by trained personnel and increase the proportion of institutional deliveries to the level of 90% and above from the current level of 80%. Intensify Training of skilled birth attendants.

iii ***Supply DDK and train dais:*** Supply disposable delivery kits to ensure clean practices for domiciliary deliveries.

iv ***Neonatal care:*** Implement essential newborn care, including cord care to reduce risks of neonatal tetanus.

v ***Strengthen service delivery:*** Td is offered at all antenatal sessions and routine immunization sessions. Provide two doses of Td during first pregnancy and further doses according to national schedule.

vi Cover adolescent girls in school and out of schools for Td immunization at age 10 and at age 16 to build up immunity against tetanus and diphtheria, this will ensure elimination of tetanus to a great degree, however priority of Td under the programme are pregnant women.

vii ***Surveillance:*** Increase reporting and appropriate action. Ensure surveillance of occurrence of NNT and establish NNT as reportable disease. NNT is included with weekly AFP in active surveillance and zero reporting. Targeted action will be taken around reported and investigated cases by improving and promoting Td immunization for pregnant women and safe and clean deliveries in the community.

viii ***Private sector:*** Involve private sector to promote institutional deliveries and Td immunization to pregnant women.

ix ***Milestones:*** National focal point for NNT is created in all the states by 2005 **Maternal and neonatal tetanus elimination** (MNTE) **has been validated** in India in **May 2015 by WHO**; however, the immunization will continue.

x ***Intensify IEC activity***.

DIPHTHERIA (A RE-EMERGING THREAT)

It is an acute communicable disease caused by *Corynebacterium diphtheriae*. The target organs of this disease are tonsils, pharynx, nose, and occasionally other mucus membranes and skin. The bacteria forms membrane over these sites and releases powerful toxins, which may lead to muscular and sensory nerve paralysis and myocarditis.

Epidemiology: Humans are the only reservoir of infection.

Case Fatality Rate

It is 5–25%.

Age Group Affected

Diphtheria mainly affects the unimmunized. Though all age groups stand to the risk of diphtheria, but predominantly children below the age of 15 years are most commonly affected.

Problem

The incidence of diphtheria and its severity has declined over the years but still cases are being reported and some of them are fatal even. Nearly 5000 cases per annum are being reported in India. The reporting is inadequate because of poor surveillance. 5826 cases and 68 deaths were reported during the year 2005, similarly 3343 cases and 177 deaths were reported in the year 2010 and 4233 cases and 99 deaths were reported in 2011, 4310 cases and 67 deaths were reported in 2013, and 4071 cases and 104 deaths in 2014 and 5421 cases and 149 deaths in 2017 and 11638 cases and 182 deaths in 2018, and 1947 cases 57 deaths in 2019, and 1991 cases and 28 deaths in 2020.

Outbreaks: The last two decades have seen a resurgence of diphtheria in both developed and developing countries. where it was previously well controlled. Due to good vaccine coverage worldwide a shift in age incidence has been observed from pre-school to school age (5–15 years) with more and more cases being reported even in adults. Outbreaks in India were reported in Kolkata (1977), Delhi in 2000 and J & K in 2002–03 and again in Delhi 18 deaths were reported in September 2018.

Transmission

The infection is transmitted through contact with a patient or carrier by droplet infection or even by contact. Without adequate treatment, the period of communicability can extend up to 4 weeks from the onset of the disease, otherwise it lasts for 24–48 hours after the initiation of treatment.

Incubation Period

It ranges between 2 and 5 days.

Clinical Features

It leads to formation of patches of greyish membrane with a surrounding dull red inflammatory zone, which may cause pharyngeal obstruction. Swelling and oedema of neck occurs in severe cases. Laryngeal diphtheria is a serious condition. There may be neurological complications and myocarditis. The illness may last for 10–21 days but it depends upon the promptness of treatment and stage of illness when reported for treatment. Administration of diphtheria antitoxin at the earliest is the most important element in treatment of diphtheria. The antitoxin should be given either by intramuscular or intravenous route in doses ranging from 10,000 to 1,00,000 units or more after sensitivity test. Erythromycine or procaine penicillin are the drugs of choice.

Prevention

Clinical attack or subclinical infection does not provide lasting immunity. Active immunity should be initiated against diphtheria at the time of discharge. Maternal antibodies provide immunity for the first 6 months of life.

DIPHTHERIA VACCINE

Diphtheria vaccine is available in the form of diphtheria toxoid and adsorbed toxoid is better and more efficient for immunity. It should be stored at 2° to 8°C and not to be frozen.

Administration

Diphtheria toxoid is routinely administered in combination with tetanus toxoid or additionally with pertussis vaccine. It is administered with oral polio vaccine as per recommended schedule.

Immunization Schedule

An infant should receive 3 doses of DPT prior to 12 months of age. The recommended age for the first dose is 6 weeks and minimum interval between 2 doses is 4 weeks. A booster dose is given at 16–24 months of age and another booster dose of DPT at school entry (5–6 years age) is recommended. DPT booster dose 1 and 2 can be given till 7 years of age. Since 2014 DPT 1, 2, 3 have been replaced by pentavalent vaccine in UIP.

Efficacy

The vaccine is highly effective and provides long lasting immunity after 3 doses. Clinical efficacy is 97%. Immunization does not prevent the carrier state.

Surveillance of DPT

Diphtheria, pertussis and neonatal tetanus lab-based surveillance rolled out in 22 states as a part of vaccine preventable diseases surveillance.

TUBERCULOSIS

EPIDEMIOLOGY AND PREVENTION

It is a communicable disease of public health significance.

Causative organism: The disease is caused by *Mycobacterium tuberculosis* in human beings *M. bovis* causes intestinal tuberculosis.

The disease is distributed widely. It is highly prevalent in India. The urban and rural prevalence is almost equal. Urban slums show higher prevalence rates.

Transmission

Sputum positive cases can transmit infection to other healthy persons through fine droplets. Close contacts are at highest risk of tuberculosis infection. After infection, the subsequent risk of development of progressive pulmonary or extrapulmonary tuberculosis is maximum within a year or two. 31.4% of people are infected with tubercle bacilli in India, while only 10% of infected persons develop TB disease in lifetime.

The tuberculosis is killer number one in adults in India. Problem of multidrug resistant tuberculosis has emerged. HIV and tuberculosis have strong nexus.

Clinical Signs

Clinical signs are pulmonary or extrapulmonary with prolonged morbidity. The initial infection goes unnoticed.

Prevention

Prevention of tuberculosis is difficult. Severe forms of tuberculosis (miliary and meningeal) can be prevented by BCG vaccination in children.

BCG Vaccine

The vaccine is freeze dried preparation made from attenuation of *Mycobacterium tuberculosis* (*Bacillus Calmette-Guérin*). BCG vaccine is now available in 10 dose vial. Reconstituted BCG vaccine should be used within 4 hours.

Administration

BCG is given intradermally and can be administered concurrently with other vaccines. Dose is 0.1 ml. The dose for children below one month is 0.05 ml.

Immunization Schedule

BCG can be given soon after birth or at any time thereafter till 1 year of age. Most children acquire natural clinical or subclinical tuberculosis infection by the age of 1 year. It can be combined with first dose of DPT at 6 weeks of age. It is safe. It prevents severe and serious TB (brain TB and miliary TB) in children.

Efficacy

Variable from 0 to 80% as reported by different trials. Subsequent trials done by WHO indicated that BCG has efficacy between 50 and 60% and offers protection against childhood tuberculosis. It prevents severe forms of (miliary and meningeal) tuberculosis in children, hence it is recommended in India. It does not prevent the occurrence of pulmonary tuberculosis. The incidence and prevalence of tuberculosis has not much declined after the introduction of BCG vaccination since 1962 in India. For diagnosing childhood tuberculosis, WHO algorithm is being followed.

Side Effects

At the site of BCG injection, a small red tender nodule appears after about 2 weeks, which might develop into ulcer, which heals by itself leaving behind a scar at the site. This is a normal reaction. Sometimes it might develop into an abscess or sinus, which takes very long time to heal, and may cause swelling of lymph glands in the axilla.

EPIDEMIOLOGY OF POLIOMYELITIS

Poliomyelitis is an acute viral infection caused by three antigenic types of polioviruses (1, 2 and 3).

The poliovirus is an enterovirus. There are three serotypes: Types 1, 2 and 3. All three can cause paralysis, although type 1 causes paralysis most often, type 3 less frequently and type 2 rarely. Most epidemics are due to type 1, cases of paralysis associated with vaccine are usually caused by types 3 and 2. During eradication, the first serotype to disappear is type 2 due to better oral polio vaccine (OPV) take rates followed by serotypes 3 and 1. Type 1 polio virus has propensity to cause huge outbreaks and travel long distances. Wild polio virus 1 accounted for 95% of polio cases in India between 2000 and 2006.

Types of Cases—Clinical Course

- Inapparent infection account for 90–95% of cases.
- Abortive polio occurs in 4–8% of cases.
- Non-paralytic aseptic meningitis occurs in 1–2% of infections.
- Share of paralytic cases is 0.5–1%.

Thus, for every one paralytic case, there are 200 inapparent infections in the community for type 1 and 1000 inapparent infections for type 3, respectively. These inapparent cases continue to excrete wild poliovirus in their faeces.

Social Significance

The cases who develop paralytic manifestation may develop permanent, partial or total disability which lasts lifelong. Thus, polio is disabling disease.

Acute attack may cause death in 2–10% of cases.

Distribution

As of now, most countries in the world have achieved eradication and have been certified. Polio is endemic in just two countries—Pakistan, and Afghanistan. India is polio-free since 14th January 2011. Pakistan reported 48 cases of (WPI) polio on 2nd July 2019. It is hoped that World will be certified Polio free by 2026.

Seasonal Variation

The incidence increases during July to September coinciding with the rainy season.

Age of Occurrence

Median age of occurrence of poliomyelitis was 18 months. Bulk of cases occurred in late infancy and early childhood period.

In endemic areas, polio is now a disease of very young children. In 2006, in western UP, more than 85% of cases were in children less than 3 years of age and 73% were less than 2 years old. Thus, wild poliovirus (WPV) transmission was surviving largely in children under the age of 3 in endemic areas. The survival of transmission in this age group is because, insufficient young children are immune to stop viral transmission and the poorer immunization status of younger children compared to older children. Surveillance data shows that younger children; under 2 years of age have received less doses of oral polio vaccine (OPV) than older age groups.

Transmission

Transmission is primarily person to person via the faecal oral route. Poliovirus multiplies in the intestine and is spread through the faeces. The virus is intermittently excreted for up to 2 months or more after infection, with maximum excretion occurring just before paralysis and during the first 2 weeks (14 days) after onset of paralysis.

Incubation Period

Average incubation period is between 7 and 10 days but the range is from 4 to 35 days.

Reservoir and Environments Monitoring

Man is the only reservoir and the infection is spread from person to person. Given the large number of inapparent infections it is difficult to find the source of infection. The half-life of excreted virus in the sewage in warm climate is only 48 hours. Detection of wild polio P1 virus in sewage in Delhi continuously in 2010 was a point of worry. Monitoring wild poliovirus in sewage is a continuous activity and is being continued in polio free India.

NATIONAL POLIO ERADICATION PROGRAMME

During May 1988, World Health Assembly passed a resolution to achieve the polio eradication by the year 2000.[1] The Government of India launched Polio Eradication Programme in the year 1995. The goal to eradicate poliomyelitis by the year 2000 adopted under the UIP could not be achieved. *India* is now *polio free* with effect from *14th January* 2011.

Goal of Eradication[2]

The polio eradication is defined as no case of clinical poliomyelitis associated with wild poliovirus, and no wild poliovirus found despite intensive efforts to do so. Wild Poliovirus has been detected in US and UK in waste during August 2022 which is worrisome

Key Strategies of National Polio Eradication Programme

1 ***Routine immunization:*** Achieve and maintain high level of coverage for oral polio vaccine—85% and above through routine immunization in infants. India achieved over 90% of OPV coverage among infants through routine immunization but this was not uniform, in all the states and districts.

2 ***Pulse polio immunization (PPI):*** By observing national immunization days (NIDs) and sub-national immunization days (SNIDs) every year.[3]

Objective: Objective of PPI strategy is to interrupt transmission of wild poliovirus in the community. PPI is primarily an eradication strategy—tested all over the world.

Essentials of PPI: To cover all children of age group 0–5 years and irrespective of their previous immunization status ensuring two extra doses of OPV; achieving close to 100% coverage throughout the country. These two extra doses supplement and do not replace the doses received during routine immunization services.

Epidemiological Basis of PPI: The intention of PPI is to replace 'wild poliovirus' by 'vaccine virus' in the community. PPI replaces harmful wild poliovirus and thereby eradicates polio in the community.

3 ***Acute flaccid paralysis (AFP) surveillance:*** To recognize and report AFP cases at the earliest and ensure rapid response (outbreak response immunization).[4] It is gold standard for detecting cases of wild poliomyelitis. It is being continued and number of AFP cases reported in 2019 were 40422 and in 2021 upto December 23829 AFP cases were reported.

What is AFP? AFP Case Definition

Acute flaccid paralysis (AFP) is defined as sudden onset of weakness and floppiness in any part of the

body in a child <15 years of age or paralysis in a person of any age in whom polio is suspected.

Focus: AFP surveillance must focus on children under 15 years. All AFP cases (polio and non-polio) should be reported.

Expected AFP Rate/Background AFP Rate

The goal in India is to have all districts reporting AFP cases, non polio AFP rates of at least 2 cases per 1,00,000 population of children below 15 years of age per year should be achieved by each district. This is an important indicator of adequacy and quality of AFP surveillance. If the rate is less than 2, it is poor quality of surveillance.

Response to an AFP case

a Immediately inform and report the outbreak to DIO/SMO.
b Collect two stool samples within 2 weeks of the onset of paralysis.
c Case investigation.
d Active case search in the community.
e Outbreak response immunization (ORI).
f Include the case in weekly report of surveillance.
g Sensitize health facilities that have missed the case.

4 ***Mopping up round:*** As and when wild poliovirus is detected mass supplementary immunization activities (SIAs) are organized by immunizing all 0–5 years old children covering 2–5 million children under this age group with type specific monovalent or bivalent vaccine. It is an end game strategy.

5 ***Protection of high-risk population:*** Migrant population, urban slums, construction sites and brick kilns workers must be protected on priority.

1. Strategy of High Coverage of OPV

Achieve the highest coverage levels possible through the administration of vaccines in routine immunization programme through fixed centres and outreach sessions. Through UIP within 10 years, India achieved over 90% coverage of routine OPV and the cases decreased by 80% from 26,226 in 1984 to 4793 in 1994. Highest coverage levels of 90% achieved but polio cases continued to occur with reduced incidence, *thus routine immunization alone could not interrupt the transmission of wild poliovirus and allow India to achieve the goal of polio eradication*.

2. Strategy of PPI—National Immunization Days (NIDs)

From 1995 onwards, India is implementing nationwide mass immunization campaigns (NIDs). India conducted its first Pulse Polio Immunization (PPI) on 9th December, 1995 and 20th January, 1996 and more than 75 million children under 3 years throughout the country received two extra doses of OPV on these days. Since then PPIs are being repeated yearly. The target age group in these PPI was increased to cover all children under 5 years of age.

WHAT IS PPI?

It means extra doses of trivalent OPV administered to all children below 5 years on the two fixed dates (*national immunization days in the country*), at the interval of 4–6 weeks. The term 'pulse' has been used to describe this sudden, simultaneous, mass administration of OPV on a single day to all children 0–5 years of age which constitute 13% of total population. During each NID 130 million children less than 5 years were given polio drops and during each SNID around 70 million children are being covered.

CURRENT SITUATION OF POLIOMYELITIS IN INDIA—POLIO ELIMINATED

The polio eradication in India has made major progress since its inception in 1995. Before 1979, when OPV was introduced in the National EPI Programme (1978); an estimated 1,50,000 polio cases occurred annually in the country. As a result of introduction of OPV under the National EPI Programme, polio incidence declined and the estimated number of cases in 1994 dropped to 5000 only. Since the inception of AFP surveillance in 1997–98 more accurate data on incidence of polio cases became available. Since 1998, when 1934 polio cases were confirmed, a consistent decline in incidence has been registered over the years. The number of cases reached an all time low in 2010 with only 42 cases reported against the background of the most *sensitive* AFP surveillance system and geographical spread confined to only a few districts in western UP, Bihar, West Bengal, Jharkhand and Maharashtra (Tables 8.28 and 8.29).

Poliomyelitis Vaccines

There are two types of vaccines available:

i ***Oral polio vaccine (OPV):*** Widely used in India (tOPV). It is live attenuated, trivalent oral polio vaccine (OPV), containing all three types of polioviruses.
ii Monovalent oral polio vaccine—mOPV1 and mOPV3 and bivalent polio vaccine (P1 and P3).
iii ***Inactivated poliovirus vaccine (IPV)*** to be given by intramuscular injection at mid thigh.

Administration

OPV is given orally: The vaccine can be administered along with DPT vaccine. It protects about 99, 98 and 91% of children from type 1, 2, and 3, respectively.

Table 8.28: Trends of poliomyelitis in India

Year	No. of confirmed cases for wild poliovirus	No. of districts affected
1978	1,50,000	All
1984	26226	All
1994	4793	All
1998	1934	314
1999	1126	192
2000	0265	089
2001	0268	63
2002	1600	159
2003	0225	087
2004	134	43
2005	66	35
2006	676	114
2007	874	99
2008	559	90
2009	741	53
2010	42	17
2011 Jan 13th	1	1
2012	0	0
2013 to 2022	0	0
2014 (27th March) Wild poliovirus eradicated from India.		

Table 8.29: Trends of P1 and P3 wild poliovirus cases in India from 1999–2022

Year	P1 cases	P3 cases	Total cases
1999	730	394	1126
2005	62	4	66
2006	648	28	676
2007	83	794	874*
2008	75	484	559
2009	80	662	741*
2010	18	24	42
2011	1	0	1
2012	0	0	0
2013–2022	0	0	0
2014 (27th March) Wild poliovirus eradicated from India.			

*Mixture of P1 and P3 wild in some cases.

Immunization Schedule

Infants should receive at least 3 doses of OPV at minimum interval of 4 weeks within the first 9 months of age. In endemic areas, the extra-dose of OPV (zero dose) should be given soon after birth (up to 15 days after birth). This can be ensured for institutional deliveries.

In non-endemic areas, the first dose of OPV can be started at 6 weeks of age.

Efficacy

OPV produces both circulatory antibodies as well as provides local gut/intestinal resistance. The OPV has been successfully used to eliminate and eradicate poliomyelitis, but some developing countries have reported poor serological response to OPV.

IPV induces circulatory antibodies but does not prevent intestinal infection.

Both IPV and OPV provide long-lasting immunity. Efficacy is 95% for fully immunized children.

Storage

OPV should be stored below –15°C where it can maintain its shelflife for 2 years, at 0° to +8°C for 1 year. It can withstand only one day at +37°C.

Risks Associated with the Use of Oral Polio Vaccine (OPV) Adverse Effects

Although OPV is the vaccine of choice for polio eradication as it provides both humoral and intestinal immunity. The major concern about OPV is that it is live attenuated virus vaccine and has ability to revert to a form that can cause paralysis called **vaccine-associated paralytical poliomyelitis** (VAPP). It is associated with a single dose of OPV given to a child or can occur in a close unvaccinated or non-immune contact of the vaccine recipient who is excreting the mutated virus. It is estimated that OPV may cause VAPP in one in 2.7 million doses of OPV given (with 25–30 cases per year in India).

Vaccine Derived Poliovirus (VDPV)

When a child is vaccinated with live OPV the virus replicates in the intestine and gets genetically altered during replication, like wild poliovirus the child excretes the altered vaccine virus for a period of 6 to 8 weeks. This is called vaccine derived poliovirus (VDPV). Amongst the three types of VDPV, the circulating vaccine-derived poliovirus (cVDPV) may cause paralysis in areas with low routine immunization coverage (low immunity areas). Due to the risk of cVDPVs, OPV must be phased out to secure a lasting polio free world. Type 2 component contained in trivalent OPV accounts for 90% of all cVDPVs cases. 43 cases of paralysis due to VDPVs have occurred in India and 40 were due to type 2 VDPVs since 2009.

THE POLIO ERADICATION ENDGAME STRATEGY 2013–18: THREE STEPS[5]

1 **Introduction of IPV in routine immunization by October 2015:** By the end of 2015 introduce at least 1 dose of IPV into all routine immunization systems at least 6 months before the switch from tOPV to bOPV (containing poliovirus types 1 and 3). India did it in Nov 2015.

2 **tOPV–bOPV switch by April 2016:** From 2016 switch from tOPV to bOPV (which does not contain type 2 Sabin virus) in routine immunization and polio campaigns.

3 **Withdrawal of routine OPV use:** Plan for the eventual withdrawal of OPV in routine use by 2019–2020.

Introduction of Inactivated Polio Vaccine (IPV)

IPV consists of inactivated (killed) poliovirus strains of all three poliovirus types (poliovirus types 1, 2 and 3). IPV is given intramuscularly at mid-thigh. The IPV produces antibodies in the blood to all three types of poliovirus. It is highly effective in preventing paralytic disease caused by all three types of polioviruses. When IPV is given after a few doses of OPV, the IPV not only enhances protection against paralytic disease but also boosts intestinal immunity. Thus, combining IPV with OPV provides strong intestinal immunity and antibody protection against all three serotypes. IPV carries no risk of VAPP and VDPV, hence IPV is one of the safest vaccines in use. IPV together with OPV prevents re-emergence and reinfection of wild poliovirus (WPV).

IPV has been introduced across all over India in November 2015 along with third dose of OPV in routine immunization at 14 weeks as single dose of 0.5 ml intramuscularly. IPV is heat and freeze sensitive vaccine, can be given up to one year of age. IPV is to be given in two fractional doses at 6 and 14 weeks along with OPV. Fractional IPV dose is 0.1 ml intradermal in the right arm.

IPV should not be frozen. It should be stored at 0° to + 8°C. At this temperature it has shelf-life of 12–18 months. It can withstand four weeks at 37°C. IPV is heat sensitive vaccine.

Rationale for Introduction of IPV into Routine Immunization Programme

The primary purpose of introducing IPV into routine immunization is to boost population immunity against type 2 poliovirus during and after the planned global widhdrawal of OPV2 and switch from tOPV to bOPV. The vaccine will also facilitate the interruption of transmission with the use of monovalent OPV type 2 in case of outbreaks, hasten eradication by boosting immunity to poliovirus type 1 and 3, and mitigate the risk of emergence and transmission of cVDPV2.

Evidence indicates that one dose of IPV may reduce risk by protecting individuals against paralytic polio should they be exposed to cVDPV2 or WPV2.

Withdrawal of Type 2 Component of Oral Polio Vaccines (OPVs): Switch from Trivalent OPV (tOPV) to Bivalent OPV (bOPV)

The **endgame strategy** plan mandates that all countries must eventually stop use of OPV beginning with removal of the type 2 component of tOPV through a globally synchronized **switch to bOPV** (containing only types 1 and 3) for routine immunization and all supplementary immunization activities. The global tOPV-bOPV switch, which occurred in **April 2016** has to be globally coordinated process because any use of tOPV after April 2016 could jeopardize polio eradication by generating circulating vaccine-derived polioviruses from the type 2 component of the vaccine.

Although no wild poliovirus type 2 has been recorded over the past years, the risk of paralytic polio diseases due to the type 2 component of OPV now outweighs its benefits. This switch is necessary because replacing tOPV with bOPV is the key to ensuring the eradication of type 2 polio. Sabin virus, which in turn will reduce the risk of new cVDPV type 2 outbreaks after OPV type 2 cessation, if a cVDPV2 appears.

Once the switch is made, tOPV will no longer be used anywhere in the world, and manufacturers will no longer supply tOPV. Selected high risk countries will conduct SIAs with tOPV in the months leading up to the switch.

What is VVM (Vaccine Vial Monitor)?

The VVM is a small square made of heat sensitive material and placed on the outer coloured circle printed on the label of the OPV vial. Combined effect of time and temperature cause the VVM to change colour gradually from light at the starting point and become darker with exposure to heat. The darkening process is irreversible. The outer coloured circle is used as reference to compare the colour of VVM.

VVM does not directly measure vaccine potency but it does give information about heat exposure over a period of time, which affects potency. The VVM, however, does not measure exposure to freezing that contributes to the degeneration of freeze sensitive vaccines.

How to Read VVM?

Start point		Square lighter than circle. If the expiry date has not passed, use the vaccine
End point		Square matches the circle. Do not use the vaccine
End point exceeded		Square darker than the circle. Do not use the vaccine

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ACUTE RESPIRATORY INFECTIONS

EPIDEMIOLOGY OF ACUTE RESPIRATORY INFECTIONS

Acute respiratory infections (ARI) in under-five children is one of the main public health problems in India. It is the major cause of morbidity and mortality in infants and young children below age 5. ARI contributes to 15% of all under-five deaths in India and most of these deaths are preventable.[1]

Definition

Acute respiratory infections comprise a group of conditions caused by a variety of pathogens including bacteria, viruses and fungi. ARI is defined as:

"An episode of acute symptoms and signs resulting from infection of any part of respiratory tract or any related structure, including nose, throat, larynx, trachea, bronchi, bronchioles, lungs, paranasal and middle ear." A new episode is one occurring in an individual, who has been free of symptoms for at least 48 hours.[2, 3]

Major Signs

Cough, difficult breathing, sore throat, runny nose, ear problem and fever.

Age Group

Under-five children are most susceptible to ARI.

Morbidity Burden of ARI

Morbidity due to ARI is considerable. Most young children have about 3–5 ARI episodes each year and each episode lasts for 7–14 days. Although the vast majority of ARIs are self-limiting, these cause considerable discomfort; as well as adverse nutritional impact. Annually around 40 million cases of ARI are being reported in India (Table 8.30) with over 4 lakh case of pneumonia.

Economic Loss

Huge expenses are incurred by the community with massive expenditure on a wide variety of medications as well as burden on limited hospital facilities. ARI accounts for 30–60% of all outpatients visits and 20–40% *paediatric* admissions.[3,4]

Case Fatality

Ten to fifteen per cent of all ARI may progress to disease of moderate to severe intensity pneumonia. Case fatality rate varies from 5 to 10%.

Table 8.30: Trends of acute respiratory infections (ARIs) in India from 2000 to 2020

Year	*Cases reported (million)*
2000	19.65
2001	20.55
2002	22.13
2003	24.25
2004	27.48
2005	25.73
2006	26.15
2007	26.17
2008	25.54
2009	28.24
2010	24.72
2013	33.42
2016	40.81
2017	42.19
2018	41.99
2019	40.7
2020	23.67 (P)

Source: National Health Profile 2015 to 2021. CBHI, DGHS, MOH and FW; GOI.

Mortality

ARI contributes to about 15% of mortality in children less than 5 years of age, it is the second most common cause of death in this age group. ICMR multi-centric study shows ARI accounting to 15–30% of childhood deaths. It is estimated that pneumonia causes 4.1 lakh deaths among children under 5 each year, accounting for almost 25% of all child deaths.

Pneumonia

Around 10–15% of all children suffer from pneumonia each year. *Pneumonia* is by far the major cause of death in ARI.

Etiology

In India around 60% of pneumonia are caused by bacteria, mainly *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Staphylococcus aureus* and *Klebsiella pneumoniae*. Pneumonia could be community acquired or hospital acquired pneumonia.

Risk Factors

1 Malnutrition (weight for age z score <–2).
2 Low birth weight, lack of exclusive breastfeeding during first 6 months.
3 Urban slum children living in overcrowded localities are much more exposed to the risk of ARI.
4 Lack of measles immunization.
5 Indoor air pollution.
6 Parental smoking.

NATIONAL POLICY ON ARI CONTROL[5–8]

Objective

The main objective of ARI control programme in India is to reduce deaths due to *pneumonia* in children.

Strategies

1 The main strategy is accurate and early detection and standard case management for reduction of mortality.
2 Continued high coverage of UIP vaccines is the key preventive strategy against measles, whooping cough and diphtheria, HIB disease and pneumococcal pneumonia.

Most of ARIs are self-limiting, but pneumonia needs to be treated. Fortunately, most bacterial pneumonias in Indian children are susceptible to the broad-spectrum antibiotics. However, wide indiscriminate use of antimicrobials can lead to bacterial resistance. Limiting the use of antimicrobial drugs to only those children who need them will have numerous health and economic benefits. The national policy on ARI control therefore emphasizes decreasing the inappropriate use of antibiotics for treatment of ARI, other than *pneumonia* in children. It is recognized that acute upper respiratory infections (AURI) rarely cause death.

Standard Case Management

WHO—protocol/algorithm is widely used. This can be used at home level by mother, family and community and by all healthcare providers.

The basic criteria for diagnosis of pneumonia is based on the counting of respiratory rate. WHO recommends breathing rate of 60 per minute or more in an infant less than 2 months of age, 50 or more in an infant 2–12 months of age and 40 or more in children 1–5 years of age as **fast breathing.** In each case, respiratory rate should be carefully counted in resting child for a full one minute.

Management of ARI Infections in Children (Cough or Difficult Breathing[2])

The strategy of integrated management of childhood illness (IMCI) as applied to management of ARI can reduce mortality and prevent morbidity. ARI presents with cough and difficult breathing and most children with cough and difficult breathing have only mild infection such as cold and cough or bronchitis. Children may cough because nasal discharge from cold drips down the back of throat or they have viral infection of bronchi (bronchitis), they are not seriously ill and can be treated at home without antibiotics.

Four steps are applied:

1 Assessing the child by asking—looking, listening and feeling.
2 Classifying the illness of the child.
3 Decision for treatment
4 Follow-up of case (Tables 8.31 and 8.32).

By carefully 'asking', 'looking' and 'listening' the condition of the child can be assessed. A child with cough or difficult breathing could have pneumonia, which is a serious disease that can result in death. However, the cough or difficult breathing can also be caused by common cold, blocked nose, dusty environment, whooping cough (pertussis), measles, tuberculosis and wheezing disorders.

1. Assessing the Child

The assessment is done by 'asking' how old is the child? Is the child coughing or have difficult breathing? For how long?

Age 2 months to 5 years	Is the child able to drink?
Age less than 2 months	Has the young child stopped feeding well? For how long? Has the child had convulsion? Has the child had fever?

Look, Listen and Feel

Child must be calm.

- Count the breaths in one minute
- Look for the chest indrawing
- Look and listen the stridor
- Look and listen the wheeze, is it recurrent?
- See if the child is sleepy or difficult to wake
- Feel for fever or low body temperature (or measure temperature)
- Look for severe malnutrition.

Danger Signs

Unable to breastfeed or drink, lethargic or difficult to wake have convulsions and vomits everything, strider in calm child and fever or low body temperature.

2. Classifying the Illness of the Child

Classifying illness means making decision about the 'severity' of disease. The purpose of classification is not specific disease diagnosis, its purpose is to make decision about severity of disease and choose line of action or treatment. Classification and categorization is done on the basis of danger signs or other signs and respiratory rate.

Colour Coding

Based on the signs, the child is classified into:

- Very severe disease—pink
- Severe pneumonia—pink
- Pneumonia (not severe)—yellow
- No pneumonia: Cough or cold—green

Table 8.31: The young infant age less than 2 months—classify the illness

Signs	• Stopped feeding well • Convulsions • Abnormally sleepy or difficult to wake • Stridor in calm child • Wheezing or • Fever or low body temperature	
Classify as	*Very severe diseases*	
Treatment	• Refer urgently to hospital • Keep young infant warm • Give first dose of an antibiotic	

Signs	• Severe chest indrawing, or • Fast breathing (60 per minute or more)	• No severe chest indrawing and • No fast breathing (less than 60 per minute)
Classify as	Severe pneumonia	Cough or cold No pneumonia
Treatment	• Refer urgently to hospital • Keep young infant warm • Give first dose of an antibiotic (If referral is not feasible, treat with an antibiotic and follow closely)	• Advise mother to give the following home care: – Keep young infant warm – Breastfeed frequently – Clear nose if it interferes with feeding – Return quickly if: • Breathing becomes difficult • Breathing becomes fast • Feeding becomes a problem • The young infant becomes sicker

Source: WHO. Classification of illness and treatment guidelines WHO algorithm.

Each disease classification has corresponding treatment plan and should be followed after the child has been classified.

Treatment plan varies in children below 2 months and 2 months to 5 years.

Young infants (less than 2 months) can become sick and die very quickly from serious bacterial infections, are much less likely to cough with pneumonia, and frequently have only non-specific signs such as poor feeding, fever and low body temperature. Further mild chest indrawing is normal in young infants because their chest wall bones are soft.

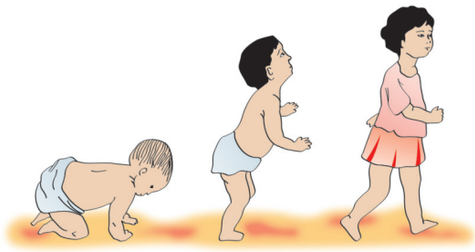
- Some of the danger signs are different. In a young infant, danger signs include 'stopped feeding well' 'fever or low body temperature', and 'wheezing'. The sign 'severe malnutrition' is not a danger sign in young infant, although it is in older children.
- Young infant must have severe chest indrawing to be classified as having severe *pneumonia*. A child aged 2 months up to 5 years is classified as having severe pneumonia if there is any general danger sign.
- The cut off for **fast breathing** is different.

  A young infant (less than 2 months) has fast breathing when he or she is breathing 60 times per minute or more. The cut-offs for fast breathing are 50 times per minute or more if the children are aged 2 months up to 12 months, or 40 times per minute or more if they are aged 12 months up to 5 years.
- Any pneumonia in young infant is considered to be severe, hence should be referred immediately to hospital. Older children can be classified as having 'pneumonia' (which can be treated at home with antibiotic) or 'severe pneumonia' (in which case they should be referred urgently to a hospital).

The classification of illness is assigned into three colour-coded columns, these are either pink, yellow or green.

Table 8.32: Child age 2–59 months with cough and/or difficult breathing—classify the illness

Does the child have cough or difficult breathing?

IF YES, ASK: • For how long? • HIV status of mother and child	***Look, listen, feel*:*** • Count the breaths in one minute. • Look for chest indrawing. • Look and listen for stridor. • Look and listen for wheezing. Child must be calm **If wheezing with either fast breathing or chest indrawing:** Give a trial of rapid acting inhaled bronchodilator for up to three times 15–20 minutes apart. Count the breaths and look for chest indrawing again, and then classify.	
If the child is: 2 months up to 12 months 12 months up to 5 years	***Fast breathing is:*** 50 breaths per minute or more 40 breaths per minute or more	

Classify cough or difficult breathing

• Any general danger sign: Not able to drink, persistent vomiting, convulsions, lethargic or unconscious, severe malnutrition. or • Stridor in calm child	**SEVERE PNEUMONIA OR VERY SEVERE DISEASE**	• Give first dose of an appropriate antibiotic • Refer URGENTLY to hospital**
• Chest indrawing or • Fast breathing	**PNEUMONIA**	• Give oral amoxicillin for 5 days*** • If wheezing (or disappeared after rapidly acting bronchodilator), give an inhaled bronchodilator for 5 days**** • If chest indrawing in HIV exposed/infected child, give first dose of amoxicillin and refer. • Soothe the throat and relieve the cough with a safe remedy • If coughing for more than 14 days or recurrent wheeze, refer for possible TB or asthma assessment • Advise mother when to return immediately • Follow-up in 3 days
• No signs of pneumonia or very severe disease	**COUGH OR COLD**	• If wheezing (or disappeared after rapidly acting bronchodilator), give an inhaled bronchodilator for 5 days**** • Soothe the throat and relieve the cough with a safe remedy • If coughing for more than 14 days or recurrent wheezing, refer for possible TB or asthma assessment • Advise mother when to return immediately • Follow-up in 5 days, if not improving

** If pulse oximeter is available, determine oxygen saturation and refer if <90%.*
*** If referral is not possible, manage the child as described in the pneumonia section of the national referral guidelines or as in WHO pocket book for hospital care for children.*
**** Oral amoxicillin for 3 days could be used in patients with fast breathing but no chest indrawing in low HIV settings.*
***** In settings where inhaled bronchodilator is not available, oral salbutamol may be tried but not recommended for treatment of severe acute wheeze.*

Pink: Refer urgently to hospital.

Yellow: Give an antibiotic and home care.

Green: Give home care.

The colour of the boxes will help to determine the severity of illness and appropriate treatment plan quickly.

Young Infants (0–2 months)

There are **three classifications** of illness for a young infant with a cough or difficult breathing: Very severe disease, severe pneumonia and no pneumonia: Cough or cold (Table 8.31).

- ***Very severe disease:*** The presenting features are stopped feeding well, convulsion, abnormally sleepy or difficult to wake, stridor in calm child, wheezing, or fever or feels too cold. In such cases, the scope of treatment is very limited at first level of health facility. After giving first dose of antibiotic, the cases are to be referred to next higher level.
- ***Severe pneumonia:*** This illness is presented with fast breathing (60 or more/minute) and severe chest indrawing. Here also after giving first dose of antibiotic, the case is to be referred.
- ***No pneumonia:*** Cough or cold in this case the child will have a breathing rate of less than 60/minute and there will be no severe chest indrawing. Antibiotic is not needed in this case. Only the mother is to be advised for giving 'home care'.

In young infants, the pneumonia cases are to be taken as severe and to be referred after giving the first dose of oral antibiotic.

Children 2 months to 5 years (Table 8.32)

There are **two classifications** of pneumonia for children aged 2 months to 5 years: Severe pneumonia or very severe disease, and pneumonia.

- ***Severe pneumonia or very severe disease:*** The general danger signs are—not able to drink, convulsion, abnormally sleepy, stridor in calm child, severe malnutrition, and persistent vomiting. Refer to facility for injectable antibiotic and supportive therapy. Before referring the child (which is a must), first dose of antibiotic is to be given. Moreover, if there is fever, necessary first dose of paracetamol is to be given.
- ***Pneumonia:*** With fast breathing and/or chest indrawing. Fast breathing will be present (rate is 50 or more) per minute for 2 months to 1 year age group and 40 or more/minute for 1 year to <5 years of age group.

  In this category of illness, oral antibiotic (amoxicillin) for 5 days is to be given along with treatment of fever if present. The mother is to be advised for 'home care'. Reassessment of the condition of the child is to be made after 2 days. If the condition gets worse, the child is to be referred.
- ***Cough and cold:*** The child will come with cough and cold without any fast breathing or chest indrawing. No antibiotic is needed. Only treatment of fever, if present paracetamol is to be given orally. Mother must be advised to give home care. However, if the cough is there for more than 14 days, the child is to be referred for possible TB or asthma assessment.

3 and 4. Decision for Treatment and Follow-up First Line Drug—At Community and Facility Level

In view of increasing resistance of *S. pneumoniae* and *H. influenzae* to cotrimoxazole, macrolides and cephalosprins, amoxycillin is recommended as the first line antibiotic for non-severe pneumonia at both community level and clinic settings. It is important to identify wheezing which can be cause of fast breathing, which may improve with bronchodilators without requiring antibiotics. Children with severe pneumonia or very serious disease should be admitted and treated with injectable ampicillin or gentamicin and supportive care including oxygen and IV fluids.[9,10]

Management of Pneumonia in 2–59 Months Child[11]

Pneumonia classification and management are simplified to two categories instead of three (*see* Figure 8.32). Combing the two previous categories of "Pneumonia" (fast breathing) and "severe pneumonia" (chest indrawing) under a single classification of pneumonia simplifies classification.

1. Integrated community case management (ICCM)

- All children with fast breathing are classified as having "pneumonia" are treated with oral amoxicillin as a first-line treatment by trained healthcare workers and care-givers. Dispersible amoxicillin is the preferred treatment for children, the recommended dose is 80 mg/kg/day in two divided doses for 5 days. In setting of low HIV prevalence, the duration of treatment for fast breathing can be reduced to three days.
- Children with "chest indrawing" pneumonia should be referred to a higher level. However, in situations where referral is not possible and local health policy allows, health workers may treat chest indrawing pneumonia with oral amoxicillin. Home treatment reduces delay in initiating treatment, reduces cost for families and healthcare system and is accessible to community.

2. Management at health facility level

- Children with chest indrawing pneumonia in setting of low HIV prevalence will be treated at the outpatient level and will no longer need to be referred for hospitalization.
- Only those children who have either general danger signs or who are HIV positive and have chest indrawing need to be referred to higher level facility for inpatient treatment with injectable antibiotics—Amoxicillin

50 mg/kg every 6 hours for at least five days or gentamicin 7.5 mg/kg IM/IV once a day for at least five days as first-line treatment.

When Referral is not Possible

If referral services for children with chest indrawing pneumonia cases are not available, or if mothers are unwilling or unable to go to PHC/hospital and local policy allows, health workers may treat chest indrawing pneumonia with oral amoxicillin.[11]

Treatment of Fever

Fever: All fever cases in young infants (less than 2 months of age) are to be referred to PHC or hospital.

In case of a child between 2 months and <5 years if the fever is low at 38–39°C, mother is advised to give only more fluids to child and continue breastfeeding and feeding.

But if the fever is more than 39°C paracetamol tablet, in appropriate dose, at 6 hourly intervals is to be given. Mother has to advised to keep the child lightly clothed.

Home Care and Follow-up

At home, mother should keep the child warm, continue breastfeeding and feeding the child and to increase feeding after recovery.

- To clear the nose if it interferes with the feeding.
- Proper dose of antibiotic for 5 days.
- Cough can be relieved by home made decoctions, e.g. ginger and tea.
- To bring back the child after 2 days for reassessment.
- To watch for danger signs, viz. breathing is difficult, child becomes sicker, and in such conditions, the child should be brought back to facility urgently.

Prevention of ARI

- This includes complete immunization against diphtheria whooping cough, measles and Hib and PCV as per schedule.
- Adequate diet and exclusive breastfeeding.
- Vitamin A prophylaxis.
- Reduce indoor air pollution by good ventilation and clean fuel for cooking.
- Avoid exposure to cold.
- Education of parents and families: In most cases of cold or fever, parents need to do no more than give the child plenty of liquids, continue breastfeeding and keep the child warm and keep the air passages clear, and parents should know the danger signs apart from no **smoking** by **parents**.

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MENINGOCOCCAL DISEASE

EPIDEMIOLOGY

Meningococcal disease is an acute bacterial disease caused by the meningococcus bacteria (*Neisseria meningitidis*) and manifested by sudden onset of fever, severe headache, nausea and vomiting, stiff neck and frequently a petechial rash, with pink macules and very rarely vesicles often accompanied by delirium and coma. Occasionally, fulminating cases exhibit severe sudden prostration, ecchymoses and shock at onset. Thirteen subtypes of serogroups of *N. meningitidis* have been identified and four serogroups (namely A, B, C and W135) are recognized to cause *epidemics*.[1] The other serogroups (X, Y, Z) are less virulent.

Occurrence and Distribution[2, 3]

Meningococcal meningitis occurs globally, it can occur in endemic form, sporadic form and epidemic form. Outbreaks have been reported all over the world. In 1996, Africa experienced the largest recorded outbreak/epidemic meningitis in history, with over 2,50,000 cases and 25,000 deaths registered.

Indian Scenario[4]

Major outbreaks in the country were reported since 1883. Major outbreak occurred in the year 1966 in Delhi. The

outbreak was due to meningococcus serogroup A. Another outbreak was reported in Delhi in 1985–86, after a gap of 20 years. During the outbreak (1966), a total number of 6133 pyogenic meningitis cases with 799 deaths were reported with an overall case fatality of 13% as compared to 1731 cases and 569 deaths in the year 1984. From 1986–89, outbreaks were reported in Delhi, Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh and Haryana. From 2005 to 2009, and 2016 outbreaks were reported in Delhi, Haryana, Meghalya and Tripura and in 2019 over 2800 cases 122 deaths and were reported from different parts of the country.

The meningococci most often inhabit the human nasopharyngeal area without causing any symptoms or with only local symptoms. The disease may become invasive with involvement of meninges and presenting as acute purulent meningitis.

Reservoir and Carriers

Man is the only reservoir, no animal reservoir is known. The bacteria can be carried, in the pharynx and sometimes for reasons not fully known, overwhelm the body's defences allowing infection to spread through the blood-stream and to the brain. It is estimated that between 10 and 25% of the population carry *N. meningitidis* at any given time, but of course, carriage rate may be much higher in epidemic situation.

Transmission of *N. meningitidis*

From person-to-person by direct contact including droplets and discharges from nose and throat of patients and carriers. Infection usually causes only a subclinical mucosal infection. Invasion sufficient to cause systemic disease is comparatively rare. Carrier prevalence rate up to 25% or more may exist without a case of meningitis.

Incubation Period

2–10 days (average 3–4 days) seasonal variation, more in winter months or spring.

Age group affected: Primarily a disease of young children, occurs commonly in children or young adults. However, no age is exempt. About 50% of total cases occur in children below 5 years and about 80–85% of cases are under 25 years.

Male–female ratio: 2:1 in clinical cases.

Seasonal variation: More in winter months or springs.

Period of Communicability

Until meningococci are no longer present in discharges from nose and mouth. Susceptible meningococci usually disappear from the nasopharynx within 24 hours after institution of specific treatment.

Risk Factors

Younger children are more at risk. Crowded localities as in urban slums are more at risk.

Case Fatality Rate (CFR)

It depends upon how early the cases are detected and accessibility and availability of medical care. The CFR ranges between 5 and 10%. In untreated cases, however, it reaches 50% or more and during epidemics may rise dramatically.

Cyclic Trend

Cyclic trends have been observed. Epidemics occur every 8–12 or more years and lasting 4–6 years; the decline of epidemic takes place slowly.

Notification

Presently the disease is notifiable or reportable in a few states/UTs of the country only. Considering the cyclic trend of meningococcal disease and occurrence of outbreaks in 1999 in many parts of the world, which may be due to rapid travel can spread to any country; it becomes mandatory to augment surveillance.

Vaccination

Vaccines against four specific antigens related to serogroups A, C, Y and W 135 are currently available. Two types of vaccines are in use—capsular polysaccharide vaccines and conjugate vaccine. In our country only polysaccharide vaccines are licensed for use. They are distributed in freezed dried form. Route of administration is intramuscular as either bivalent A + C vaccine or quadrivalent A + C + Y + W135 vaccine containing 50 μg of each antigen. Dose of vaccine is 0.5 ml given sub-cutaneously. The group A vaccine is more immunogenic than some other polysaccharide vaccines and it can induce an appreciable antibody concentration even in 3 months old infant. In some countries, recruits are routinely vaccinated with A + C vaccine at the beginning of military service. Duration of immunity is 1–3 years.

Vaccination Policy in the Country

- For Haj pilgrims
- For high-risk groups
- For routine vaccination of adult population at large is not recommended except during epidemic situation.

Chemoprophylaxis

Chemoprophylaxis has been considered for control of meningococcal disease but it has several limitations and its use should be limited to special circumstances. The aim of chemoprophylaxis is to prevent secondary cases by eliminating nasopharyngeal carriers. Chemoprophylaxis must begin within 48 hours of diagnosis. The chemo-prophylaxis with rifampicin, spiramycin, ciprofloxacin and ceftriaxone is recommended. Mass chemoprophylaxis to control/prevent epidemic is not recommended. It is recommended for close contacts of case in the family

or contacts in school or nursery classes or roommates, etc.

MENINGOCOCCAL DISEASE AND HAJ PILGRIMS

Visitors from the entire world arriving for the purpose of pilgrimage are required to produce a certificate of vaccination against meningitis issued not more than 3 years and not less than 10 days before arrival in Saudi Arabia.

- Adults and children over the age 2 must be given one dose of quadrivalent vaccine (A + C + Y + W135).
- If necessary children between 3 months and 2 years must be given 2 doses of polysaccharide vaccine with 3 months interval between 2 doses.

In case of documented outbreak at the Haj site, all the Hajis returning to the country should receive chemoprophylaxis irrespective of their vaccination status.

Travellers Health Information

Travellers to areas affected by meningococcal outbreaks are advised to be vaccinated. For pilgrimage to the Haj and Ramadan Omra, Saudi Arabia requires visitors to obtain a tetravalent vaccine (against A, C, Y and W135) at least 10 days prior to their arrival in the country (Ref. WHO International Travel and Health. Vaccination requirements and health advice).[5,6]

INVESTIGATION OF AN OUTBREAK OF MENINGITIS

When analysis of observational epidemiology reveals a suspected increase in the number of cases in a given area or when clustering of cases is observed, an investigation should be initiated promptly.

Preparation

Trained epidemiologist should conduct the investigation. Team should carry with them adequate material for obtaining, analyzing and transporting spinal fluid specimens as well as antibiotics and other supplies.

Investigation should involve:

i ***Confirmation of case:*** Confirm that clinical illness is compatible with the bacterial meningitis.

ii ***Search additional cases*** in the community including those that may have been misdiagnosed/undiagnosed.

iii Obtain appropriate clinical specimens and send to the reference laboratory for confirmation and sensitivity testing.

iv Define the extent of outbreak geographically.

v Assure that appropriate therapy is given to the cases.

vi Proper control measures are instituted.

vii Make interim recommendation to local authorities concerning preventive measures.

STANDARD CASE DEFINITION OF MENINGOCOCCAL MENINGITIS

1. Suspected Case of Acute Meningitis

- Sudden onset of fever (>38.5°C rectal or 38.0°C axillary), with
- Stiff neck

In patients under one year of age, a suspected case of meningitis occurs when fever is accompanied by a bulging fontanelle.

2. Probable Case of Bacterial Meningitis

- Suspected case of acute meningitis as defined above, with
- Turbid CSF

3. Probable Case of Meningococcal Meningitis

- Suspected case of either acute bacterial meningitis as defined above, with
- Gram stain showing Gram-negative diplococcus, or
- Ongoing epidemic, or
- Petechial or purpural rash.

4. Confirmed Case

- Suspected or probable case as defined above, with either:
  - Positive CSF antigen detection for *N. meningitidis*, or
  - Positive culture of CSF or blood with identification of *N. meningitidis*.

This case definition allows the detection of cases of meningococcal septicaemia.

Often the diagnosis can be made in the dispensaries (peripheral level of healthcare).

Diagnose in health centre where lumbar puncture and CSF examination are feasible (intermediate level).

Diagnose in well-equipped hospital (state or central level) for elaborate tests.

Standard Case Definition of Meningococcaemia

Probable

Sudden onset of fever (>38.5°C rectal or 38.0°C axillary) with or without shock, and one of the following:

- Petechial or purpural rash.
- Gram stain showing Gram-negative diplococcus.

Confirmed

- Probable case, and
- Demonstration of *N. meningitidis* or antigen in blood and/or CSF.

How to Manage Patients with Meningococcal Disease?

Meningococcal disease (either meningitis or septicaemia) is potentially fatal and should always be viewed as a medical emergency.

- Admission to a hospital or health centre is necessary for diagnosis (lumbar puncture and CSF examination) and for treatment.
- Antimicrobial therapy is essential and should be combined with supportive treatment.
- As contagiousness of patients is moderate and disappears quickly following antimicrobial treatment, isolation of the patient is not necessary.

Antimicrobial Therapy

Antimicrobial treatment must be instituted as soon as possible after the lumbur puncture has been carried out. Many antimicrobials are active against meningococci *in vitro*, but only those that penetrate sufficiently the cerebrospinal space and are affordable should be used. A range of antibiotics used for treatment are—penicillin, ampicillin, chloramphenicol and ceftriaxone. Chloramphenicol is a good and inexpensive alternative. The third generation cephalosporins, ceftriaxone and cefotaxime are also very effective.

Control of Epidemics

Management of Patients

- Prompt management of patient in hospital
- Augmentation of surveillance and
- Epidemiological investigation.

Immunoprophylaxis

It has been documented that mass vaccination campaign, if appropriately carried out is able to halt the epidemic due to serogroups A and C within weeks. However, such a decision depends on many other issues, e.g. geographical distribution of cases, age-specific attack rates and the resources available. If the number of cases is below the epidemic threshold, mass vaccination is not recommended. Mass vaccination of population may be considered only when attack rate of disease exceeds *10 cases per lac population* in a given area—usually a district. During epidemics vaccination can also be given to healthcare workers and other close contacts of cases. For the first time in the country, mass vaccination of the entire population (2–50 years age group) of two of the worst affected districts of Meghalaya by meningococcal disease outbreaks, has been carried out using bivalent (A + C) meningococcal polysaccharide vaccine during May 2009.

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YAWS AND ITS ERADICATION PROGRAMME (YEP)

Yaws is disfiguring, disabilitating, non-venereal treponemal infection. It is a contagious disease transmitted by direct (person-to-person) contact with infectious yaws lesions. The disease can be cured and prevented by a single injection of long-acting benzathine benzyl penicillin. Yaws is amenable to eradication. It is one of the neglected tropical diseases.

Causative Organism

The organism responsible for yaws is *Treponema pallidum* subspecies *pertenue*. It is morphologically and immunologically identical to *T. pallidum* (the organism that causes venereal syphilis).

Lesions

Early or Infectious Yaws

Yaws is characterized by skin lesion with exudates which may dry up to form scabs and yellow crusted granulomatus eruptions on the skin. The lesions may appear as papillomata, ulceropapilloma; crab yaws appear on plantar surface causing limping in gait; hyperkeratosis on palmar and plantar surface, nodules, polydactylitis due to inflammation of interphalangeal joints, osteoperiostitis and hypertrophic osteitis.

The initial lesions may persist for 3–6 months and heal spontaneously, often leaving a scar.

Late Yaws

Usually after 5 years of onset of illness, destructive and often deforming lesions of skin and bone may appear. The late lesions are non-infectious. The late lesions consist of gummas of skin and subcutaneous tissues, hyperkeratosis, chronic ulcers of skin and subcutaneous tissues, scars, multiple pathological fractures and ulcerated nodules.

Reservoir

Man is the only reservoir of infection. The early cases of yaws are infectious and serve as source of infection.

Incubation period: 9–90 days (average 21 days).

Mode of transmission: Yaws is transmitted by direct (person-to-person) contact with exudates or serum from

infectious yaws lesions. Abrasions, scratches and injuries to skin facilitate penetration of *Treponema*. Infection through intact skin is doubtful.

Person affected: Early yaws is primarily a disease of children and adolescents in the endemic areas.

Seasonal variation: Because of humid environments during rainy season, transmission of infection increases and the incidence of eruption of lesions in latent cases result in high prevalence.

Geographic distribution: It is endemic in several countries. Due to the efforts of WHO and UNICEF in launching of **Treponema** control programme (TCP), the prevalence was reduced by more than 95% in 46 countries. Subsequently, the TCP became the part of primary healthcare.

India

Yaws has been endemic in India. The disease has been reported from the communities living in hilly and forested areas in the tribals inhabited belt, affecting 51 districts of 10 states, namely—Andhra Pradesh, Assam, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Tamil Nadu and Uttar Pradesh. Yaws begins where road ends in these areas.

Problem

It affects the tribal areas. It is disabling disease and has social relevance. During the acute infection, the patient is highly infectious, but it is the chronicity of the infection that gradually destroys the bones and cartilages leading to permanent crippling and disfiguring of individual.

Latent cases are 5–10 times more than clinical cases. In India, the disease is mostly known by the name of the tribe affected. For example, in Bastar district, the disease is called 'Madia Roga' and in Maharashtra in Sironcha area it is called 'Gandi Roga' and in Andhra Pradesh it is called 'Koya Rogam'.

Due to mass campaign launiched in 1950 by WHO and UNICEF, the disease prevalence has been brought down from 14.0% to below 0.1% in many areas. Following dramatic decline in transmission, the active anti-yaws activities were abandoned in endemic area and consequently there was resurgence of yaws in 1977. NICD, Delhi was made nodal agency by the Government of India for planning, guidance, coordination, monitoring and evaluation of the programme.

Laboratory Diagnosis

Commonly used tests are venereal disease research laboratory (VDRL) test and the rapid plasma reagin (RPR) test. Both these tests are inexpensive.

Treatment

Injection Benzathine penicillin is the drug of choice. Alternate drugs are tetracycline and erythromycin (Table 8.33).

Tetracycline is not given to pregnant and lactating women and children below 8 years of age.

YAWS ERADICATION PROGRAMME

The disease is a significant public health problem in tribal areas. Yaw is not a killer disease but it is crippling and disabling disease affecting tribal people who are poor, unreached and susceptible. A simple, affordable and acceptable treatment is available for eradicating the disease. WHO expert committee on venereal disease and treponematoses has also stressed that from technical considerations, eradication is feasible.

The Government of India launched eradication programme on Yaws as Pilot Project in Koraput district of Odisha in 1996–97. Subsequently, the scheme was expanded to the states of Andhra Pradesh, Gujarat, Madhya Pradesh and Maharashtra. The programme was extended to all endemic areas in 1999. Currently, the programme is operational in 51 districts of 10 states; which are endemic.

Programme Objectives

The yaws eradication programme aims to interrupt the transmission of yaws infection in the country (i.e. no infectious cases) and ultimately achieving the goal of yaws eradication (i.e. no sero-reactivity to RPR/VDRL in 1–5 years old children). National health policy has set the goal to eradicate yaws by 2005.

Programme Management

NICD has been identified as nodal agency by the Government of India for planning, guidance, coordination monitoring and evaluation of the programme. The programme is being implemented by the states as integral to part of primary healthcare delivery system in collaboration with the department of Tribal Welfare and other related institutions.

Table 8.33: Dosages of drugs used in yaws eradication programme

Age	*Drug*	*Dose*	*Route*	*Duration*
<10 years	Benzathine benzyl penicillin	0.6 million units	IM	Single dose
>10 years	-do-	1.2 million units	IM	Single dose
<8 years	Erythromycin	30 mg/kg body wt. in four divided doses	Oral	15 days
8–15 years	Tetracycline or erythromycin	250 mg four times daily	Oral	15 days
>15 years	Tetracycline or erythromycin	500 mg four times daily	Oral	15 days

Programme Strategies

To achieve the stated objectives, following strategies are being adopted.

- Manpower development by in-service training.
- Case finding—by active surveillance, by making house-to-house visit, by trained paramedical workers and community level functionaries at frequent intervals. The active searches are required to be carried out every year of which one should be in post-monsoon season for better yield of cases, besides passive surveillance and rumour reporting.
- Treatment of cases and contacts simultaneously.
- Information, education and communication activities.
- Multisectoral—coordinated approach.

Yaws 'Eliminated' in India

India declared yaws elimination on 19th September 2006 **WHO certified India Yaw Free in July 2016**. However, monthly surveillance, active search operations, verification of rumour reports, health education and sero-survey in 1–5 years children are being undertaken as per international requirement to eradicate the disease. One of the criteria for eradication has been to establish 'nil' yaws transmission by proving 'nil' sero-reactivity to RPR/VDRL/TPHA among 1–5 years old children.

Desired sample size of children 1–5 years from yaws affected villages and yaws non-affected villages will be collected by random sample method. Sero-surveys shall be carried out once a year coinciding with active searches.

Impact

Reports received from 1996 to 2020 from various states confirm zero incidence of new infectious cases based on the evidence of search and lab tests. However, preventive measures will continue till global eradication of yaw is achieved.

AGE OF PANDEMICS

World has witnessed several disease Pandemics, besides famines, natural and man made disasters in the past. Pandemic of Smallpox, Plague, Cholera, Yellow fever, Spanish flu, HIV/AIDs, Swine flu, SARS, Ebola, MERS and COVID-19 Caused Loss of lives in millions, livelihood and economic fallout (Table 8.34). The impact of these pandemics was more in developing countries including India. World is ill prepared for adequate response and health systems are overwhelmed and prove to be inadequate. However, these pandemics provided an opportunity to strengthen health systems, epidemiological surveillance and global cooperation.

Table 8.34: Age of Pandemics

Pandemics	*Global deaths*	*Deaths in India*
541–542 plague	30–50 million	12 million
1347–1351 black deaths	200 million	–
1520 onwards smallpox	56 million	–
1817–1966 Cholera (7 pandemics)	19 million	80000
1918–19 influenza (spanish flu)	40–50 million	20 million
2003 SARS	916 deaths	–
2009 Swine flu	80000	19046
2018 NIPAH	–	16
2019–22 Covid-19	6.6 million	5.26 lakh

SEVERE ACUTE RESPIRATORY SYNDROME

A new disease called severe acute respiratory syndrome (SARS) emerged in several countries of Asia in epidemic form in the year 2003, declared as pandemic by WHO.

SARS is a newly identified human infection caused by coronavirus unlike by any other known human or animal virus in its family.

The disease came into notice when a patient was admitted in Hanoi (Vietnam) on 26th Feb. 2003 with respiratory illness and died on 13th March 2003 and seven workers who cared for this patient also became ill on 5th March 2003 (nosocomial infection).[1]

Incubation Period

2–10 days. Once a person is exposed to infection, it may take 2–10 days to develop the illness.

Clinical Features

The illness begins with fever which is sudden in onset and may be accompanied with chills and rigors, headache, general feeling of discomfort, muscular stiffness, body aches, loss of appetite, confusion and diarrhoea. Some people also experience mild respiratory symptoms at the onset. The main symptoms of SARS are high fever more than 38°C or 100.4°F, dry cough, shortness of breath, or difficulty in breathing. Changes in X-ray indicative of pneumonia also occur in 10–20% of cases, disease may become severe enough to require intubation and mechanical ventilation.

Spread and Transmission

The infection spreads through droplets/aerosols. The persons having close contacts with cases especially the healthcare workers and family members are at higher risk. Transmission mainly occurs from person to person during face-to-face exposure to infected respiratory droplets expelled during coughing or sneezing or following contacts with body fluids during certain medical intervention.

Case Fatality Ratio

The overall case fatality ratio was 11% but with much higher rates among elderly persons.

Case Definition (by WHO)

The patients are classified as suspected or probable based on the following criteria.

Suspect Case

A person presenting after 1st November 2002 with all of the following.

- Sudden onset of high fever (more than 38°C or 100.4°F),
- One or more respiratory symptoms (cough, shortness of breath, difficulty in breathing),
- And one or more of the following.
  - History of visit to SARS affected countries within 10 days of onset of symptoms.
  - History of having cared for, having lived with, having had face-to-face contact with or having had contact with respiratory secretions and body fluids of a person who has been diagnosed with SARS.

Probable Case

A suspect case having X-ray findings of pneumonia, or a suspect case with an unexplained respiratory illness resulting in death, with an autopsy examination demonstrating the pathology of respiratory disease syndrome without identifiable cause.

Occurrence

The disease occurred in epidemic or outbreaks and spread to 30 countries resulting in 8422 cases and 916 deaths up to 7th August 2003 giving case fatality ratio of about 11%. Outbreaks started in China (5327 cases) and Hong Kong and Canada and imported cases were recorded in other countries. It was thus a global phenomenon (pandemic).[2, 3]

PREVENTION AND CONTROL

Against SARS there is no vaccine or any specific drug available. The treatment of cases is symptomatic.

Response

The cases were notified to WHO by China and Canada as also by other countries of the world. Prevention and control measures were:

1. Isolation of suspected and probable cases of SARS in hospital or home, preferably in homes.
2. Observance of universal precautions by the healthcare workers and others who are likely to come in contact with SARS cases would prevent the further spread of disease as there is no vaccine or specific drug available for SARS.
3. WHO recommends that international travellers departing from places on the affected list should be screened for possible SARS at the point of departure. Such screening involves answering a few questions only. Travellers with one or more symptoms of SARS and who have history of exposure or who appear acutely ill should be assessed by a clinician and may be advised to postpone their trip until they feel better.
4. Under the international health regulations, all aircrafts pilots and masters of ships are required to provide a general declaration of health to the airport/port authorities and PAHOs/PHOs wherein any sickness on board is declared. This needs to be further strengthened and sensitizing all concerned to remain vigilant.
5. Do not visit hospitals where SARS cases have been isolated to avoid contacts.
6. Persons who come in contact with SARS cases should report to local health authority if they develop the symptoms of SARS within 10 days of exposure.
7. All persons disembarking in India were required to fill-up proforma and any person meeting the criteria of suspected/probable SARS would be referred to hospital for treatment and isolation. Mandatory screening for SARS was introduced in 12 ports and 21 airports in the country for all the persons disembarking in India.

NICD, Delhi and National Institute of Virology, Pune, were identified as nodal agencies for laboratory investigations.

Infection Control Guidance at Hospitals

- All persons requiring assessment for SARS at the hospital should be assessed at a separate area to minimize transmission to others.
- Cases under investigation should be isolated from probable cases.
- All suspected/probable cases to wear N95 mask or three layered surgical facemask or any mask of 0.3 mm filter size.
- Healthcare staff involved in treatment or cleaning should wear personal protective equipment (disposable masks N95 or triple layer surgical or a 0.3 mm filter size mask).
- *Handwashing* is very important and should be done before and after contact with patient, after activities likely to cause contamination and after removing gloves.
- Alcohol-based skin disinfectants can be used if there is no organic material contamination.
- Cases should be isolated or cohort placement should be done with independent air supply, exhaust system and bathroom facilities.
- Turn off the air conditioners and open windows, if independent air supply is not possible.
- Strict barrier nursing using precautions for airborne, droplet and contact transmission.
- Movement of patient outside the isolation area should be avoided.
- Non-essential staff should not be allowed in the ward.
- Use disposable equipment wherever possible and dispose appropriately. All devices to be reused should be sterilized properly. Surface should be cleaned with broad-spectrum disinfectants of proven antiviral activity.
- All sharps should be dealt with promptly and safely.

LESSONS LEARNED

i Early notification of cases and no hiding of cases.
ii Timely global alert by WHO
iii Travel recommendation and screening measures introduced in all the countries.
iv International collaboration was achieved in this outbreak.
v Weaknesses in the existing health system were identified.
vi Outbreak was contained swiftly with general measures in the absence of any vaccine or drug against SARS.
vii SARS will not be the last new disease. We must be prepared to face challenges of new emerging diseases.

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INFLUENZA

The influenza is an acute viral respiratory tract infection caused by influenza virus types A, B and C. These are antigenically distinct and there is no cross-immunity.

It occurs in pandemic and epidemic forms. Most pandemics and epidemics are associated with type A and B viruses. These have two distinct surface antigens—the haemagglutinin (H) and the neuraminidase (N) antigens. Influenza is one of the oldest and most common disease known to man. It can also be one of the deadliest. The 'Spanish flu' pandemic of 1918–19 considered to be the worst disease outbreak in the last century claimed up to 50 million lives and infected **half of the world's population**. The world could still experience an estimated 2 to 7.4 million deaths (projected from data obtained during the 1957 pandemic). An alarming reminder came again with the emergence of an avian influenza virus known as H5NI in Hong Kong, Special administrative region of China, in 1997 when one-third of affected patients died. Fortunately, this outbreak did not develop into a global health emergency.

PANDEMIC INFLUENZA

Influenza pandemics are caused by new influenza viruses. Pandemics are rare events that occur every 10–50 years (Table 8.35). During the 20th century, 3 influenza pandemics occurred[1] and during 2009 H1N1 pandemic occurred followed by Covid-19 pandemic in 2019.

Table 8.35: Influenza pandemics and antigenic shifts[1, 2]

Years	*Designation*	*Severity*	*Death toll*
1892	H3N2	Moderate	Not available
1918	H1N1 (Spanish)	Devastating	20–50 million
1957	H2N2 (Asian flu)	Moderate	1–2 million
1968	H3N2 (Hong Kong flu)	Moderate	7,00,000
2004–09	H5N1 (Avian flu) 442 human cases till Sept 2009	Mild	262
2009	H1N1	Moderate	80,000

Characteristics of Influenza Pandemics

- Occurrence outside the usual season
- Extremely rapid transmission with concurrent outbreaks throughout the globe
- High attack rates in all age groups with high mortality rates even in young adults.

The world may be on the brink of another pandemic. Health experts have been monitoring a new and extremely severe influenza virus—the H5N1 strains. Fortunately, it has not spread easily from one person to another. Very limited human-to-human transmission was documented in healthcare workers and family contacts. If H5N1 evolves to a form as contagious as normal influenza, a pandemic could begin and all countries will be affected leading to widespread illness and large number of deaths apart from economic and social disruption. Medical supplies, vaccines and antiviral drugs will run short. Regular flu shots do not provide any protection against the pandemic influenza viruses that are circulating right now (H1N1 and H3N2). However, in India, there is no policy for vaccination against seasonal influenza. H3N2 virus caused 3038 cases and 2 deaths in India from Jan to March 2023.

Disease Burden

During the most recent influenza outbreak in Madagaskar which began in early June 2002 and lasted until late August, more than 22,000 people were infected and 671 died. The victims were mainly children and had poor nutrition apart from lack of access to care. In the United States in the year 2001 influenza killed an estimated 20,000 people.

Clinical Features

For most healthy people, influenza leads to high fever, headache, coughing and a few days off work or school, followed by complete recovery. For the elderly and chronically ill, however, the disease can mean hospitalization and even death. In developing countries where it is often not perceived as a major public health problem, there is particularly urgent need to assess the impact of influenza and tackle the disease appropriately.

Reservoir

Human cases (clinical and subclinical) are the major reservoir during epidemic/outbreak. During inter-epidemic period, the virus may survive in animal reservoir (birds, poultry, pigs, equines, dogs and cats).

Incubation period is 24–72 hours and the period of infectivity is about 3 days after the illness. It is transmitted through droplet infection and it spreads very rapidly in crowded places.

Incidence and Vulnerability

As per WHO estimate 5–15% of population get infected globally per year. The **elderly, chronically ill** and **young children** are particularly at risk. In addition to death toll, influenza also inflicts a huge toll of suffering, medical consultations, hospitalization, absenteeism and economic loss.

Problem

Effective control of influenza epidemics or individual infection has not yet been achieved. The main reason for this is the continued antigenic variation of the viral surface glycoproteins, particularly of the haemagglutinin (HA), but also of the neuraminidase (NA), giving rise to minor amino acid changes at antigenic sites **(antigenic drift)** or major changes of the HA or NA structure that generate new influenza A virus subtypes **(antigenic shift)**.[2] Because of these problems, every year WHO expert committee meet and decide the composition of influenza vaccine.[3]

Vaccine

Each year WHO brings together, international influenza experts to decide the composition of the influenza vaccine for the next year. More than 250 million influenza vaccine doses are then produced and administered globally every year, saving hundreds of thousands of lives and reducing illness. WHO recommends that Governments begin vaccination campaigns prior to the influenza season and ensure that as many vulnerable people as possible are covered before the first case of influenza appear.[3–4]

In the absence of epidemiological surveillance regarding the influenza serotypes in our country, presently the use of influenza vaccine in India is not recommended.

Prevention and Control of Epidemics

The epidemics are sudden and unpredictable. The influenza vaccine does not help to contain epidemic or its spread

- Social distancing—avoid large gatherings and contact with infected persons.
- Observe—hand hygiene, cough etiquette and use protective barriers.

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AVIAN INFLUENZA AND HUMAN HEALTH (NEW THREAT)

Avian influenza or 'bird flu' is a contagious disease of animals caused by viruses that normally infect birds and, less commonly, pigs. Avian influenza viruses are highly species specific but have, on rare occasions, crossed the species barrier to infect humans.

Avian influenza viruses cause two main forms of disease. 'Low pathogenic' and 'highly pathogenic' which has high mortality reaching 100% within 48 hours. Viruses responsible: Influenza viruses are grouped into three types, designated A, B and C. Influenza A and B viruses are of concern for human health. Only influenza A virus can cause pandemics. The H subtypes are epidemiologically most important, as they govern the ability of the virus to bind to and enter cells, where multiplication of virus then occurs. The N subtypes govern the release of newly formed virus from the cells.

Current Outbreaks in Poultry

The current outbreaks of highly pathogenic avian influenza, which began in South–East Asia in mid-2003 are the largest and most severe on record.[1]

The causative agent, the H5N1 virus has proved to be especially tenacious. Despite the death or destruction of an estimated 150 million birds, the virus is now considered endemic in many parts of Indonesia and Vietnam and some parts of Cambodia, China, Thailand and Lao People's Democratic Republic. The outbreaks in poultry have affected many countries between December 2003 and October 2005: Republic of Korea, Vietnam, Japan, Thailand, Cambodia, Lao People's Democratic Republic, Indonesia, China, Malaysia, Russia, Mongolia, Turkey and Romania. Avian influenza affected India in Feb–March, 2006. West Bengal outbreak of 2008 was more serious than the previous outbreaks in Maharashtra and Manipur. More serious risk factors are associated with this outbreak.[2] Recent outbreak in 2021 occurred in nine states (Rajasthan, Gugarat, UP, Kerala, HP, MP, Haryana Maharashtra and Delhi).

Outbreaks in India were investigated by NICD.

Risk to Human Health

The widespread persistence of H5N1 in poultry population poses two main risks for human health. One: The virus

passes from poultry to humans, resulting in very severe disease unlike normal seasonal influenza, where infection causes only mild respiratory symptoms in most people. In the present outbreaks with H5N1, more than half of those infected with virus have died. Most cases have occurred in previously healthy children and adults. A second risk, or even greater concern, is that the virus—if given enough opportunities will change into a form that is highly infectious for humans and spreads easily from person to person. Such a change could mark the start of a global outbreak (a pandemic).

Current Outbreak in Human Population

In the current outbreak, since 1997 more than 100 laboratory confirmed human cases have been reported in four countries: Cambodia, Indonesia, Thailand and Vietnam. Up to Sept. 2009, 442 human cases and 262 deaths have been reported in 48 countries. First human case of bird flu—An 11 year old child from Gurugram, Haryana, died at AIIMS Delhi on July 12 in 2021 confirmed by NIV Pune.

Transmission

Direct contact with infected poultry or surfaces and objects contaminated by their faeces, saliva and mucous is presently considered the main route of human infection. Most human cases have occurred in rural or peri-urban areas where many households keep small poultry flocks, which often roam freely, sometimes entering homes or share outdoor areas where children play.

The poultry products are safe for consumption in areas free of disease, provided these are properly cooked and following hygienic practices. In area experiencing disease outbreaks, poultry products can also be safely consumed provided these items are properly cooked and properly handled during food preparation.

Pandemic Risk

Though more than 400 human cases have occurred in current outbreak, this is small number compared with the huge number of birds affected and the numerous associated opportunities for human exposure especially in areas where backyard flocks are common. A pandemic can start when three conditions have been met: A **new influenza** virus subtype emerge; it **infects humans**, causing serious illness, and it **spreads easily** and sustained among humans. The H5N1 virus amply meets the first two conditions: It is a new virus for humans (H5N1 have never circulated widely among people) and it has affected more than 400 humans, killing over half of them. No one will have immunity should an H5N1 like pandemic virus emerge. All prerequisites for start of a pandemic have therefore been met save one: the establishment of efficient and sustained human-to-human transmission of the virus. Though rare instances of limited human-to-human transmission of H5N1 and other avian influenza viruses have occurred in association with outbreak in poultry and should not a cause of alarm. In no instance has the virus spread beyond a first generation of close contacts or caused illness in the general community. There have been a number of instances of avian influenza infection occurring among close family members. It is often impossible to determine if human-to-human transmission has occurred since the family members are exposed to the same animal and environmental sources as well as to one another. WHO overall assessment of the pandemic risk remains. The virus can improve its transmissibility among humans via two principal mechanisms—'reassortment' mechanism and more gradual process of 'adaptive mutation'.

Other Reservoirs

Domestic ducks can excrete large quantities of highly pathogenic virus without showing signs of illness, and are now acting as a 'silent' reservoir of the virus perpetuating transmission to other birds. H5N1 appears to have expanded its host range, infecting and killing mammalian species previously considered resistant to infection with avian influenza viruses.

Vaccine

Vaccines effective against a pandemic virus are yet not available. Vaccines are produced each year for seasonal influenza but will not protect against pandemic influenza.

Drugs

Two drugs (in the neuraminidase inhibitor class), oseltamivir (commercially known as tamiflu) and zanamivir (commercially known as Relenza) can reduce the severity and duration of illness caused by seasonal influenza. These drugs should be administered within 48 hours after symptoms onset. These drugs involve limited production capacity and prohibitive cost for many countries.

So far most fatal pneumonia seen in cases of H5N1 has resulted from the effects of the virus, and cannot be treated with antibiotics. Nonetheless, since influenza is often complicated by secondary bacterial infection of the lungs, antibiotics could be life-saving in case of late onset pneumonia. WHO regards it as prudent for countries to ensure adequate supplies of antibiotics in advance.[3]

Prevention

To prevent influenza, we have to eliminate the virus from birds, but it cannot be achieved in the near future.

WHO will have a stockpile of antiviral medications sufficient for 3 million treatment courses by early 2006. These drugs could be used prophylactically near the start of pandemic. Despite of advance warning the world is ill-prepared to defend itself during pandemic. 40 countries have developed preparedness plans. India has prepared a

contingency plan for management of human cases of avian influenza.[3] India has stockpiled 10 million doses of Tamiflu.

PANDEMIC INFLUENZA A (H1N1) 2009 (SWINE FLU)

The problem—global problem.

Globally pandemic influenza A (H1N1) 2009, first caused illness in Mexico and the US in March and April 2009. It continued to spread globally with more than 4,00,000 laboratory confirmed cases and 80,000 deaths reported to WHO. The year 2015 witnessed outbreaks in various states of India, 42,952 confirmed cases and 2990 deaths were reported due to swine flu.

INDIAN SCENARIO (TABLE 8.36)

India reported 19,046 cases with 1747 deaths, in 2009 mostly in Maharashtra, Gujarat, with case fatality rate of 9.17%. The years 2015 and 2017 witnessed outbreaks in various states of India with 42,952 cases and 2990 deaths in 2015 and 38,811 cases and 2266 deaths in 2017 against 15,266 cases and 1128 deaths in 2018 and 28,798 cases and 1218 deaths were reported in 2019. In the year 2020 around 2752 cases and 44 deaths were reported. Outbreak of HINI in Pune and Nasik reported 65 deaths and 700 cases.

Current Pandemic

The current pandemic in humans is associated with influenza A (H1N1) which was earlier referred to as 'swine flu' because initial testing showed many of the genes in the virus were similar to influenza viruses normally occurring in North American swine. But further research has shown that the outbreak is due to a reassortment strain of H1N1 not previously reported in pigs.[4]

Influenza type A viruses are divided into subtypes and named on the basis of two proteins on the surface of the virus: Haemagglutinin (HA) and neuraminidase (NA).

Table 8.36: Cases and deaths of influenza A H1N1

Year	*Cases*	*Deaths*	*CFR (%)*
2009	19046	1747	9.17
2010	20604	1763	8.55
2011	603	75	12.4
2012	5044	405	8.0
2013	5253	699	11.0
2014	937	218	23.2
2015	42592	2990	14.9
2016	1786	295	16.6
2017	38811	2270	6.0
2018	15266	1128	7.4
2019	28798	1218	4.2
2020	2752	44	0.63

There are 16 known HA subtypes and 9 known NA subtypes. Many different combinations of HA and NA proteins are possible. For example, 'H1N1' virus has an HA1 protein and an NA1 protein only. Some influenza A subtypes (i.e. H1N1, H1N2 and H3N2) are currently in circulation among people H3N2 caused.

Epidemiology

i Pandemic influenza 2009 was caused due to emergence of a novel virus to which all individuals are susceptible, i.e. overall population holds no immunity.
ii New virus has been able to replicate and caused disease in humans.
iii New virus is being transmitted efficiently from human to human (H2H).

In late April 2009, WHO, declared H1N1 influenza a 'Public Health Emergency of International Concern'. On 11 June 2009, WHO declared *Pandemic Phase 6* in response to spread of new influenza A (H1N1) virus. What does it mean? The same identified virus has caused sustained community level outbreak in at least one or other countries in another WHO region.[4,5] It is not related with severity. At this time WHO considered the overall severity of the influenza pandemic to be moderate (Table 8.36). Monitoring the evolution of pandemic virus and sharing information for public health response have been key components of the global response.

Phases

Phase 1: Predominantly animal-to-animal transmission—few human cases.

Phase 2: An animal influenza virus is capable of human infection.

Phase 3: Small outbreaks among close populations.

Phase 4: Sustained human-to-human transmission (H2H).

Phase 5: Spread across two countries or more in one of the WHO regions (continents).

Phase 6: Spread across two countries or more in one of the WHO regions plus spread to another WHO region.

The current WHO phase of pandemic alert is 6. WHO has declared the outbreak as *public health emergency* of *international concern*.

(*Source:* WHO: Pandemic influenza preparedness and response).

Post-peak period: Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.

Possible new wave: Levels of pandemic influenza activity in most countries with adequate surveillance rising again.

Post-pandemic period: Levels of influenza activity have returned to levels seen for seasonal influenza in most countries with adequate surveillance.

WHO declared pandemic to be over in August 2010. In the post-pandemic phase India experienced outbreaks, as presented in Table 8.36.

THE AGENT

Novel influenza A (H1N1) virus: The 2009 novel A (H1N1) appears to be of swine origin and contains a unique combination of gene segments that has not been identified in the past. Genetic sequencing shows a new sub-type of influenza A (H1N1) with re-assorted segments from four influenza viruses: North American swine, Eurasian swine, North American Avian and Human virus. It has not been previously detected in pigs or humans. The present novel virus has shown sensitivity to oseltamivir but is resistant to both amantadine and rimantadine. It is an enveloped RNA virus and belongs to the family Orthomyxoviridae.

Transmission

It is transmitted from person to person. Influenza virus is present in respiratory secretions of infected persons. As a result, influenza virus can be transmitted through droplets by sneezing and coughing. It also spreads by *touching infected objects* and then touching nose or mouth. The pandemic H1N1 influenza virus can survive on hard and nonporous surfaces, in plastic and stainless steel up to 24 hours, on cloth, paper and tissue for 8–12 hours.

Incubation Period

It ranges from 1 to 7 days and more likely from 1 to 4 days.

Communicability

From one day before to 7 days after the onset of symptoms. If illness persists for more than 7 days, chances of communicability may persist till resolution of illness. Children may spread the virus for a longer period.

Infectivity

H1N1 appears to be more contagious than seasonal influenza. Secondary attack rate of seasonal influenza is 5–15% while secondary attack rate of H1N1 is estimated between 22 and 33%.

Clinical Manifestations

The clinical manifestations of H1N1 influenza A pandemic are fever, cough, sore throat, malaise and headache; vomiting and diarrhoea. Children are less likely to have the usual influenza signs and symptoms such as fever and cough. Infant may present with fever and lethargy and may not have cough. Symptoms of severe disease in infants and young children may include apnoea, tachypnoea, dyspnoea, cyanosis, dehydration, altered mental status and extreme irritability.

Outcome

Most people recover from infection without the need for hospitalization or medical care or antiviral drugs. Overall national levels of severe illness from influenza A (H1N1) appear similar to levels seen during local seasonal influenza periods, although high levels of disease have occurred in some local areas and institutions. Overall, hospitals and healthcare systems in most countries have been able to cope with the number of people seeking care.

High-risk Group (HRG)

HRG for complications of influenza is defined as a person such as:

- Residents of institutions for elderly people and the disabled.
- Elderly people and very young persons.
- People with certain chronic health conditions (chronic heart or lung disease, metabolic or renal disease or immuno deficiencies).

National Influenza Surveillance

Surveillance of **influenza like illness** (ILI) is an essential epidemiological tool to monitor:

- Geographical spread of influenza pandemic.
- To identify high-risk groups
- To know the burden of disease in terms of health and economic impact
- To plan for preventive and other responses to control the pandemic.

  Standard case definitions are essential for comparison between different areas within a country and also between countries.

A network of 12 laboratories located in medical colleges have been established to generate quality data on influenza viruses through ILI surveillance programme.

CASE DEFINITION OF PANDEMIC INFLUENZA IN HUMANS[5]

A Suspected Case

A suspected case of the pandemic influenza A (H1N1) virus infection is defined as a person with acute febrile respiratory illness (reported or documented fever and one of the following: cough, sore throat, shortness of breath, difficulty in breathing or chest pain) with onset:

- Within 7 days of close contact with a person who is a probable or confirmed case of the new influenza A (H1N1) infection, or
- Within 7 days of travel to a community internationally where there has been one or more confirmed pandemic influenza A (H1N1) cases or
- Resides in a community where there are one or more confirmed new influenza cases.

A Probable Case

A probable case of pandemic influenza A (H1N1) 2009 virus infection is defined as an individual, with an influenza

test that is positive for influenza A, but is unsubtypable by reagents used to detect seasonal influenza virus infection;

or

An individual with a clinically compatible illness or who died of an unexplained acute respiratory illness who is considered to be epidemiologically linked to a probable or confirmed case.

A Confirmed Case

A confirmed case of pandemic influenza A (H1N1) virus infection is defined as an individual with laboratory confirmed new influenza A (H1N1) virus infection by one or more of the following.

- Real time reverse transcriptase (RT-PCR)
- Viral culture.
- Fourfold rise in new influenza A (H1N1) virus specific neutralizing antibodies.

Chemotherapy of Influenza A (H1N1)

Oseltamivir is the drug of choice. Dosages are according to body weight and age for 5 days.

CONTAINMENT STRATEGIES OF MOH AND FW (GOI)[6]

- Early detection, investigation and containment of cases of influenza A (H1N1).
- Training and equipping manpower to investigate and contain number of cases.
- Strengthening of healthcare infrastructure.
- Stockpiling of antiviral drugs, personal protection equipment (gloves, mask, long-sleeved cuffed gowns, cap and plastic apron), N95 and triple layer mask.
- Increasing awareness by information education and communication.
- Management of cases.
- Lab network for influenza A (H1N1) surveillance and contact tracing.
- Drug resistance monitoring
- Enhanced surveillance.

Broad Guidelines for Schools and Educational Institutions

- To reduce the possibility of spread of infection, schools should be advised to avoid any large gathering of students during the course of the day.
- It should be made mandatory by the school authorities that all class teachers should begin their class with active screening of each student in the class so as to detect any student who is having symptoms of flu (mild fever with cough/sore throat with or without bodyache, headache, diarrhoea and vomiting). If such student is detected, he/she should be referred immediately to the medical facility of the school. He/she should be further advised to stay at home for 7 days and observe strict discipline of home isolation. The onus of observance of discipline of isolation henceforth is shifted to the parents and accordingly the school health authorities should write a letter to the parents.

Management of Suspected Patients of Influenza A (H1N1)

Category A

Patients with **mild fever plus cough/sore** throat with or without bodyache, headache, diarrhoea and vomiting. They **do not require** oseltamivir and should be treated for the symptoms mentioned above. The patients should be monitored for their progress and reassessed after 24–48 hours by the doctor. **No testing of patient for H1N1 is required**. Patients should confine themselves at home and avoid mixing with public and high risk members in the family.

Category B

i Category A + if the patient has high grade fever and severe sore throat – home isolation + oseltamivir;

ii Category A + one or more of the following high risk conditions shall be treated with oseltamivir (Table 8.37):

Children under five, pregnant women, those above 65 years, those with lung diseases, heart disease, liver disease, kidney disease, blood disorders, diabetes, neurological disorders, cancer and HIV/AIDS; and patients on long-term cortisone therapy. All patients of category B(I) and (II) should confine themselves at home and avoid mixing with the public and high risk members in the family. **No tests for H1N1 are required for category B (I) and (II).**

Category C

Categories A and B + if the patient has one or more of the following: breathlessness, chest pain, drowsiness, fall in blood pressure, sputum mixed with blood, bluish discolouration of nails, irritability among small children, refusal to accept feed, worsening of underlying chronic conditions. Such patients require **testing, immediate hospitalization and treatment** with oseltamivir.

Guidelines for screening centres and isolation facilities in hospitals should be strictly observed.

Table 8.37: Dose schedule of oseltamivir

Body Weight (in kg)	*Age in years*	*Therapeutic dose for 5 days*	*Prophylaxis dose for 5 days*
≤15 kg	1–2	30 mg BD	30 mg OD
15–23 kg	3–5	45 mg BD	45 mg OD
24–40 kg	6–9	60 mg BD	60 mg OD
>40 kg	10–12	75 mg BD	75 mg OD
For infants			
	<3 months	12 mg BD	Not recommended unless situation judged critical
	3–5 months	20 mg BD	20 mg OD
	6–11 months	25 mg BD	25 mg OD

Influenza A H1N1 Vaccine

Pandemic vaccines have their greatest impact as a preventive strategy when administered before or near the peak incidence of cases in an outbreak. In response to current influenza H1N1 pandemic, the WHO strategic advisory group of experts (SAGE) have recommended use of influenza vaccine for healthcare workers as a first priority. The Government of India has taken the initiative to fast track the indigenous production of the H1N1 vaccine in the country. Target group for vaccine include pregnant women, people who live with or care for children younger than 6 months of age, healthcare and emergency medical services personnel, persons between ages 6 months and 24 years old, and people aged 25 to 64 years of age who are at higher risk because of chronic disease or compromised immune systems. The US Food and Drug Administration (FDA) has approved the use of one dose of 2009 H1N1 flu vaccine for persons 10 years of age and older and two doses for children 9 years of age and younger. India launched a monovalent H1N1 indigenous produced vaccine on 4th June, 2010 meant for people aged 18–60 years.

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MIDDLE EAST RESPIRATORY SYNDROME—CORONAVIRUS (MERS-CoV)—GLOBAL ALERT AND RESPONSE (GAR)

MERS is caused by coronavirus. It is a novel coronavirus. The virus is believed to circulate among bats and camels. It has been around since 2012—for over a year, so it has been persistent in Middle East and continues to cause cases. It has been quite severe in those that it has infected; the case fatality has been about 50%. The tally of laboratory confirmed cases reported was 114 cases including 54 deaths up to 7th Sept 2013. MERS has spread to South Korea in 2015 where 87 cases and 7 deaths were reported till June 7th, 2015.

While it is transmissible in healthcare settings, it is not that easily transmissible outside of that. There is no specific medicines right now. Firstly, observe general measures such as handwashing, hand hygiene as it turns out to be an extremely important way to prevent yourself from getting infected. Secondly, if respiratory symptoms become severe—high fever and troubled breathing you must seek care. Thirdly, cough and sneeze into tissue papers or perhaps into sleeves of your shirt. Ensure systematic implementation of infection control measures in hospitals. WHO is monitoring the situation very closely and so far it has not been declared as public health emergency of concern under IHR. Healthcare providers are advised to maintain vigilance and continue their surveillance for severe acute respiratory infection (SARI).

EBOLAVIRUS DISEASE (EVD)

The World Health Organization declared EVD outbreak in West Africa as a public health emergency of international concern on 8.8.2014 and again on 17th July 2019 (outbreak in Republic of Congo) and issued detailed advisories for countries to prevent their citizens from risk.

Epidemiology and Surveillance of EVD

Ebolavirus has been named after a river in Congo, where disease was first recognised in 1976. EVD is severe, often fatal illness, with case fatality rate of up to 90%. It is one of the World's **most virulent diseases**.

Transmission

Ebola is introduced into human population through close contact with the blood, secretions, organs or other body fluids of infected animals. In Africa infection has been documented through handling of infected chempanzees, gorillas, fruit bats, monkeys, forest antelopes and procupines found ill or dead in rainforest. Ebola then spreads in the community through human to human transmission, with infection resulting from direct contact (through broken skin or mucous membranes) with the blood, secretions, organs and other body fluids of infected people and indirect contact with environments contaminated with such fluids.

People are infectious as long as their blood and secretions contain the virus. **Ebolavirus** was isolated from semen 61 days after onset of illness in a man infected in laboratory.

Incubation Period

Incubation period is 2–21 days (time interval from infection to onset of symptoms).

Distribution of EVD: 1711 cases of EVD and 932 deaths (case fatality rate of 54%) have been reported from Guinea, Liberia, Nigeria and Siera Leone up to 4th August, 2014. From 2014–16 death toll of 11000 have been reported.

Symptoms

Sudden onset of fever, intense weakness, muscle pain, headache, sore throat, vomiting, diarrhoea, impaired kidney and liver function and in some cases internal and external bleeding. Laboratory findings include low white blood cell and platelet counts and elevated liver enzymes.

Diagnosis

Other diseases should be ruled out before the diagnosis of EVD be made include: Malaria, typhoid fever, shigellosis, cholera, leptospirosis, plague, rickettsiosis relapsing fever, hepatitis and other viral haemorrhagic fevers. Lab tests include ELISA (antibody capture enzyme-linked immunosorbent assay), antigen detection test, reverse transcriptase polymerase chain reaction (RT-PCR) assay, electron microscopy and virus isolation by cell culture.

Management of Cases and Prevention of EVD[1]

This includes isolation and quarantine measures and symptomatic treatment as there is no specific drug against the virus. Effective vaccine against **Ebolavirus** disease has been developed and is in trial stage. Standard precautions are to be observed to reduce the risk of transmission of bloodborne and other pathogens. These include the basic level of infection control—hand hygiene, use of personal protective equipment to avoid direct contact with blood and body fluids, prevention of needle stick injuries from other sharp instruments, and a set of environmental controls.

In India advisories to state disease surveillance units for early detection and management have been issued by Ministry of Health, and all airports have designated facilities to manage travellers manifesting with Ebola symptoms.

The disease (EVD) has killed 4922 till 26.10.2014 people in West Africa with no sign of Abating. Number of confirmed, probable and suspected cases has risen to 10,141.

A Spanish nurse: Teresa Romeo, this is the first person to have contracted Ebola outside of Africa, as also a nurse in USA. One UN health worker died in Germany. WHO says there could be up to 10000 new cases of Ebola per week within 2 months if the response to the Ebola crisis is not stepped up within 60 days (isolation of 70% cases within two months to reverse the outbreak).

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NIPAH

EPIDEMIOLOGY AND PREVENTION

An outbreak of Nipah was reported in May 2018 localized at Kozhikode and Malapuram districts of Kerala killing 16 people out of 18 confirmed cases (CFR–88.8%) in a short span of 20 days including 31-year nurse.

Nipah is highly virulent paramyxovirus; Zoonotic pathogen normally occurring in animals; first reported in 1998 in Nipah village of Malaysia at Kampung; thereafter in 2001 in Bangladesh. In India two outbreaks occurred in West Bengal one in 2011 and second in 2007 in Siliguri and Nadia districts, and third outbreak in Kerala in May 2018 and again in 2019. On 3rd Sept 2021 a 12-year-old child died of NIPAH and two contacts—health officials developed symptoms of Nipah in Kerala.

Incubation period: Ranges from 4 days to 2 weeks.

Transmission: Nipah is transmitted after direct contact with infected bats, pigs and persons. Patients secretions, especially respiratory secretions and other body fluids are the main drivers for person to person transmission. Transmission may occur due to drinking raw date palm sap infected with Nipah virus.

Symptoms: The symptoms include fever, headache, dizziness and vomiting that develop into severe encephalitis. The brain is most severely affected organ and virus is commonly identified in lungs and kidney.

Diagnosis: By ELISA, PCR and virus isolation.

Mortality: Mortality is estimated at 40–75% and may go up to 100%.

Treatment: There is no vaccine or specific antibiotic against Nipah. Treatment is symptomatic. Ribavirin may reduce mortality among patients with encephalitis. Monoclonal antibody (developed in Australia) against Nipha is effective to save life.

Prevention

Hand hygiene—washing hands with soap and water after coming in contact with infected person/animals. Avoid consuming raw date palm sap or toddy. Consume only washed fruits avoid eating half eaten fruits from the ground. Contact tracing, aggressive monitoring and quarantining of suspected cases/contacts are effective forms of infection control and containment source of infection. In Kerala outbreak source could not be traced.

ZIKA VIRUS DISEASE

What is zika?

Zika is caused by a virus and transmitted by **Aedes** mosquitoes, which is also the vector for dengue. In May 2015, Brazil reported first case of zika, since then the disease has spread to 84 countries. The disease is commanding worldwide attention because of an alarming link with severe birth defect (microcephaly) and Guillain-Barré syndrome. Babies born to infected pregnant women can develop **microcephaly**.

Common Symptoms

Incubation period of Zika is 3–14 days. People with zika can have mild fever, skin rash, conjunctivitis, muscle and joint pains, malaise or headache; symptoms last for 2–7 days.

Prevention

Zika can be prevented by preventing mosquito bites, and source control-breeding of ***Aedes*** mosquitoes. No vaccine or specific medicine is available for disease. Zika is mild and requires no specific treatment. Treatment is symptomatic.

SPREAD

Zika virus outbreak was declared by WHO as a global public health emergency of international concern (PHEIC) on Feb 1, 2016. About 3 million cases were estimated in Latin American countries, hardest hit was Brazil with 1.5 million cases. PHEIC was declared as over in November 2016. Zika virus is a serious threat to health and well-being of pregnant women and newborn child.

The World Health Organization (WHO) announced zika virus outbreak in India in May 2017. Three laboratory-confirmed cases from Ahmedabad in Gujarat were reported to WHO. Second outbreak was reported in Krishnagiri district of Tamil Nadu in July 2017. Following this, Health Ministry has decided to screen newborns with head circumference less than 31 cm for zika-related microcephaly. Their blood will be subjected to testing to rule out/confirm virus at 55 top institutes of the country. Third outbreak with 154 cases and one death reported from Jaipur in Rajasthan and fourth outbreak with 127 cases from Bhopal in MP in September 2018. On 9-07-21 an outbreak of zika virus disease was reported in Kerala. Up to 2nd Aug, 64 confirmed cases in Kerala and one case in Maharashtra at Pune on 1-08-21. These outbreaks were successfully contained by effective surveillance and vector control measures.

WHO has not imposed any travel or trade restrictions as it was low level of transmission. WHO has asked the countries of South–East Asia Region to take decisive steps to prevent, detect and respond to zika virus.

MONKEYPOX A GLOBAL THREAT

Over 18000 cases of Monkeypox and 6 deaths were reported from across 78 countries since the beginning of year 2022. The case count is expected to change as more information becomes available. In view of its global spread WHO on 23.07.2022 declared monkeypox as Public Health Emergency of International Concern (PHEIC).

Geographical distribution: It occurs primarily in tropical rainforest areas of central and West Africa Situation in India up to December 2022: India reported its first monkeypox case from Kerala on 15.07.2022. Since then a total of 23 cases (from Kerala and Delhi) have been reported with one death in Kerala. Most of these cases were returnee from UAE. Global tally has increased to over 85,756 confirmed cases and 261 deaths in 110 countries.

What is Monkeypox?

Monkeypox is a viral Zoonosis, (a virus transmitted from animals). It is caused by monkeypox virus, a member of Orthopoxvirus Genus in the family Poxviridae.

Hosts: Squirrels, Gambian Pouched rats and non-human primates serve as animal hosts to monkeypox virus.

TRANSMISSION

Human to human transmission is limited. It is transmitted to humans through close skin or respiratory contact with an infected person or an animal or with material contaminated with virus. Sources of infection - are body fluids, lesions of skin and secretions of mucous membranes.

Clinical Symptoms and Signs

Usually Monkeypox is a self limiting disease, symptoms last for 2-4 weeks. Young people below 40 or 50 year are affected. It presents clinically with fever skin rashes starting from face spreading to arms, legs, palms and soles; lymph node enlargement, headache, muscle ache, exhaustion, sore throat and cough. Severe cases can occur. Case fatality has been around 3-6%. The clinical manifestations of monkeypox resembles that of smallpox which was declared eradicated worldwide in 1980, however it is less contagious than smallpox and causes less severe illness. Close to 98% of cases arise out of sex between men and men (MSM) and 41% of patients had HIV infection. Vaccines used during smallpox eradication programme also provided protection against monkeypox. Persons below 40 or 50 who were born after 1980 no longer enjoy protection afforded by smallpox vaccination hence are more prone to monkeypox.

A **suspected case** is a person of any age having history of travel to affected countries within the last 21 days reporting any of the symptoms.

Probable Case

A suspect who has had exposure to a confirmed case or infected goods/material

Confirmed Case

Anyone testing positive for virus by Polymerase chain reaction or sequencing or viral DNA

Public-Health Response So Far

- **Surveillance:** Screening at Airports–Thermal screening and rashes screening
- Contact tracing and Laboratory investigation
- Isolation of cases showing symptoms in special hospitals for 21 days
- **Clinical management of cases:** Symptomatic only no specific antibiotic is effective.

Preventive Measures

- To raise awareness and community engagement. Those who are exposed to virus, to monitor their health for 21 days for symptoms.
- Avoid skin to skin or face to face including sexual contact with anyone sick and reduce sexual partners, wear mask when in contact with person showing symptoms and wash hands often
- Out of newer vaccines one has been approved for prevention of monkeypox (WHO). ICMR has isolated the virus and invited tenders to make vaccines and diagnostics. Rome and US have started vaccination programme against monkeypox.

Current Situation

From 2 cases in the UK in May 2022 it has spread globally to 110 countries with case count to over 85,756 up to Feb 2023.

EPIDEMIOLOGY OF NON-COMMUNICABLE DISEASES AND RELATED NATIONAL HEALTH PROGRAMMES

"Primordial prevention is real pervention in NCDs as it focuses on prevention of emergence of known risk factors or unhealthy lifestyles in population". In community medicine, patient is community not an individual.

Goal: United Nations Sustainable Development Goal: One-third reduction in premature mortality from NCDs by 2030.

EPIDEMIOLOGY[1]

Disease burden: India is faced with double burden of communicable and non-communicable diseases (NCDs).

As per the NCD country profile 2016, overall mortality due to NCDs was 60%. The disease specific share was as follows: **Cardiovascular diseases:** 26%, cancer 7%, diabetes 2%, COPD 13%, and other NCDs 12%.

Rising burden of NCDs is due to rise in expectancy of life, unhealthy lifestyles and exposure to environmental risk factors and use of tobacco and alcohol.

- It is estimated that there were 2.26 million 5 years prevalent cancer cases in the country in 2018 and this would double over the next two decades.
- The prevalence of coronary heart disease (CHD) is now reported to be 1.6 to 7.4% in rural areas and 6.5 to 13.2% in urban areas in adults (Table 8.38).
- 25% of urban and 10% of rural adult population suffer from hypertension.
- The estimated prevalence of rheumatic heart disease (which constitutes 20–30% hospital admissions due to cardiovascular diseases) in India, is 0.9 per 1000 in the 5–15 age group.
- A record study carried out in 6 cities in India showed age standardized prevalence of diabetes and impaired glucose tolerance of 12.1% and 14%, respectively, with no gender difference in adults.

Competency addressed: The student should be able to:
CM 8.2: Describe and discuss the epidemiological and control measures including the use of essential laboratory tests at the primary care level for non-communicable diseases (diabetes, hypertension, stroke, obesity and cancer, etc.)

How to achieve it?

Visit to NCD cell at district, and intervention Programmes for NCDs at HWC, PHC and CHC besides CBAC by ASHA.

EPIDEMIOLOGY OF CARDIOVASCULAR DISEASES (CVDs) (UNHEALTHY LIFESTYLE DISEASES)

Cardiovascular diseases—ischaemic heart disease (IHD) and stroke (cerebrovascular disease) are two of the three leading causes of burden of disease in adults in India and major cause of sudden cardiac arrest. CVDs contributed to 28% of the total deaths, of these IHD and strokes contributed 2.4% of deaths in India, while obstructive pulmonary disease led to 10.8% of all deaths.

A case study on unhealthy life styles. World Health Report 2002 points out that world faces some common large and certain risks to health. India falls in-group of

Table 8.38: Burden of CCDs, NCDs and cardiovascular diseases

Diseases groups	*Burden (%)*	*WHO: Global status report 2014*	
• Communicable diseases	24.4	• Cardiovascular diseases (CVDs) Caused 31% of all deaths	
• Non-communicable disease	39.1	• Ischaemic heart disease (CHD) and strokes attributed to 80% of all CVDs in 2012	
• Maternal and neonatal ailments	13.8		
• Injuries	11.8	*Prevalence of CHD	1.6–7.4% Rural area
• Rest of diseases	10.9		6.5 to 13.2% Urban area
Total	**100**		

Source: National Health Policy (Draft 2015) *PHFI

high mortality countries and risk factors like tobacco use, high cholesterol and high blood pressure are fast emerging.[2,3]

The world is living dangerously, either because it has little choice or because it is making wrong choices. Today there are more than 8 billion people co-existing on this fragile planet on one side who are dangerously short of food, water and security they need to live. Developing countries still face the burden of poverty, undernutrition, unsafe sex, unsafe water, unsafe excreta disposal, poor sanitation and hygiene, micronutrient deficiency, indoor smoke from biomass fuels. On the other side, lies unhealthy consumption, particularly of tobacco and alcohol. The risks from blood pressure, and cholesterol strongly linked to **heart attacks** and **strokes are** also closely related to excessive consumption of fatty, sugary and salty foods. They become even more dangerous when combined with the deadly forces of tobacco and harmful alcohol consumption.[1]

Obesity, a result of unhealthy consumption coupled with *lack of physical activity*, is itself a serious health risk. All of these risk factors—blood pressure, cholesterol, tobacco, alcohol and obesity and the diseases linked to them are known to wealthy societies. The real worry is that they are now also increasingly dominating in low mortality developing countries where they create a double burden on top of infectious diseases that always have affected poorer countries. They are even becoming more prevalent in high mortality developing countries.

The Framingham study, the best known study, and a model for many others launched in 1950s developed the concept of coronary risk factors. The study brought out the classic *consistent risk factors* such as cigarette smoking, blood pressure and total cholesterol. Others were less common (diabetes mellitus), less consistent (obesity and exercise) or less readily measured (diet, alcohol and psychological factors). Subsequently, many other studies were conducted and the world's largest study of **heart diseases, strokes,** risk factors and population trends was undertaken by MONICA project (multinational monitoring of trends and determinants in **cardiovascular disease**) from 1979–2002).[4]

In summary, the major CVD risk factors of tobacco use, inappropriate diet and physical inactivity (primarily expressed through unfavourable lipid concentrations, high body mass index, and raised blood pressure) explain at least 75–85% of new cases of **coronary heart disease**.[1] In the absence of elevation of these risk factors, coronary heart disease is a rare cause of death.

The basic underlying conditions and risk factors for CVD are:

1. Tobacco use
2. High blood pressure >140/90 mmHg
3. High total cholesterol >200 mg/dl
4. (a) Overweight—obesity, (b) BMI ≥30 kg/m^2
5. Physical inactivity—sedentary lifestyle
6. Low intakes of fruits and vegetables
7. Diabetes mellitus
8. Use of alcohol (there is no safe limit)
9. Air pollution
10. Stress
11. Hereditary and genetics.

NCDs require lifetime continued care and lifelong medicines after diagnosis. Cost of treatment is very high, hence prevention should be the mainstay.

The national programmes on non-communicable diseases include, National Trauma Control Programme, Control of Blindness, Mental Health Programme, control of iodine deficiency disorders, fluorosis control and National Oral Health Programme besides the healthcare of elderly and National Programme for Prevention and Control of cancer, diabetes, CVD and **strokes** as also drug deaddiction programme.

NATURAL HISTORY AND LEVELS OF PREVENTION OF CVDs

Primordial Prevention (PP)

80% of heart diseases and strokes are preventable. PP begins during childhood period, i.e. shaping lifestyles during early years of life. Primordial prevention in CVD consists of prevention of development of coronary risk factors in population/community. This measure is directed to healthy community or total population. *Generally primordial prevention should begin during childhood, continue through adolescents, and youth and later years of life.*

Since the clinical manifestations of CVD appear in fourth or subsequent decades of life, the pathological process begins much earlier during childhood period.

Primordial prevention focuses on prevention of emergence and establishment of known risk factors or unhealthy lifestyles in *population*.

Actions: Healthy Policies by Government

- The government should have comprehensive *policy* to discourage tobacco use, ban on tobacco production, sale and consumption. **Smoking** at public places is banned in India and similarly sale of cigarette to minor is an offence in India.
- Adopt policy on crops alternative to tobacco.
- *National policy* and *programmes* on **nutrition** involving the agriculture sector, the food industry, and food import/export sector to curb excessive use of **saturated fats, transfats** and "fast foods" through food "Joints" and regulating *salt* in processed foods and encourage production of **fruits and vegetables** and to promote healthy eating practices in population by regulating food prices/industries and by sound agriculture policy.
- Healthy foods through Mid-Day Meal Programme in schools and SNP in *Anganwadis*.
- Policy on alcohol use and education.

- Shaping personality and healthy lifestyles such as "no smoking", avoid eating excess of "junk foods", "fast foods" and promoting healthy eating to avoid overweight and obesity begins in **family** and **home** first. Unfortunately, the high fat fast foods are much cheaper than fruits, vegetables, whole grains and pulses today. This coupled with aggressive marketing in the media promotes unhealthy eating habits which increases cholesterol levels and obesity. "The food Industry is driving nutrition off the natural path." by ultraprocessing of foods.

  Promoting **physical activities** in childhood and adolescent period prevents obesity. Development of **healthy lifestyles** begins at home and parents and family lay down foundations of these lifestyles. Dietary patterns, smoking habits are family-based and transmitted from parents to children and conditioned by environments in later life where peer groups play important role. Similarly, preschool education programmes and school teachers leave permanent impression on the mind of child and have great influence in shaping healthy lifestyles and personality development. Healthy public policies promoting evidence based, cost effective, high impact interventions known as "BEST BUYS" (tobacco control, physical activity, reduction of salt, sugar and saturated fats) can prevent 80% of CVDs.

PRIMARY PREVENTION

Once the risk factors have established or have appeared in the population, attempt is made to prevent the development of CVD in persons having risk factors.

Purpose

Purpose of primary prevention is to *limit the incidence* of CVD by controlling risk factors and causes or by modification of risk factors.

There are two approaches in primary prevention:

i **Whole population**

ii **High-risk approach.**

Focus on Whole Population—Population-based Approach[5]

Population-based primary prevention strategies are much more beneficial, cost effective, make high impact, here effort is made to focus on total population. Population-wide risk factors modification such as reduction in tobacco use/salt, saturated fats and sugar intake, control of factors which can give rise to hypertension and diabetes mellitus is most appropriate. Regular physical exercises, diet rich in dietary fibre (containing lot of green leafy vegetables, whole grain cereals, mixed cereal diets, fresh fruits and vegetables, dried beans, peas, nuts and oil seeds) maintenance of ideal body weight and avoidance of stress (relaxation techniques like yoga and meditation) avoidance of alcohol could prevent a large proportion of disease events in the whole population. It aims at community adoption of *healthy lifestyles*; by **health promotion** and behaviour change communication (BCC) strategies.

Preventive Measures and Strategies

Mean blood pressure of a population accurately predicts the number of hypertensive individuals and mean body weight predicts the number of obese subjects. Rose identified that the prevalence of a high-risk state (hypercholesterolaemia, hypertension, obesity, etc.) is largely a reflection of the *lifestyles* and *attitudes* of the masses. Population-wide approach corrects the *underlying cause* of the epidemic and is safer, cheaper and more cost-effective than the high-risk corrective approach.

Epidemiological studies have identified that many traditional **coronary risk factors** are important in Indians. Adopting *healthier lifestyles* as *norms* for the entire population can change most of these factors.

High-risk Approach

Here attempt is made to screen out high-risk individuals by **periodical medical check-up** at regular intervals measuring of risk factors such as blood pressure, blood glucose, weight and cholesterol level. Those individuals who show abnormal values are prescribed individualized programme directed at modifying or reducing or eliminating the risk factors and thus preventing the CVD and delaying the development of CVD.

Screening of risk factors is a costly proposition.

The relationship between risk factor and disease events is continuous and most events of CVD occur in people in middle range of the risk factor distribution, who are not normally judged as high-risk. The effort spent in measuring risk factors in individuals is therefore questionable.

SECONDARY PREVENTION

This level of prevention is applied to persons who have developed CVD. In CVD, secondary prevention aims to cure patients of CVD and reduces more serious complications through early diagnosis and prompt treatment. It also aims at reducing morbidity and mortality and *reduces the prevalence* of CVD. Apart from prompt treatment, the measures include avoiding smoking, promoting physical exercise, lowering lipids, controlling obesity, hypertension and diabetes by diets, drugs and exercise regimen. Low doses of aspirin and use of β blockers are popular regimen. Treatment is lifelong.

TERTIARY PREVENTION IN CVD

This consists of disability limitation and rehabilitation by advanced treatment and surgical interventions like angioplasty and coronary bypass. It treats the complications and

sequelae of CVD (renal and retinal). *Rehabilitation* of patients of myocardial infarction and strokes in the *community* and at *home* by physical, emotional and psychological rehabilitation by yoga and biofeedback. The aim is to enable the individual to take part in daily social life.

Modifiable risk factors of CVD are being explained in details hereunder:[6]

Smoking and Second-hand Smoke (SHS)

Tobacco is the second major cause of death in the world. Use of tobacco is harmful to health and **heart**. Tobacco use in any form is harmful to **heart**, it increases the atherosclerosis, raises the level of cholesterol besides producing lung cancer. Tobacco kills 8 million people every year in the world mostly in poor countries and poor population. Controlling tobacco is primordial prevention. Governments of various countries have various forms of bans on use of tobacco, but these are not sufficient. Tobacco consumption is still prevalent. Second-hand smoke (SHS) or environmental tobacco smoke (ETS) exposure among the population in general and women and children in particular at home, at public places and at work places is alarming.

In India, more than 1 million people die due to tobacco consumption. India is second largest consumer of tobacco in the world.

Hypertension

A subject (adult) is called hypertensive if the blood pressure level is >140/90 mmHg. Blood pressure control helps prevent development of CVD. Goal is to keep blood pressure less than 140/90 mmHg. Adopt **healthy lifestyles right from early childhood** period to control eating and body weights and to achieve normotensive level.

High blood pressure adversely affects the heart and blood vessels. Elevated blood pressure levels produce a variety of structural changes in the arteries that supply blood to the brain, heart, kidneys, eyes and elsewhere. High blood pressure increases the work of heart and produces hypertrophy of left ventricle. An increase in bulk means increased oxygen demand for the heart muscle. Since at the same time, blood flow is facing an obstruction, the heart does not get enough oxygen. This is how the blood pressure increases the risk of heart attacks. High blood pressure does not produce symptoms as such, therefore, it is called "silent killer".

In recent decades, it has become increasingly clear that the risks of **strokes** and **ischaemic heart disease**, renal failure and other diseases are not confined to population with particular high levels (hypertension), but rather continue among those with average and even below average blood pressure. Worldwide high blood pressure is estimated to cause 7.1 million of deaths.

Regular blood pressure check-up after the age of 30 has been recommended. Any one with pressure higher than 140/90 mmHg needs treatment.

High Cholesterol Level

Cholesterol is key component in the development of atherosclerosis—the accumulation of fatty deposits on the inner lining of the arteries. High cholesterol is estimated to cause 18% of global **cerebrovascular disease** and 56% of global **ischaemic heart disease**. Overall, this amounts to 4.4 million deaths. Normal level of cholesterol ranges from 150 to 250. Safe upper limit is 200 mg/100 ml or less. Hypercholesterolaemia is a risk factor in CVD.

There are two sources of cholesterol in body. Food cholesterol (exogenous source) and endogenous source synthesized by body tissues such as liver. The dietary cholesterol is derived from animal products and no plant food has it. The richest sources are egg yolk, whole milk dairy products and organ meat. Cholesterol is carried as lipoprotein molecules in plasma. There are 3 classes of lipoproteins, high density lipoprotein (HDL), low density lipoproteins (LDLs), very low density lipoproteins (VLDLs) and chylomicron.

HDL (α-lipoprotein) is protective and friendly to heart it contains 20% of cholesterol. LDL (β-lipoprotein) contains 45% of cholesterol and is not good for heart. VLDL contains 60% of triglycerides and is not good for heart. Chylomicron contains 90% of triglycerides and again not good for heart.

High consumption of animal fats, eggs, organ meat and saturated fats raises the level of cholesterol and increases the level of harmful lipoproteins (LDL, VLDL and chylomicron). Monounsaturated fatty acids (MUFAs), and polyunsaturated fatty acids (PUFAs) lower the cholesterol level in the body. A blend of rice bran oil with palm oil in the proportion of 3:1 can yield a blend with ideal ratio of saturated fatty acids (SFAs), MUFAs and PUFAs (1.0: 1.5:1.0) which can be good for prevention of heart disease according to **American Heart Association** and **Japanese** Ministry of **Health and Welfare.**

Indian diets are vegetarian primarily hence fats come through vegetable oils and some are derived from milk and milk products.

Visible fats are consumed through coconut, vanaspati, groundnut and red palm; these are all saturated fats and provide SFAs (saturated fatty acids). Unsaturated fatty acids are derived from soya bean, sunflower, safflower, sesame oils and mustard oil. These oils provide unsaturated fatty acids like MUFA (monounsaturated fatty acid), linoleic acid (LA) and alpha-linolenic acid (ALA).

In Indian diet, 25–40 g of visible fat as oil is recommended per adult person per day and children should have at least 25–30 g per day and pregnant women 30 g per day.

Invisible Fat (IF)

In Indian diet IF come through cereals, millets, pulses and adequate intakes of these can provide 8–10 g of invisible fats. Invisible fats of plant are known good sources of oleic acid, linoleic (LA) and alpha-linolenic acid (ALA). Pulses

and green leafy vegetables and spices contain high proportion of ALA.

Therefore, Indian vegetarian diets, which are cereal-based with adequate quantity of legumes, fruits, green vegetables and oils can reduce the level of cholesterol in the body and are **good for heart**. Excess consumption of saturated fats (derived from eggs, meat and dairy products); "junk foods" and "fast foods" and "transfats" can be harmful and raise the level of **harmful cholesterol**. Vegetarian diets promote the level of good cholesterol (HDL).

Dietary fibre, which are insoluble and soluble fibres. Insoluble fibres are cellulose, hemicellulose and lignin. These are present in plant cell wall. Soluble fibres may reduce LDL level by 5–15%. The soluble fibres are psylium, pectins, gums and mucilages. Sources of soluble fibres are fresh fruits, dry fruits, pulses, legumes, coarse cereals and isabgol. These foods lower the level of harmful cholesterol and hence should be encouraged. Refined carbohydrates as in white flour, white bread, polished rice, sugar are poor sources of fibre and are harmful. **Natural antioxidants** in food like vitamins E and C, β-carotene and selenium are present in green leafy vegetables, yellow fruits, nuts, garlic and onion and are good for heart. No more than 20–30% of calories should come from fats in daily diet.

Overweight, Obesity, and High Body Mass Index

The prevalence of overweight and obesity is commonly measured by using body mass index (BMI), weight in kg/height in m^2 which has a strong correlation to body fat content. WHO criteria define *overweight* as a BMI of at least 25 kg/m^2 and *obesity* as a BMI of at least 30 kg/m^2. These markers provide common benchmark for assessment, but risks of disease in all populations increase progressively from BMI levels of 20–22 kg/m^2. NIN has revised the normal range of BMI as 18.5 to 23.

Excessive consumption of free sugar (refined carbohydrates), saturated fats and consumption of alcohol combined with reduced physical activity lead to obesity and obesity rates are on increase in prosperous people. Urban middle class, rich and higher economic status people, have more tendency to develop obesity.

Overweight and obesity lead to adverse metabolic effects on blood pressure, cholesterol, triglycerides and insulin resistance. Risks of coronary heart disease, ischaemic strokes and type 2 diabetes increase steadily with increasing BMI. Type 2 diabetes mellitus confined to older adults for most of the 20th century—now affects obese children before puberty.

58% of diabetes mellitus, 21% of ischaemic heart diseases globally are attributable to BMI above 21 kg/m^2.

Physical Inactivity

The world health survey found that overall, 29% of the population had inadequate physical activity.

Overall, physical inactivity was estimated to cause more than 2 million deaths. Physical inactivity is estimated to cause globally 10–16% of cases each of breast cancer, colon and rectal cancers and diabetes mellitus and about 22% of **ischaemic heart disease**.

Physical activity reduces the risk of cardiovascular disease; some cancers and type 2 diabetes. In general, physical activity improves glucose metabolism, reduces body fat and lowers blood pressure. These are the main ways in which it is thought to reduce the risk of cardiovascular diseases and diabetes. Physical activity also reduces risk of colon cancer by effects on prostaglandin, reduced intestinal transit time and higher antioxidant level. Besides, this, physical activity can improve the musculoskeletal health, control body weight and reduce symptoms of depression, stress and reduced risk of breast cancer and prostate cancer.

When you walk briskly, play, skate, clean house or climb stairs, you are **moving for health**. Any amount of physical activity will make you feel better. The minimum amount of physical activity required for prevention of disease is at least 30 minutes of moderate activity everyday.

Low Fruit and Vegetable Intake in India

Adequate consumption of fruits and vegetables prevents CVD and certain cancers principally of digestive system. There are several mechanisms by which these protective effects may be mediated, involving **antioxidants** and other micronutrients such as **flavinoids, carotenoids,** vitamin C and folic acids as well as dietary fibres. These and other substances block or suppress the action of carcinogen, and as antioxidants, prevent oxidative DNA damage. In India, fruits and vegetable intake is low. Horticulture and agriculture policies can increase their production and consumption. One should encourage the consumptions of fruits and vegetables to control weight and reduce CVD apart from reduction of risk of cancers.

Diabetes Mellitus

Normal fasting blood sugar level of healthy adult varies between 72 and 100 mg/100 ml. Persons with 100–125 mg level are pre-diabetics. Diabetes accentuates the risk of CVD by 2–3 times in men and 3–7 times in women. Reduction in the risk of CVD with well-controlled diabetes is well established. But this requires a control of other risk factors too. Diabetic must ensure that blood pressure and cholesterol levels are normal. They should avoid smoking, control their weight and exercise regularly. Alcohol consumption is harmful to health and heart.

Air pollution: A Global problem worldwide as 7 million deaths in 2018 were caused by household and outdoor air pollution. Most of these deaths were caused by **ischaemic heart disease** which accounted for 34% of total deaths, 21% were caused by pneumonia while 20% lost their lives from strokes, 18% due to COPD and 7% due to lung cancer.

Stress

Stress does exert adverse effects on heart and blood vessels. It results in release of hormones, which damage the inner lining of blood vessels. Such an injury promotes cholesterol deposition to produce atheroma. Stress hormones also damage the heart muscle and can change the properties of platelets and help in formation of clots. Hence, there is indirect evidence of the value of stress control for prevention of ischaemic heart disease.

Type A behaviours are more prone to the effect of stress and consequences of stress (Table 8.39).

Hostility and anger are probable independent risk factors to CVD, both letting out anger and suppressing produce negative emotions, which increase the risk to CVD.

Stress Management

Number of stress management/prevention techniques are available and are useful to cope stress and prevent stress.

- Relaxation techniques
- Biofeedback
- Thought stopping
- Cognitive behaviour modification
- Yoga and meditation.

Relaxation Techniques

Stress encountered by the individual produces state of muscular tension which disrupts the adaptive functions of various body systems. Relaxation techniques are helpful in altering certain physiological parameters associated with CVD like blood pressure and anxiety. Various techniques have been used for releasing muscular tension. Jacobsonian technique has been used widely; deep-breathing and physical massage are other techniques.

Biofeedback

It is a technique of achieving voluntary control over autonomic function by constant feedback of visual, auditory or graphic signals through instrumental conditioning like controlling heart rate, body temperature and so on. This helps to control anxiety, reduction of muscle tension and is helpful in treatment of cardiac arrhythmia and angina pectoris, hypertension and type A behaviour.

Thought Stopping

Negative thoughts like thoughts about succeeding, being a failure, if left unchecked lower down one's self-esteem, self-control, and builds-up physical tension and lead to stress. Counselling techniques and family support can stop these negative thoughts.

Cognitive Behaviour Modification

Individual can be trained to learn positive self-enhancing rational thinking by variety of procedures to inculcate positive beliefs and thinking.

Yoga and Meditation

Practice of yoga and meditation relieves tension, improves psychological functions and lowers heart rate, respiratory rate and blood pressure. Yoga and meditation under guidance are helpful to reduce stress. Beginning should be made in schools, continued during adolescents and in later life.

Heredity and Genetic Factors

There is strong likelihood that Indians have genetic predisposition to CVD mediated by Lp (a) a form of LDL cholesterol with an additional protein called Apo (a). It binds with other components in blood to form plaques, which deposit inside the arterial wall. Lp (a) also promotes intravascular clotting and prevents clot lysis as its structure is homologous to plasminogen.

Lp (a) is 10 times more atherogenic than LDL and 15 times more deadly than total cholesterol.

Individual with high Lp (a) levels should be targeted for rigorous lifestyle modifications to minimize the risk of CVD.

Table 8.39: Characteristic behaviour patterns of type A and type B personalities

Type A behaviours	*Type B behaviours*
• Hurried speech • Constant rapid movement/eating • Open impatience with the rate at which things occur and how others operate • Chronic sense of time urgency • Thinking and performing several things at once • An active attempt to dominate the conversation, to determine the topics and to remain preoccupied with one's own thoughts when others are talking • Vague guilty feelings during period of relaxation when doing nothing • Over concern with getting things worth having no time to become the things worth being • No compassion for others • Characteristic nervous gestures—tics, clench fist and jaw, pound on table, grind teeth	• Complete freedom from all type A traits • No sense of time urgency • No free-floating hostility • No felt need to display or discuss one's achievements and accomplishments unless the situation demands it • An ability to relax without guilt and to work without agitation

Surveillance of Risk Factors

To achieve 25% reduction in mortality. Epidemiological surveillance of risk factors of CVD is appropriate; to monitor the trends, to evaluate the risk reduction strategies and to improve the implementation of strategies in a region or country as also to draw comparison of prevalence between different regions. Surveillance can be part of integrated surveillance of communicable and non-communicable diseases. Surveillance operations involve, substantial cost and these should be taken up with definite objective or policy in mind. Academic surveillance is of little use. Parameters of risk assessment have been simplified and being used at field level by paramedical workers such as ASHAs, ANMs and by people themselves such as weight, and height records, tobacco use status, family history of CVD, past history of disease, diets, physical activity, etc.

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OBESITY (AN EPIDEMIC IN INDIA)

EPIDEMIOLOGY

Globalization has brought in lot of changes in the food habits of children and adolescents because of availability, accessibility and affordability of fast foods—junk foods.

Less than 20% of Delhi adolescents took on to any physical exercise like walking and participating in sports. Over the last 3 decades, there have been substantial changes in the socio-economic status of people, some increases in the dietary intake of men and women, especially of the affluent segments, in rural and urban areas, ready availability of fast foods, ice creams and other energy rich food items at affordable costs have resulted in increased energy consumption.[1]

Defining Obesity

The obesity can be defined simply as the disease in which excess body fat has accumulated to such an extent that health may be adversely affected. However, the amount of excess fat, its distribution within the body and associated health consequences vary considerably between obese individuals.

Measuring Obesity

I. Skin Fold Thickness

Measuring skin fold thickness indicates deposition of fat and indirectly measures the level of obesity in a person. Triceps skin fold and subscapular skin fold thickness is measured commonly. Holtain skinfold calipers are used for this purpose. Global standards for under 5 children are available.

II. Waist Circumference in Adults

Waist circumference is an important measurement of central or abdominal obesity. It should be less than 90 cm for men and less than 80 cm for women. If it is more than 80 cm in female and more than 90 cm in male it is an overweight or obese level. Waist circumference can also be measured across umbilical line (at the naval).

III. Waist–Hip Ratio (WHR)

A waist–hip ratio exceeding 0.85 in female and 0.95 in male is indicative of abdominal obesity. To maintain appropriate waist–hip ratio is most desirable. It is measured at a midpoint between the lower border of rib cage and iliac crest in cm and may provide more practical correlate of abdominal fat distribution and associated ill-health.

IV. Body Weight

Obesity has been measured by using weight of an individual for his/her height. It has been suggested that if the weight-for-height exceeds 120% of standard weight-for-height than the subject should be labelled as an obese. Excess weight is most likely due to excess deposition of fat in the body but it may also be due to excess muscle mass and other tissues as well. Body weight alone is thus insufficient measure of obesity.

V. Body Mass Index (BMI)[2,3]

BMI is now used as an indicator of choice to diagnose obesity in adults. Garrow's earlier classification of obesity has been replaced by the International Obesity Task Force criteria developed and endorsed by the WHO 2000, and 2004 (Table 8.40). NIN new guidelines on range of normal BMI is 18.5 to 23 keeping BMI in the range of 21–23 is good for health.

WHO definition of overweight for South Asians is:

BMI ≥ 23 compared to BMI ≥ 25 for other regions.

Table 8.40: International classification of adult overweight and obesity according to BMI[4]

Classification	*BMI kg/m² principal cut-off points*	*Additional cut-off points*
Normal range	**18.50–24.99**	**18.50–22.99** **23.00–24.99**
Overweight	**≥25.00**	**≥25.00**
Pre-obese	25.00–29.99	25.00–27.49 27.50–29.99
Obese	**≥30.00**	**≥30.00**
Class I	30.00–34.99	30.00–32.49 32.50–34.99
Class II	35.00–39.99	35.00–37.49 37.50–39.99
Class III	≥40.00	≥40.00

Source: Adapted from WHO 1995, WHO 2000 and WHO 2004.

These BMI values are age independent and the same for both sexes. However, BMI may not correspond to the same degree of fatness in different populations due, in part, to differences in body proportions. The health risks associated with increasing BMI are continuous and graded and begin at a BMI below 25. The interpretation of BMI gradings in relation to risk may differ for different populations. The WHO Expert Consultation concluded that the proportion of Asian people with a high-risk of type 2 diabetes and cardiovascular disease is substantial at BMI's lower than the existing WHO cut-off point for overweight (= 25 kg/m²). However, the cut-off point for observed risk varies from 22 to 25 kg/m² in different Asian populations and for high-risk, it varies from 26 to 31 kg/m². The Consultation, therefore, recommended that the current WHO BMI cut-off points should be retained as the international classification. But the cut-off points of 23, 27.5, 32.5 and 37.5 kg/m² are to be added as points for public health action.

BMI is most useful tool in estimating the prevalence of obesity and chronic undernutrition or chronic energy deficiency (CED) in adults. A person with BMI of 25 and above is overweight, BMI between 25 and 29.9 is pre-obese and BMI of 30 and above is obese. A person with BMI of 40 and above is called "morbid obese" (Table 8.38).

Cut-off Levels

BMI norms for Indian population are as under:

- Normal range 18.5 to 22.9
- Overweight 23 to 24.9
- Obese grade 25 and above

Other Methods

Techniques of body fat assessment are more sophisticated and costlier.

Global Problem[4]

Globally more than one in three adults (33%) over the age of 18 were overweight and more than one in ten (10%) were obese in the year 2014.

Obesity is a global public health problem. On an estimate, nearly 1.4 billion adults worldwide are obese.

WHO MONICA project provides most comprehensive data on prevalence of obesity worldwide in European population. Between 50% and 75% of adults aged 35–64 were either overweight or obese during the period 1983 and 1986.

Epidemiology of Obesity in India

Obesity is an *emerging epidemic* in India. Adult male and female are equally affected. High prevalence of obesity in adult women has been reported in some states. One-fourth (25%) of Indian children above the age of eight in urban India are obese and overweight as per new national survey on physical fitness (The Tribune Sept 11, 2010.) These children have poor endurance, based on indicators of BMI, aerobic (walking and running) and anaerobic (sprinting) capacities, muscle strength, endurance and flexibility. 2% of children 1–4 years, 4% of 5–9 years and 5% of adolescents were overweight or obese (CNNS 2016–2018) in India. As per NFHS-5 nearly 24% of women in age group 15–49 years who were overweight or obese and 23% men were overweight or obese in 2019–21 (Table 8.39).

Developed and Developing Countries

The belief that obesity or overnutrition was the problem of developed countries alone is no longer true. Affluent sections in India and urban middle class and higher classes are affected much more hence India is one of the developing countries along with other countries showing emerging and rising trends as indicated by NFHS-4 and -5 surveys in adult women and men (Table 8.41).

Urban Rural Differences

In India, the available information indicates the urban affluents are more at risk and have high prevalence of obesity because of sedentary lifestyles, consumption of junk foods rich in calories and lack of exercise. Over 33%

Table 8.41: Nutritional status and obesity in men and women 15–49 years (2015–2021) in India (%)

All India and select states	*NFHS-4 2015–16*		*NFHS-5 2019–21)*	
	Men	*Women*	*Men*	*Women*
BMI < 18.5 (underweight)	20.2	22.9	16.2	18.7
BMI 18.5-24.9 (Normal range)	61.2	56.4	60.9	57.3
BMI > 25 (obese)	18.9	20.6	23	24
Delhi BMI > 25 (obese)	24.6	34.9	38	41.3
Punjab BMI > 25 (obese)	27.8	31.3	32.2	40.8
Haryana BMI > 25 (obese)	20.2	21.0	28.3	33.1

women in urban area were obese or overweight against 20% in rural area. Similarly 30% of men were obese or overweight in urban area against 19% in rural India (NEHS-5).[5]

Levels of obesity have (in adults 15–49) increased in men and women in India over the last 5 years. Prevalence has increased in men from 18.9% to 23% and in women from 20.6% to 24% while in women. Obesity is maximum in prosperous states like Delhi, Punjab and Haryana. Delhi and Punjab with obesity levels of 41.3% and 40.8% in women respectively being the heaviest states in India.

Socioeconomic Status

Upper socioeconomic classes and affluents are more affected as compared to urban poor; however, it all depends on lifestyles of eating and exercise. NNMB data observed high obesity levels in urban slums indicating that obesity is now affecting urban poor.

Ethnicity

People of Indian origin living in USA, UK and Malaysia have high incidence and prevalence of obesity as compared to local people.

Physical Inactivity

With increase in prosperity, the lifestyles have changed because of urbanization, industrialization and mechanization. The physical activity much reduced due to use of automobiles, long hours of watching of television and playing computer games and load of books which confines the children, adolescents and adults in homes. The energy spending is less and energy consumption is much higher with higher use of junk foods (refined carbohydrates). Eating junk foods and television watching go together, due to excessive use of mobile telephones, the mobility is further reduced. Urban surveys from Indian cities have indicated low level of physical activities in 61–66% of men and 51–75% of women. Nearly 41% of adults in India fail to meet minimal levels of physical exercise (WHO ICMR study 2020) or 41% of adults lead inactive lifestyles, are at risk of lifestyle diseases.

Risk Factors

Physical inactivity, unhealthy eating, consumption of alcohol are the risk factors for overweight and obesity and other NCDs.

New Trend

Obesity is emerging as a problem of younger age groups, i.e. younger children in urban affluent areas have the tendency towards overweight due to more amenities and less of physical activities as also overeating tendencies. A study of 4000 Indian children in 15 cities indicated that 25% of children in 5–14 years age in urban schools being overweight, while nearly 11% kids were obese. While malnutrition continues to be a major health concern in many parts of the world, excess of food consumption and sedentary lifestyles are leading to an epidemic of obesity and chronic non-communicable diseases (NCDs).

Obesity is strongly linked to low physical activity and a major cause for insulin resistance. Insulin resistance is a characteristic feature of Asian Indians even with non-obese body mass index. A genotype which provided metabolic defence at times of famine has probably placed the present generation at a higher risk of developing metabolic disorders when exposed to constant overnutrition and physical inactivity.

Hitherto, our concern remained on undernutrition in young children. Long-standing malnutrition in India exposes these children during adulthood period to the consequence of degenerative metabolic disorders even at low BMI when they indulge in overeating and physical inactivity. Currently, the *dietary transition* (of overeating and physical inactivity) has affected the urban rich and adults; however, obesity and metabolic disorders have affected the urban poor as well as rich in India. India is currently fighting against undernutrition as well as impending outbreak of overweight and obesity.

Consequences of Obesity

Overweight and obesity is a risk factor for development of various non-communicable diseases (NCDs), over the years epidemiological data has proved that obesity and overweight leads to increased mortality and increased risk of chronic diseases like **cardiovascular diseases, diabetes, hypertension, osteoarthritis, osteoporosis, gallbladder diseases, gallstones** and certain **cancers** like breast and uterine and infertility. Obesity is a major risk factor for non-insulin dependent diabetes mellitus also apart from non-alcoholic fatty liver disease. Diabetes together with obesity is often referred as *diabesity*.

Prevention and Control of Obesity

Since **overweight** and **obesity** is an emerging epidemic and significant public health problem, its prevention and control strategies are important. Following strategies can be applied.

Primordial Prevention

It involves prevention of development of obesity risk factors in population/persons not known to have the risk factors of the disease. The aim is to avoid emergence and establishment of the social, economic and cultural pattern of "lifestyles" that are known to contribute to an increased risk of obesity. In obesity, primordial prevention consists of physical activity and regulating dietary pattern. WHO says obesity cannot be prevented or managed or physical activity promoted, solely at the level of individual governments. The *food industry*, *international agencies*, the media and the community all need to work together to modify the environments so that it is less conducive to weight gain.

Lifestyles

Lifestyles such as eating pattern, overweight and taking onto physical activity begins early in life during childhood period. Hence, the *primordial prevention* of *obesity begins during childhood period*. Developing healthy lifestyles is the responsibility of parents, school teachers, media, industrial establishment and the government (regulating town planning and eating establishments). Let us give our future generation a healthy start. During this *transition period* when we are faced with undernutrition on one hand and overnutrition on the other, we have to strike a balance.

PHYSICAL ACTIVITY

Habit of regular physical exercises can be inculcated during childhood at home by parents, in schools by school teachers and at workplace by peers and the management. Any amount of physical activity helps at any age. The minimum amount of physical activity required for prevention of obesity is at least 30 minutes of moderate activity every day or to spend 150 calories or energy per day. Therefore, 30 minutes of moderate activity every day is helpful. Half an hour is a minimum recommendation, of course, more time you spend moving for health, the more you gain. Walking 2.34 km in 30 minutes; or walking 3.12 km in 30 minutes, basketball game for 15 minutes, cycling, gardening, dancing fast for 30 minutes and washing a car or motorcycle, etc. help and keep away obesity. Exercise to your capacity. Everybody above 2 years of age should undertake for a cumulative duration of 30 minutes moderate physical activity. Persons with medical problems should consult a physician and take medical advice before starting a vigorous exercise. Avoid extremes and inappropriate or excessive physical activities. One can have interrupted physical activity of 10 minutes session or two sessions of 15 minutes each.[6]

Diet—Curb on "Junk Foods" Regulatory Measures

Improve nutrition knowledge of people and eating sensibly and avoiding excess of eating. Caloric excess and physical inactivity lead to obesity. Avoidance of eating junk foods helps to reduce calories. **Curb sale** of junk foods in the vicinity of **schools**. The left front Government in Kerala has imposed 14.5% of tax on restaurants selling foods high on saturated fats such as Pizzas, burgers and tacos. Eating more of protective foods like green leafy vegetables and fruits in place of sweets is beneficial. Have only 20 g of visible fats in the food and right proportion of saturated, monosaturated and polyunsaturated fatty acids in diets to maintain optimum level of HDL in the blood. Derive 60–65% of energy from carbohydrates with emphasis on complex carbohydrates of whole grain cereals which are good sources of fibre. Sugar should provide less than 10% of total energy. 10–15% of energy should be obtained from proteins and 20–30% from fats. Vegetarian diets based on complex carbohydrates, edible oil such as groundnut oil, sesame oil with moderate level of linoleic acid and GLV (green leafy vegetables) and fruits are helpful and better than animal foods. Fish and lean meat are good.

Primary Prevention by Periodical Check-up

Primary prevention in obesity involves preventing the development of obesity in those who are overweight. Know your weight by checking your weight periodically at home or at workplace. Regular weighing at an interval of 1 to 3 months helps screening of persons for risk factor of overweight. If a person is overweight, regular programme of diets and physical activity can be chalked out and results can be monitored by the individual himself.

Secondary Prevention

If one has developed obesity, attempts are made to avoid further progression of obesity to **morbid obesity** and its complications. Graduating physical activity and dietary regimens can still be useful. Physical activity reduces stress and promotes active life.

Tertiary Prevention

It involves treating of advanced obesity and associated illnesses with obesity to reduce mortality and morbidity by advocating combination of drugs, physical activity, diet regulation, avoidance of tobacco, alcohol and weight loss bariatrics surgery procedures for "morbid obesity".

Different strategies have to be adopted in rural and urban areas in the light of National Nutritional Policy and action plan on nutrition.

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DIABETES

EPIDEMIOLOGY

World Health Day 7th April 2016—"Halt the rise beat diabetes". Diabetes as a non-communicable disease is significant public health problem. The prevalence rate all the world over is rising.

Diabetes mellitus is characterized by hyperglycaemia and disturbance of carbohydrate, fat and protein metabolism that are associated with absolute or relative deficiency of insulin action and/or insulin secretion. Therefore although diabetes is an endocrine disease in origin its major manifestations are those of metabolic diseases (WHO). The body needs insulin to convert starches and other foods into energy.

"Cut-off" level for diabetes (Table 8.42).

Table 8.42: Criteria for diagnosis of type 2 diabetes

	Fasting glucose (mg/dl)	*2 hours post-glucose load (mg/dl)*
Diabetes mellitus	≥126 or	≥200
Impaired glucose tolerance	<126 and	>140 to <200
Impaired fasting glucose	≥110 to <126	

*WHO Definition 1999.

Pre-diabetic

Fasting Plasma Glucose: > 100 mg/dl and ≤ 126 mg/dl HbAIC > 5.6 % and ≤ 6.4 %

Life style change interventions in pre-diabetics are essential to prevent development of diabetes

These "cut-off" levels help in making decisions to manage diabetes and also help in determining the disease burden and prevalence level of diabetes in population.

Capillary blood glucose value is also sufficient. Where capillary blood glucose measured by glucometer is used in the fed state (i.e. post-food/post-glucose/post-meal), the >200 mg/dl cut off may be revised to >220 mg/dl.

Criteria for the Diagnosis of Diabetes Mellitus

1. Symptoms of diabetes plus casual plasma glucose concentration ≥200 mg/dl (11.1 mmol/L). Casual is defined as any time of day without regard to time since last meal. The classic symptoms of diabetes include polyuria, polydipsia, and unexplained weight loss. OR
2. Fasting plasma glucose (FPG) ≥126 mg/dl (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 hours. OR
3. Two hours post-load glucose ≥200 mg/dl (11.1 mmol/L) during an OGTT. The test should be performed as described by WHO, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.

In the absence of unequivocal hyperglycaemia, these criteria should be confirmed by repeat testing on a different day. The third measure-oral glucose tolerance test (OGTT) is not recommended for routine clinical use.

Glycosylated haemoglobin (HbA1C): It measures blood sugar control in diabetics. Level should be less than 7%.

Types of Diabetes

Type 1 (Due to autoimmune destruction of beta cells)

Formerly known as insulin-dependent diabetes mellitus (IDDM). Proportion of IDDM is less than 15% mostly in children and below 30 years, i.e. in younger persons.

Type 2

Formerly known as non-insulin-dependent diabetes (NIDDM). Proportion of NIDDM is over 85% mostly above 40 years of age.

This is the predominant type of diabetes in India. This classification has significance because etiology and management of these 2 types of diabetes are different. In type 1, the definite risk factors are obscure while in type 2, the environmental risk factors are known and therefore these can be minimized or reduced to control the prevalence and incidence of diabetes. Most preventive programmes are against type 2 diabetes.

Type 2 is much more prevalent as compared to type 1. Prevalence and incidence of type 2 has risen all the world over.

Gestational diabetes mellitus (GDM): It is defined as diabetes first recognized during pregnancy. The degree and severity of hyperglycaemia in this form of diabetes vary considerably. Following delivery, some women revert to normal glucose tolerance. About 10–25% of pregnant women have GDM. (GTT more than 140 mg/dL). All pregnant women are screened for GDM.

Impaired glucose tolerance test (IGT) and impaired fasting glucose (IFG): Fasting plasma glucose (FPG) 110–125 mg is called impaired fasting glucose (IFG) and 2 hours post-load glucose 140–199 mg/dl is called Impaired glucose tolerance (IGT). IFG and IGT are associated with the **metabolic syndrome**.

Malnutrition-related diabetes: This develops in young persons who were low birth weight babies and infants who were malnourished, and when they grow as adults they develop insulin resistant diabetes. Such adults are below 30 years with body mass index less than 18.5. Such adults are prone to develop metabolic disorders.

Prevalence

World over the prevalence of adult diabetes was around 4.7% in the year 1980 and has risen to 8.5% in 2014.

In India, prevalence was estimated to be 4.0% in 2000 and this has risen to 7.8% in 2014 in adults, indicating that diabetes was a major public health problem and epidemic of non-communicable diseases (Table 8.43). According to NFHS-5 (2019–2021) 13.5% women and 15.6% of men age 15 years and above were diabetic in India.

Overall prevalence of pre-diabetes in India is 10.3%. One in ten school-age children and adolescents were pre-diabetic with fasting plasma glucose >100 mg/dl and ≤126 mg/dl.

Table 8.43: Estimated prevalence of diabetes in adults (18 + years) in WHO regions[1, 2]

WHO regions	*Prevalence (%)*			
	1980	*1990*	*2014*	*2019–21*
African region	3.1		7.1	
Region of the Americas	5.0		8.3	
Eastern Mediterranean region	5.9		13.7	
European region	5.3		7.3	
South East Asian region	4.1		8.6	
Western Pacific region	4.4		8.4	
India	**4.1**	**5.5**	**7.8**	**13.5 to 15.6**
World	4.7		8.5	

Global Burden

Globally, an estimated 422 million adults were living with diabetes in 2014, compared to 108 million in 1980.[1] The global prevalence (age-standardized) of diabetes has nearly doubled since 1980, rising from 4.7 to 8.5% in the adult population. This reflects an increase in associated risk factors such as being overweight or obese. Over the past decade, diabetes prevalence has risen faster in low- and middle-income countries than in high-income countries.

With the current rates of prevalence, it is projected that India along with China and US will be "top three" countries to have most diabetics in terms of numbers. Thus, most of the burden will fall on developing countries and India would be home to 123.5 million cases of diabetes (Table 8.44).[3,4] Currently 77 million Indians are living with diabetes (year 2020) with prevalence level of 13.5 to 15.6%.

The number of people with diabetes is mounting due to rapid population growth, ageing, urbanization and increasing prevalence of obesity and physical inactivity.

Table 8.44: Top ten countries for number of adults (20–79 years) with diabetes (2015–2040)

Country	*Number of people with diabetes (million)*	
	2015	*2040*
China	109.6	150.7
India	65–69.2	123.5
USA	29.3	35.1
Brazil	14.3	23.3
Russian Federation	12.1	12.4
Mexico	11.5	20.6
Indonesia	10.0	16.2
Egypt	7.8	15.1
Japan	7.2	–
Bangladesh	17.1	13.6

Source: IDF Diabetes Atlas, 7th edition, 2015 and ICMR 2016

Deaths due to Diabetes

In India, 63% of all deaths were due to non-communicable diseases. During the base year of 1998 mortality due to Diabetes was to the extent of 0.2% which has now risen ten folds (2%) in the year 2014. Globally diabetes caused over 4 million deaths in 2019.

Risk factors

1 Physical inactivity
2 Overweight (BMI >23 kg/m^2), and obesity
3 Family history of diabetes
4 High blood glucose, impaired fasting glucose, impaired glucose tolerance.
5 High cholesterol
6 High triglycerides.

People have adopted sedentary life and have become inactive and have put on weight on account of excessive consumption of food. For hours, people watch TV, are busy with computers and use vehicles and contact people on telephones and mobile phones and thereby they have become inactive. Physical inactivity has added a new dimension of iatrogenic problem or self-created problem of obesity and diabetes. Rapid urbanization and reduced playground space and excessive load of books and reading have reduced physical activities of children.

Age

The prevalence increases as the age advances. The type I diabetes which is more severe diabetes occurs mostly in younger people while type II diabetes prevalence is much more in middle and old age group. As the life expectancy is increasing, the people above the age group 60 and 65 will have to bear the brunt of diabetes. Data on diabetes in younger age group below 20 and above 65 is limited. In developing countries, the majority of people with diabetes are in 45–64 years age range while in developed countries most people have diabetes above the age of 64.

Sex

The prevalence of diabetes is higher in men than women.

Rural and Urban Distribution

For most developing countries in rural areas, the prevalence is assumed to be one-half that of urban areas. Urbanization leads to increased risk of diabetes because of altered diet, obesity and physical inactivity and other factors such as stress. In India, the prevalence of diabetes in rural area was 4.3% against 11.2% of urban areas in the year 2017.

Economic Status

Diabetes is more prevalent in higher income brackets, because of unhealthy lifestyles and physical inactivity leading to problem of overweight and obesity.

Example: Punjab has highest prevalence level at 10% against 4.3% in Bihar

Family History of Diabetes

It is a strong risk factor and indicates genetic predisposition. Person who has family history of diabetes needs to observe precaution and undergo regular check-ups.

Nutritional Status

Low birth weight babies and severely and moderately malnourished children, when they grow-up as adults suffer from *metabolic disorders* including insulin resistant diabetes. These persons when they develop diabetes have BMI less than 18.5 and require large doses of insulin for glycaemic control. In Indian context, this is quite significant in view of widespread childhood malnutrition.

Prevention of Diabetes

Over 80% of type 2 diabetes is preventable.

Primordial prevention: It consists of prevention of emergence and establishment of risk factors (physical inactivity, overweight and obesity). Initiate actions to prevent people becoming overweight and obese beginning **before birth** and in **early childhood**. Promote universal breastfeeding and consumption of healthy foods and discourage the consumption of unhealthy foods such as sugary sodas and promote physical activity.

Primary Prevention: Population-based Approach

Adoption of healthy lifestyles (dietary modification and physical activity) are the corner stones of both primordial and primary prevention of diabetes. These are beneficial for the total population, hence the focus should be on total population. Healthy lifestyles are not only beneficial for diabetes alone but are generally good for prevention of other non-communicable diseases like obesity, coronary heart disease, strokes, hypertension and some cancers. Hence, integrated preventive programmes for non-communicable diseases are called for because most of the risk factors are common.

Prevention of Type I Diabetes

It occurs much less frequently and it results from autoimmune destruction of the β cells of the pancreas. Though the environmental and genetic factors appear to be involved, but there is no convincing evidence of role for lifestyle factors which can be modified to reduce the risk. The primordial and primary prevention for type I diabetes, is not practical for want of evidence.

Prevention of Type II Diabetes

Type II diabetes results from an interaction between genetic and environmental factors, however, the environmental factors play a major role and are the main risk factors. Overweight and obesity are associated with an increased risk of type II diabetes and the evidence is convincing. Increased BMI and increased waist–hip ratio and obesity are important determinant of insulin resistance which is the underlying abnormality in most cases of type II diabetes.

Overweight and Obesity

Voluntary weight reduction improves insulin sensitivity maintaining optimum BMI, i.e. striving for BMI at the lower end of normal range. For adult population, this means keeping BMI in the range of 21–23 kg/m^2 and maintaining waist hip ratio of less than 0.9 is good for health. It is more important for Indians because abdominal/central obesity is predominant obesity in India and they are more susceptible to develop insulin resistant diabetes and **syndrome X** (insulin resistance syndrome). **Syndrome X** consists of abdominal obesity, insulin resistance, hypertriglyceridaemia, hyperinsulinaemia and hypertension.

Syndrome X and insulin resistance syndrome have been renamed by WHO in 1998 as "Metabolic syndrome". The modified adult treatment panel (ATP) III and third report of National Cholesterol Education Programme criteria works better for the diagnosis of metabolic syndrome in Indians.

Physical Activity

Increased physical activity which has a major beneficial effect on insulin sensitivity independent of its effect on weight. Moderate level of physical activity of half an hour brisk walking, cycling or jogging or running, jumping, dancing or intense physical activity depending upon one's physical capacity is good for maintaining appropriate weight and helps reduction of weight. Physical activity should be done on regular basis and on most days per week. Physical activity means you move for your health. Moderate to intense physical exercise enhances insulin sensitivity.

Voluntary weight loss in overweight and obese people decreases the risk of diabetes because of improved insulin sensitivity.

Diets

High-saturated fat intake and excess of refined carbohydrates has been associated with a higher risk of impaired glucose tolerance, higher fasting glucose, insulin levels, and risk of type II diabetes. Consumption of unsaturated fatty acids and polyunsaturated fatty acids from vegetable sources are associated with reduced risk of type II diabetes. MUFA and PUFA increase the insulin sensitivity and improve glucose tolerance. Total visible fat intake should not exceed 20–40 g per day and not more than 20–30% of total calories or energy be derived from fats, lesser the better.

Dietary Fibre (DF)

Dietary fibre (DF) or complex carbohydrates have beneficial effect on weight reduction. Adequate intake of dietary fibre prevents obesity. Achieving adequate intakes of DF by regular consumption of whole grain cereals, legumes, pulses, fruits and vegetables (particularly green leafy vegetables) are most probably helpful in prevention of development of type II diabetes. Indian diets which are predominantly cereal-based provide adequate quantities of dietary fibre. We need to promote intakes of green leafy vegetables, fruits and pulses by adopting healthy dietary and agriculture policies to be saved from type II diabetes. Recommended intake of DF is 20–35 g per day.

Fenugreek seeds (Methi seeds) which have high level of insoluble dietary fibre (28%) and soluble dietary fibre (20%) is very effective in reducing blood glucose and cholesterol levels.

Secondary Prevention

This involves early diagnosis and prompt treatment of type II diabetes, to prolong life or to live full life. Make essential medicines such as **human insulin** made available and affordable to all who need them.

The primary purpose of secondary prevention is early detection or identification of individuals without symptoms who either already have a disease or are clearly at high-risk of developing it, through screening programme.

Screening programme have two approaches: Population-based screening programme for type II diabetes remains controversial, it involves high cost and is not feasible for whole population. However, it is done for epidemiological research purposes to determine prevalence and trends of diabetes for the purpose of planning and measuring the impact. Population-based screening is not recommended to screen children and young adults for NIDDM (non-insulin-dependant diabetes mellitus).

Selective screening: This is feasible and undertaken for high-risk individuals. The possible high-risk groups are:

- Persons above the age of 30 years at the point of primary contact with health facility.
- Those with a strong family history of diabetes.
- Migrant Asians and Indians, other ethnic groups who show high prevalence and those changing traditional to westernized lifestyles.
- Obese and overweight persons and women with history of gestational diabetes mellitus (GDM) or high birth weight babies.
- Those with other elements of chronic metabolic syndrome, e.g. hypertension, obesity, dyslipoproteinaemia.

Opportunistic screening: This is most practical way, when high-risk people present themselves to healthcare facility, they are screened for diabetes and hypertension. This is highly cost-effective and no extra resources are used to organize the screening programme.

Screening of TB in diabetes and diabetes in TB has been initiated in 2015 for integrated management of diabetes, TB and HIV/AIDS.

Screening strategies include testing of casual blood glucose, measurement of blood pressure, BMI, physical activity, tobacco and alcohol use.

Diabetes increases the risk of tuberculosis by 3 folds and is estimated to be responsible for 10% of cases of TB in India.

Screening for diabetes and hypertension as on December, 2020–2021 more than 46 million adults persons have been screened for diabetes and hypertension. 8.05% were found suspected to be diabetic and 9.47% found to be hypertensive.

Tertiary Prevention

When the diabetes is established; all attempts should be made to keep it under control. Aim here is to prevent complications such as blindness, kidney failure, foot ulceration which may lead to gangrene and subsequent amputation, increased risk of infection, coronary heart disease and stroke. Education of individual to observe practice of personal hygiene to prevent infection and trauma and seek early treatment of infection and trauma. Life can be prolonged and full life despite diabetes is possible. Life-threatening complications can be avoided by effective treatment. Diet regulation, physical exercise and regular drugs including cheaper human insulin ensure effective control of diabetes.

Main lifestyle changes that reduce insulin resistance and prevent NIDDM:

- Increased physical activity
- Voluntary weight reduction
- Correction and prevention of obesity
- Limit fat intake and saturated fats
- Increase PUFA and MUFA in diet
- Encourage dietary fibre.

National Diabetes Control Programme was launched as Pilot Programme in the 7th Five-Year Plan. The project was initiated in two districts in Tamil Nadu and one district in Jammu and Kashmir.

Now the national programme for prevention and control of cancer, diabetes, CVD and strokes has been launched in India. Population-based screening programme has been launched for adults above the age of 30 years.

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HYPERTENSION (A SILENT KILLER)

"High blood pressure" was chosen as Theme of World Health Day, 7th April 2013. Hypertension is a "silent killer". Hypertension is a complex public health problem. The higher the blood pressure in the community, the higher is the prevalence of **cardiovascular diseases, strokes** and renal **diseases**. Hypertension constitutes an important risk factor for ischaemic heart disease or coronary heart disease, stroke, eye and renal complications.

EPIDEMIOLOGY OF HYPERTENSION

Rules of Halves in Hypertension

Majority of the persons suffering from hypertension are unaware of the disease. In accordance with the "rules of Halves", 50% of persons do not know about their higher blood pressure; only 50% of cases who are aware of the disease are on medication. These patients who are being treated, 50% are on proper antihypertensive therapy with their BP regularly monitored. It is, therefore, estimated that BP of only 10–12% hypertensive is controlled with appropriate treatment. There are on estimated 200 million adults with hypertension in India, but less than 10% of them have their blood pressure under control (IHCI–2022). Cardiology Society of India reports 33% of adults tested had high blood pressure, over 60% had no clue of having high BP, while 42% had controlled BP. In developed and developing countries with low mortality, higher blood pressure is the second most important risk factor in terms of DALYs losses. Over 11% of DALYs lost in developed countries are attributable to high blood pressure.[1] In India 8.5% of DALYs are lost due to high blood pressure.

In developed countries of North America, Europe and Asian Pacific at least one-third of disease burden is attributable to **tobacco, alcohol, blood pressure, cholesterol** and **obesity**.

Suboptimal blood pressure causes 7.1 million of deaths annually worldwide.[1]

Rural/urban distribution: Hypertension is a risk factor for **coronary heart disease** and **stroke** and is three times more prevalent in urban areas as compared to rural, this may be because of different lifestyles in two populations.[2] But hypertension level of >140/90 is almost equal in two populations indicating low prevalence of risk factors in majority population of rural areas. Epidemiological survey by Chadha et al indicated prevalence rate of 12.75% in adult population (25–64 years) of urban area in Delhi in the year 1989–1992.

PREVALENCE IN INDIA—NFHS-5

Results of several community-based studies in India indicate prevalence of hypertension in 25% of urban and 10% of rural population. NFHS-5 data reported rising trend of hypertension prevalence of 24% in men and 21.3% in women in adults age 15 years and above. ICMR-NCDIR study carried out in 2021, indicates that 28.0% of adults in India were hypertensive and 72 % were unaware of their status of high BP. Prevalence was higher in urban areas (34%) than in rural areas (25.7%). Treatment adherence was low at 59.2% in Rural areas (2019–21).

What Constitutes Hypertension

The distribution of blood pressure values differ considerably among various populations. For example, the 90th percentile of systolic blood pressure varies between 146 and 176 mmHg resulting in wide differences in the proportion of people having "hypertension" in various parts of world. The worldwide projects like MONICA, INTERSALT and INTERHEALTH and India hypertension Control Initiative (IHCI) have contributed on the subject of hypertension substantially. The question is—What is most appropriate level at which the treatment should begin? This "cut-off" level determines the burden of hypertension in the community. Level of >140/90 has been chosen as "cut-off" point for classifying person into hypertensive and normal. Classification of blood pressure into various categories such as normal, prehypertension, stage 1 and stage 2 hypertension is depicted in Table 8.45.[3,4]

Table 8.45: Classification and management of blood pressure for adults[4]

BP classification	*SBP mmHg*		*DBP mmHg*	*Lifestyle modification*
Normal	<120	and	<80	Encourage
Prehypertension	120–139	or	80–89	Yes
High blood pressure				
Stage 1 hypertension	140–159	or	90–99	Yes
Stage 2 hypertension	≥160	or	≥100	Yes

DBP: Diastolic blood pressure; SBP: Systolic blood pressure
Source: Joint National Committee on Cardiovascular Diseases, 2003 (JNC VII) and JNC VIII.

CLASSIFICATION[3,4]

The classification of blood pressure in adults (18 years and older) is based on the average of two or more properly measured blood pressure readings from two or more clinical visits (Table 8.43). If the systolic blood pressure and diastolic blood pressure values fall into different categories, the overall classification is determined based on the higher of the two blood pressures. Blood pressure is classified into one of four categories: Normal, prehypertension, stage 1 HTN and stage 2 HTN. Prehypertension is not considered a disease, but identifies those who are likely to progress to stage 1 or stage 2 HTN in the future.

Blood pressure goals	
Population	*Blood pressure goal (systolic/diastolic)*
<60 years old	<140/90 mmHg
>60 years old	<150/90 mmHg
Chronic kidney disease (CKD)	<140/90 mmHg
Diabetes	<140/90 mmHg

The risk of blood pressure with adverse outcomes of disease operate on "continuum" rising progressively over a range of systolic (upper) and diastolic (lower) blood pressure. It is desirable that the resting blood pressure in adults should not exceed 120 mmHg systolic and 80 mmHg diastolic since the risk of complications associated with blood pressure are minimal at such levels. However, the range up to 140 mmHg systolic and 90 mmHg diastolic is considered within normal range and does not qualify for the label of "hypertension" but are classified as "prehypertensives". In this intermediate range (120–139 mmHg systolic and 80–89 mmHg diastolic), it is advisable that persons should attempt to lower the pressure to desired level or at least avoid its rise into hypertensive range through lifestyle measures like regular physical exercise, reduced salt intake, avoidance of obesity, daily intake of adequate amount of fresh fruits and vegetables rich in potassium and management of stress through individual, family and community mechanisms.

Interventional levels: Blood pressure in the range starting with 140 mmHg systolic or 90 mmHg diastolic is at higher risk of blood pressure related complications and needs effective intervention to lower blood pressure. Such interventions necessarily include all of the lifestyle measures listed above and may also require drug therapy.

Goal: The goal of therapy is to lower the blood pressure to values lower than 140/90 mmHg and then attempt progressively to bring it closer to desirable level, if such reductions are well tolerated. Much depends on initial blood pressure.

Diagnosing Hypertension

WHO recommends use of affordable and reliable electronic devices. Blood pressure measurement needs to be recorded for several days before diagnosis of hypertension is made. BP is recorded twice daily, ideally in the morning and evening. Two consecutive readings are undertaken, at least a minute apart and with the person seated. Average value of all measurements is taken to confirm hypertension.

Stages

Desirable level → high initial blood pressure → border line hypertension → hypertension.

High initial blood pressure is the strongest, but still a weak predictor of future hypertension. Predictive value increases if more readings are taken.

Risk Factors for Hypertension

Environmental (Behavioural Risk Factors)

I. Over-weight and Obesity

Unhealthy diet and obesity is risk factor for hypertension thus putting on excess weight during childhood, adolescence and youth period is undesirable. Weight control should result in decreased prevalence of hypertension, i.e. favourable weight control in a population can reduce the prevalence of hypertension by as much as 25%.

II. Consumption of too much Salt and Fat

Excessive salt intake particularly in those who have family history of hypertension can be in injurious. Communities where salt consumption is low have low blood pressure but other dietary factors are important such as excess of saturated fats and excess of energy or calories and low consumption of fruits and vegetables. Reduction of salt intake helps in control of hypertension.

Sodium intake, potassium intake and other dietary factors may have important influences on blood pressure regulation in individuals with different backgrounds. The decrease of sodium intake and/or an increase in potassium are potentially important primary prevention measures. It is desirable that diets of young children and adults limit the salt consumption of 5 g per day. It is advantageous in population where the prevalence of hypertension is high and salt intakes are also high. NIN (ICMR) recommends 6 g of salt intake per day per person.

III. Physical Inactivity or Lack of Exercise

Physical inactivity and lack of exercise leads to metabolic disturbance—obesity, raised blood lipids, impaired glucose tolerance and higher fasting insulin levels compared with normal is seen in hypertensive patients. Physical activity reduces the level of obesity and improves sensitivity towards insulin and prevents increased blood pressure.

IV. Alcohol and Tobacco

Use of **alcohol** and use of **tobacco** is injurious and a potential risk factors in hypertension and cancer. The WHO has warned, there is no "safe limit" to alcohol consumption.

V. Psychological and Social Influences (Stress)

Acute stress situation like anxiety and worry elevates blood pressure through increased central sympathetic outflow. Sustained stress may have deleterious effects on blood pressure. Modifications of psychological influences may be an important approach in primary prevention of

hypertension. Reduction of stress and modification of individual response to stress may be useful in primary prevention. Stress management is an important area in modern world to reduce its impact on untoward outcomes.

VI. Social Factors/Determinants

The role of social factors/determinants such as globalization of unhealthy lifestyles, urbanization, economic conditions, social status, rural and urban distribution needs to be evaluated carefully in conjunction with levels of obesity, alcohol consumption, sodium and potassium intake, psychological stresses and various kinds of other lifestyles and habits. Some other factors have been implicated for hypertension such as **noise** pollution, **air pollution** and water quality. Noise pollution and air pollution may have a bearing on the primary prevention of essential hypertension.

Other Factors

Age

Average blood pressure increases with age and in many individuals it may rise little after adolescence, but in others it may increase progressively as the age advances.

Genetic Factors (Family History)

Blood pressure levels are determined partly by genetic factors, but environmental factors play a major role. The detailed mode and mechanism of heredity in hypertension has not yet been conclusively analyzed. It is possible to identify and modify the environmental factors, causing progressive risk of blood pressure, to prevent "essential hypertension".

PREVENTION OF HYPERTENSION

Primary Prevention

Primary prevention of hypertension means to reduce the incidence of essential hypertension in the population by reducing the risk of onset. Primary prevention of **essential hypertension** has two approaches:

1 ***Population-based approach:*** *Reducing salt and trans fats contents of manufactured foods:* Reduction in mean population blood pressure values has been achieved in the USA by reducing the salt content of manufactured food. Manufacturers have to mention the salt content of food item under law. Following NIN recommendation, the Food Safety and Standards Authority of India (FSSAI) has asked the packaged food manufacturers to use less salt in their products and display sodium level on their packaging. Dietary intake of sodium from all sources influences blood pressure level in population and should be limited so as to reduce the coronary artery disease and strokes both. Salt intake should be restricted to less than 5 g per day; it is beneficial in reducing blood pressure.

Reduction in mean population blood pressure values averts millions of deaths in population. This can be achieved by policies on **salt restriction** in food and diets, promoting **physical activity**, reduction of obesity and cholesterol level and cessation of **smoking** and **tobacco** use and avoiding **use** of alcohol.

Information and education: Community education on salt intakes, diet control, healthy diets through multimedia channels and interpersonal communications can build a favourable environment and raise the level of awareness on the subject of hypertension in the population beginning at home, schools, colleges and workplace wellness programmes.

Physical Activity

The promotion of physical activity is a public health priority especially in the context of nutritional abundance and to counter the pandemic of obesity, serious consideration should be given to the environmental determinant of obesity and physical inactivity. Regulating the diets of *infants*, *young children* and *adolescents,* and promoting physical activity helps prevention of obesity and thereby hypertension along with other lifestyle diseases. WHO recommends physical activity for at least 30 minutes a day—five times a week or 150 minutes per week at least.

Healthy Diets

Promote healthy lifestyles and healthy diets. Reduce saturated and *trans* fats intake. Adequate dietary intake of potassium lowers blood pressure and is protective against stroke and cardiac arrhythmias. Potassium intake should be at a level which will keep the sodium to potassium ratio close to 1:1, i.e. daily potassium intake level of 50 mmol per day. This may be achieved through adequate consumption of fruits and vegetables.

Dietary fibre: Fibre is protective against coronary heart disease and has also been used to lower blood pressure. Adequate intake of 25–35 g per day may be achieved through fruits, vegetables and whole grain cereals as also pulses.

Tobacco

Stopping tobacco use and exposure to tobacco products by education and legislation.

Stress and Sleep

Management of stress through individual, family and community mechanism by yoga and meditation. It eases tension and helps in maintaining normal blood pressure. Adequate sleep of 8 hours helps reduce blood pressure.

2 ***High-risk approach:*** The relations between high blood pressure and disease events such as cardiovascular

disease is continuous and most events occur in people in the middle range of high blood pressure, who are not normally judged as hypertensive. Hypertensives who are considered to be high-risk are only part of risk continuum, rather than a distinct group. Preventive strategy focusing on the high-risk individuals will deal with only margin of the problem. This approach does not alter the underlying cause of hypertension. People with slightly raised blood pressure suffer more from cardiovascular events than hypertensive minority. While high-risk approach is more appropriate to individuals and their physicians but it has little impact at population level. High-risk approach requires continued and expensive screening for few high-risk individuals.

Secondary Prevention

It aims at reduction of prevalence of essential hypertension in the community. Early diagnosis and prompt treatment necessitates opportunistic screening programmes, i.e. measuring blood pressures of adult population (30 years and above) who come in contact with health facility. Now all NCD clinics screen all adults for hypertension and diabetes.

Prompt and continued treatment with modification of lifestyle will keep the blood pressure to desired level and will prevent the complications of hypertension. Opportunistic screening programme can be encouraged through self-examination of blood pressure. Training to record correct blood pressure is essential—heath workers have not been trained and they lack this skill. The instruments for measuring blood pressure have not been standardized/calibrated and available instruments are in bad shape. New component of control of non-communicable diseases has been added in the job description of health workers at Health and Wellness Centres.

Tertiary Prevention—Limiting Disability and Rehabilitation

It means to limit the disability in persons who have developed complications due to hypertension, by treating the complications (coronary heart disease, retinal hemorrhages, cerebral haemorrhages/strokes) and sequelae of hypertension. Family-based rehabilitation is advisable.

National Programme

Population based screening for diabetes, hypertension and three common cancers is being done amongst men and women aged 30 years and above at subcentres (health and wellness centres) as part of Comprehensive Primary Healthcare. For hypertension and diabetes screening is conducted once a year and for cancers once in five years. People who have already been diagnosed as hypertensive or diabetics their BP and blood glucose is measured on a monthly basis at the village level.

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RHEUMATIC HEART DISEASE (RHD)

EPIDEMIOLOGY OF RHD

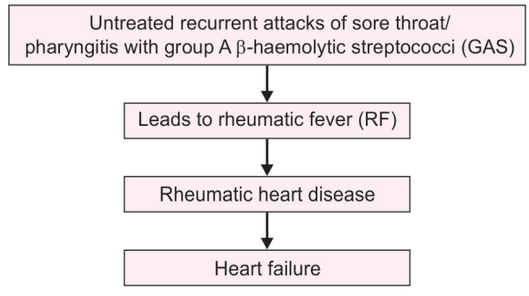
RHD comprises a group of cardiac complications, in which there is permanent progressive heart valve damage because of recurrent attacks of rheumatic fever. RHD is a chronic disabling heart disease, which may require frequent hospitalization and cause physical disabilities, growth retardation and premature deaths.

BURDEN OF RHD IN INDIA

In India, prevalence of RHD is estimated around 0.9 cases per 1000 children in the age group 5–14 years, translating to 2.18 lakh cases of RHD in the country (on the basis of 20% of population of 5–14 years in the country).

Natural History of Rheumatic Heart Disease

RHD is a non-communicable disease yet the etiology of RHD is infectious in origin.



Rheumatic fever is an inflammatory connective tissue disorder caused by untreated throat infection with **group A β-haemolytic streptococci** (GAS). The bacteria have

affinity with heart valves and heart muscles, joints and skin. Therefore untreated and recurrent episodes of GAS infection may lead to rheumatic fever, which may ultimately result in RHD.

Agent: Group A β-haemolytic streptococci which cause throat infections, can easily spread from one child to another through close contact or air, in overcrowded houses with **poor ventilation**. GAS infection causes inflammation of heart (carditis) and untreated and repeated infections cause permanent scarring/damage of heart valves.

Host: Commonest age group involved is 5–15 years children.

Environment: Poor living conditions such as over-crowded slums, poor ventilation and unhygienic conditions, poverty, malnutrition and inadequate access to medical care.

Bacterial Sore Throat

What is Bacterial Sore Throat?

Sore throat is usually caused by viruses or bacteria. Bacterial sore throat in children and young adults may be caused by group A β-haemolytic streptococcus (GAS).

Bacterial sore throat is typically associated with fever, painful cervical lymph nodes enlargement and absence of cold/running nose or cough. Bacterial sore throat spreads from person to person through air droplets overcrowding, poor ventilation in poor housing conditions contribute to easy spread.

Significance of Sore Throat in RF and RHD

About 30% of the sore throats in children 5–15 years of age are caused by group A β-haemolytic streptococcus infection and about 0.3–3% of untreated GAS infection results in **rheumatic fever** and around 50–90% of those with RF eventually develop cardiac complications like heart valve damage, cardiac failure, etc. (RHD)[1] (Fig. 8.14).

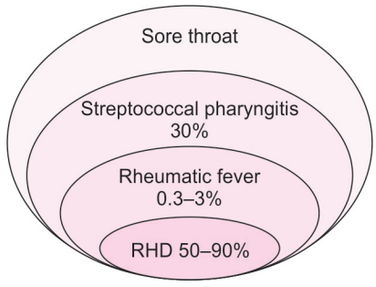


Fig. 8.14: Burden of RF/RHD

How is Streptococcal Sore Throat Distinguished from other Causes of Sore Throat?

Sore throat is caused by variety of bacteria and viruses. Common features of GAS sore throat are: High fever (≥38°C), tender anterior cervical lymph nodes, redness of pharynx, pus-like exudates on pharynx and throat, bleeding points on throat, and pain while swallowing. Signs of common cold, conjunctivitis, running nose and hoarseness of voice are not suggestive of bacterial sore throat. Throat swab culture can confirm GAS infection along with other tests.

Prevention of Rheumatic Fever and Rheumatic Heart Disease

Primordial Prevention

Minimize the exposure to GAS infection in community by:

- Raising the level of awareness by health education on GAS infection by health workers in community, in school health programme, immunization sessions, village health and sanitation committee meetings, and outreach session and *Mahila Mandal* meetings.
- Improving **housing conditions**, overcrowding by slum clearance and improved ventilation, poverty reduction and improving nutritional status of young children.

Primary Prevention—Detection of Streptococcal Pharyngitis and its Management

- Identification of GAS infection among children in age group 5–15 by health teams followed by adequate treatment with appropriate antibiotics.
- Prevention of recurrence of GAS infection.

What is the Management of Bacterial Sore Throat?

All bacterial sore throats should be treated appropriately with antibiotics. The drug of choice is penicillin. If there is sensitivity to penicillin, then other alternative drugs may be given.

The dosage and duration of treatment with penicillin or other alternate drugs are mentioned in Table 8.46.

Which Drug should not be Given to Treat Bacterial Sore Throat?

Tetracycline, sulfonamide and chloramphenicol should not be used to treat GAS pharyngitis because of widespread prevalence of drug resistance.

How to Prevent Bacterial Sore Throat among Children (Fig. 8.15)

The bacteria causing sore throat are highly contagious and can spread from one child to another by the following:



Fig. 8.15: Child suffering from sore throat should reduce exposure to other children

Table 8.46: Dosage and duration of bacterial sore throat management

Drug	*Dose*	*Frequency and duration*
Penicillin V (phenoxymethyl penicillin) (oral)	Children: 250 mg	Three times daily, for 10 days
To be given one hour before or two hours after meals, contraindicated if penicillin allergy present	Adults: 500 mg	Two times daily, for 10 days
Benzathine penicillin G (deep IM injection)	For those >27 kg: 12 lakh units	Single dose
To be given after skin sensitivity test. Contraindicated if penicillin allergy present	For those ≤27 kg: 6 lakh units	Single dose
Amoxicillin (oral)	Children: 25 mg/kg/dose	Two times daily, for 10 days
Contraindicated if penicillin allergy present	Adults: 500 mg	Two times daily, for 10 days
Cefadroxyl (oral)	Children: 15 mg/kg/dose	Two times daily, for 10 days
	Adults: 500 mg	Two times daily, for 10 days
Cephalexin (oral)	Children: 10–15 mg/kg/dose	Three times daily, for 10 days
Erythromycin ethyl succinate (oral)	Adults: 500 mg	Two times daily, for 10 days
	Children: 20 mg/kg/dose (maximum dose: 800 mg)	Two times daily, for 10 days
	Adults: 800 mg	Two times daily, for 10 days

- Coughing and sneezing
- Not washing hands (poor hand hygiene).
- Sharing food and drinks

Proper cough hygiene and oral hygiene are important to prevent spread of infection for this, the following habits are to be adopted:

- Wash hand frequently
- Keep teeth clean, brush twice daily
- Cover mouth while coughing and sneezing.

Rheumatic Fever (RF)

What is Rheumatic Fever?

RF is multisystem disease. It occurs following sore throat caused by GAS. About 1–5 weeks after GAS infection in throat child may develop painful or swollen joints (knee, elbows, ankles and wrists) with or without fever. The risk of RF following untreated GAS sore throat is less than 3%. However, if RF progresses to RHD then the damage to heart is irreversible.

How to Diagnose Rheumatic Fever?

In rheumatic fever, a child typically complains of fever accompanied by pain and swelling in more than one joint (particularly the large joints). Pain may shift from one joint to another. In addition, some patients may present with involuntary movements of the limbs called 'chorea'.

Diagnosis of Rheumatic Fever is Based on Revised Jones Criteria 2015[2]

Major criteria

- Carditis (clinical and/or subclinical)
- Monoarthritis or migratory polyarthritis
- Polyarthralgia (only after excluding other causes)
- Chorea (jerky movements)
- Erythema marginatum (skin rash)
- Subcutaneous nodules

Minor criteria

- Monoarthralgia
- Fever (≥38°C)
- ESR ≥30 mm/h and or CRP ≥3.0 mg/dL
- Prolonged PR interval, after accounting for age variability (unless carditis is a major criterion)

Diagnosis of first attack of Rheumatic Fever: 2 major or 1 major plus 2 minor criteria

Diagnosis of recurrent Rheumatic Fever: 2 major or 1 major and 2 minor or 3 minor criteria.

Will the Symptoms of Rheumatic Fever go Away?

Most of the acute symptoms such as painful or swollen joints (knees, elbows, ankles and wrists), skin rash, fever,

and jerky movements usually disappear with time or symptomatic treatment.

However, in cases where the heart also gets involved, the scarring and damage to heart valves becomes permanent, resulting in rheumatic heart disease. The cardiac valvular damage persists even after the other features have disappeared.

Secondary prevention—early diagnosis and management of RF and RHD by regular administration of penicillin injection to a child who is at risk of RF recurrence.

How to Manage Rheumatic Fever and RHD

Once RF is diagnosed, the child should be treated with benzathine penicillin injection (or erythromycin, if sensitive to penicillin). Penicillin injection is given deep intramuscular (thigh or gluteal region), once every three weeks, as per advice of the treating physician. The treatment may be done for a longer duration if there is cardiac involvement (Table 8.47).

This duration of treatment may seem like a long time for parents but healthcare staff has to convince the parents about the importance of the injections in order to avoid recurrence of episodes of rheumatic fever.

Other symptomatic treatment may include:

- Bed rest and anti-inflammatory drugs for arthritis and arthralgia
- Carbamazepine/sodium valproate for severe chorea.

How can Another Attack of Rheumatic Fever be Prevented?

- Treatment with injectable penicillin can reduce the attack of RF following GAS infection by about 80%.
- The best way to stop a child from having another attack of rheumatic fever is to make sure that he/she takes regular penicillin injections in time and till the duration advised by the treating doctor.

What if a Child Misses or Forgets an Injection?

It is very important that a child under treatment does not miss an injection. Medical officer should inform the patient or his/her caretaker about the next visit. Before penicillin injections are given it is mandatory to do penicillin sensitivity test every time. There must be adequate arrangements to manage penicillin reaction by having anaphylactic shock treatment kit.

Rheumatic Heart Disease (RHD)

When heart valve is progressively scarred and damaged over time (mitral valve in 90% of cases) it causes the heart chamber pressure to rise and heart fails to function as pump. The major cause of death and disability form RHD is heart failure. The symptoms of heart failure include breathlessness, tiredness and weakness, increased heart-beat, bilateral pedal oedema and enlargement of liver.

Reliable auscultation is sufficient for **screening of RHD** in most cases, however cases require confirmation by

Table 8.47: Recommended dose of penicillin G (secondary prevention)

Drug	*Dose*	*Frequency of doses*
Benzathine penicillin G (deep IM injection) To be given after skin sensitivity test contraindicated if penicillin allergy present	If body weight >27 kg: 12 lakh units If body weight ≤27 kg; 6 lakh units	Every 21 days Every 14 days
Penicillin V (oral) To be given one hour before or two hours after meals Contraindicated if penicillin allergy present	250 mg	Two times a day
Erythromycin ethyl succinate (oral) Contraindicated in liver disease	250 mg	Two times a day

Duration of secondary prophylaxis	
Categories	*Duration of secondary prophylaxis*
Rheumatic fever with no proven carditis	Minimum of 5 years after last RF episode or Until age 18 years (whichever is longer)
Mild carditis (or healed carditis)	Minimum of 10 years after last RF or Until age 25 years (whichever is longer)
Moderate or severe RHD and following cardiac surgery	Lifelong, or up to 40 years of age

Echocardiography. Other investigations for confirmation are—electrocardiogram, laboratory test: ASO titre, C-reactive protein, (CRP) ESR, and X-ray chest.

The main strategy of long-term management of RHD is to prevent recurrence of rheumatic fever and thus prevent its progression to RHD.

Prevention of RHD in Community

- Health promotion activities in community
- Health eduction activities in schools on prevention of RHD
- Training of school teacher
- Surveillance for case finding by RBSK teams and RKSK
- Diagnostic facilities at district, CHC under National Programme for Prevention and Control of cancer, diabetes, cardiovascular diseases and strokes (NPCDCS)

Tertiary prevention: Disability limitation by valve replacement and vocational rehabilitation.

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Competency addressed: The student should be able to:
CM 8.3: Enumerate and describe disease specific National Health Programs including their prevention and treatment of a case of NCDs.

NATIONAL PROGRAMME FOR PREVENTION AND CONTROL OF CANCER, DIABETES, CARDIOVASCULAR DISEASES AND STROKES (NPCDCS)

GLOBAL BURDEN OF NCDs

A total of 56 million deaths occurred worldwide during 2016; of these 40.5 million (72%) were due to NCDs, principally cardiovascular diseases (CVDs), chronic respiratory diseases, cancers and diabetes. Nearly three quarter of these (28 million) occurred in low middle income countries (LMIC) and one-third were at age 30–69 years. The total % of deaths due to NCDs reported in 2018 by WHO was 62%.

Disease Burden due to NCDs in India

Over the last 26 years (from 1990 to 2016) the country's disease pattern has changed. Disease burden due to most communicable, maternal, neonatal and nutritional problems has declined substantially, at the same time the burden of non-communicable diseases and injuries has increased as people live longer life now, economic status has improved and lifestyles have changed and urbanization and globalization has influenced living pattern. There are wide variations between the states/regions in the range of contribution of major disease groups to the total disease burden in 2016.

- Disease burden due to communicable, maternal, neonatal and nutritional diseases has declined from 61% disability adjusted life years DALYs lost in 1990 to 33% DALYs lost in 2016.
- There was corresponding increase in burden of non-communicable diseases from 30% of DALYs lost in 1990 to 55% in 2016 (Table 8.48).
- Burden due to injuries has increased from 9 to 12%.

Measurement of Disease Burden

Disease burden has been measured in units of DALYs. One DALY equals one lost year of "healthy life" DALYs combine (a) losses from premature deaths, which is defined as the difference between actual age at death and life expectancy at that age in a low mortality population, and (b) loss of healthy life resulting from disability. For disability—number of years of healthy life lost was obtained by multiplying duration of disability by its severity weight. Of the total disease burden 2/3 was due to premature deaths and 1/3 due to disability.

- The NCDs emerged as leading cause of deaths in India in 2016 contributing nearly 62% of total deaths which included: Cardiovascular diseases 28%, followed by chronic respiratory diseases 11%, cancers

Table 8.48: Disease burden in India by major disease groups in terms of percentage of DALYs lost in 1990 and 2016

Major disease groups	*DALYs loss in percentages of total disease burden*	
	Year 1990	*Year 2016*
i. Non-communicable diseases	30.5	55.4
ii. Communicable, maternal, neonatal and nutritional diseases	60.9	32.7
iii. Injuries	8.6	11.9
Total	**100.0**	**100.0**

Source: ICMR, PHFI, IHME, 2017 Health of the Nation States. The India state level disease burden initiative, New Delhi, India.[1]

8.3% and the diabetes and urogenital disorders 6.5% (Fig. 8.16).

- Overall communicable, maternal, neonatal and nutritional diseases contributed 27.5% of all the deaths including—15.5% deaths due to diarrhoea, lower respiratory and other common infectious diseases, followed by tuberculosis HIV/AIDs 5.4%, neonatal disorders 3.8%, neglected tropical diseases and malaria 0.8%, maternal disorders 0.5%, nutritional deficiencies 0.5% and others 0.9%.
- Injuries contributed 10.7% of all the deaths which included transport injuries 2.9%, unintentional injuries 4.9% and suicide and violence 2.8%.

To address the problem of NCDs National Programme for Prevention and Control of cancers, diabetes, cardiovascular diseases and strokes (NPCDCS) has been launched in 2010 after integrating the National Cancer Control Programme with NCDs.

Components of NPCDCS

The Programme has Two Components

1 **Cancer prevention and control**
2 **Prevention and control of diabetes, CVDs and strokes**.

Chronic obstructive pulmonary disease, chronic kidney disease and non alcholic fatty liver disease have been now included in the programme.

Global Target of NCDs

Premature mortality (Sustainable Development Goals of UNs): The premature mortality target is a one third reduction of overall mortality from cardiovascular diseases, cancers, diabetes and chronic respiratory diseases by 2030 between the age 30 and 70 years from base year 2015.

Major Objectives of NPCDCS

i To prevent and control NCDs (reduce morbidity and mortality).
ii To provide early diagnosis and management of NCDs
iii To build capacities at various levels.

Strategies/Interventions to Achieve the Objectives

i Promotion of "healthy lifestyles" by education
ii Specific protection
iii Early detection by population-based screening (PBS) and opportunistic screening
iv NCDs clinics at CHC and district level for management of NCDs and rehabilitation
v Development of trained manpower
vi Strengthening of tertiary level facilities.
vii Surveillance monitoring and evaluation.

Natural History and Major Risk Factors in NCDs

Most NCDs are strongly associated and causally linked with following major **behavioural risk factors** (modifiable risk factors)[2] (Fig. 8.17), hence NCDs are **multifactorial**.

i Tobacco use
ii Physical inactivity
iii Unhealthy diets—excessive consumption of fatty, sugary and salty foods.
iv Use of alcohol
v Household air pollution and outdoor air pollution
vi Stress

Risk factors of NCDs are cumulative and operate on a life course perspective. All the behaviour risk factors are amenable to modification through lifestyle changes. In nutshell today's risk factors are tomorrow's disease. The primordial, primary, secondary and tertiary prevention levels are the time tested approaches. Population based primordial and primary prevention are most valued and sustainable and **best buy's** in the long run, and much more cost effective. **Primordial prevention is real prevention.**

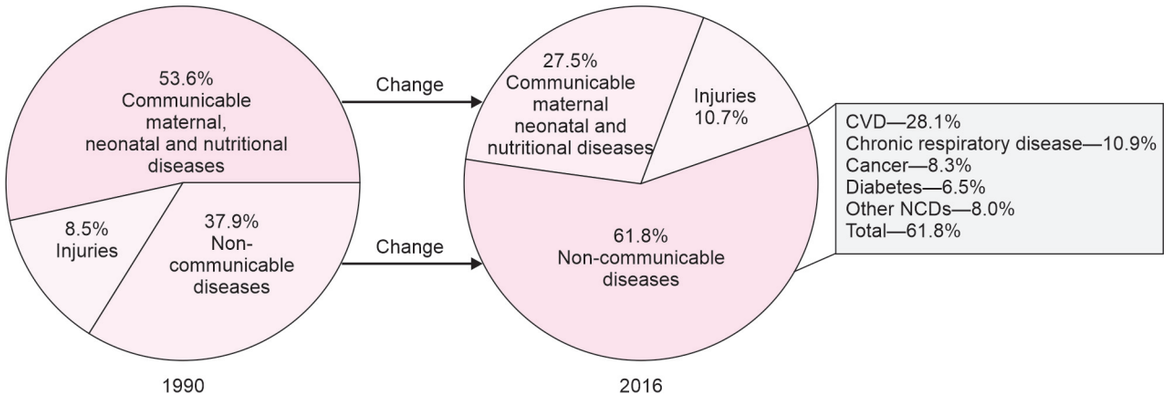


Fig. 8.16: Percent of deaths to total deaths due to major disease groups in India in 1990 and 2016[2]

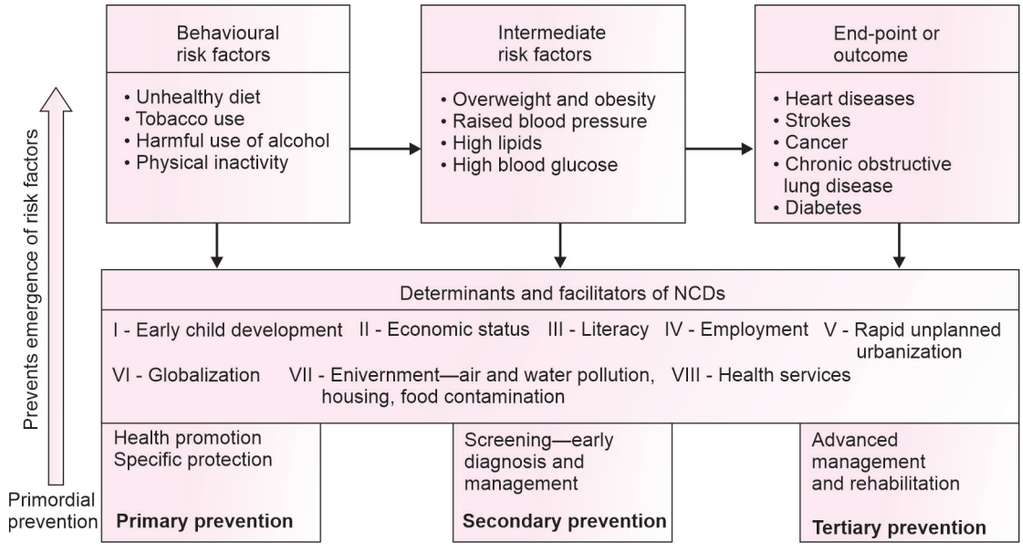


Fig. 8.17: NCDs risk factors, their natural history and levels of prevention

Non-modifiable risk factors are—age, sex, heredity and family history. These are also associated with occurrence of NCDs.

If the above behavioural risk factors are not managed or modified these can lead to **biological risk** factors such as overweight/obesity, high blood pressure, raised blood sugar and raised level of total cholesterol or lipids. Disease outcome as a result of these risk factors are—CVDs, Cancers, COPD, and diabetes (Fig. 8.17).

The process of atherosclerosis starts at an early age. Most of behavioural risk factors begin during **early childhood** period and adolescence and their effects appear in 4th or subsequent decades.

Levels of Prevention of NCDs[3,4]

NCDs are very expensive to treat. Treatment is lifelong, these also usually not curable. Almost all the NCDs require continued care throughout the lifespan of a patient, hence national strategies have to focus on **prevention** and **health promotion** as **key strategy** to reduce disease burden by adopting healthy lifestyles.

PRIMORDIAL PREVENTION IN NCDs

Approximately 80% of heart diseases and strokes, 80% of type 2 DM and 30% of cancers can be prevented by eliminating common risk factors. Primordial prevention is real prevention, which does not allow the people to get NCDs. Primordial prevention in CVDs, diabetes, obesity and hypertension begins before birth and in early childhood, i.e. shaping lifestyles during early years of life. Maternal malnutrition, obesity and diabetes can increase the risk of NCDs in children.

AIM/GOAL

Primordial prevention aims at prevention of emergence and development of "unhealthy lifestyles" or "known risk factors" in population by following actions.

Actions

At government level (whole of government): By healthy public policies in various sectors—"health in all policies".

National multisectoral action plan requires whole, of government or 'health in all government policies' in different sectors/ministries. Intersectoral coordination between health, excise and taxation, home, education, agriculture, youth and sports, town planning and women and child development is necessary to defeat NCDs.

a **Comprehensive legislation against tobacco:** Cigarettes and Other Tobacco Products Act (COTPA), 2003: Bans tobacco advertisement, bans smoking at public places, curb on Hookah bars, sale of tobacco products to children, pictorial and written warning on tobacco products such as tobacco kills, tobacco causes cancer.

- WHO framework convention on tobacco control (FCTC) has been adopted by India—a landmark in tobacco control.
- Crop alternatives to tobacco to curb production of tobacco.

b **Agriculture and nutrition policy**

- Production and promotion of protective foods—green leafy vegetables and fruits, whole grain cereals and pulses and regulating their prices.
- Healthy foods through Mid-Day Meal Programmes in schools and supplementary nutrition at *Anganwadis*.

c **Food industries:** Regulating the salt content and *trans* fats in processed foods, ban on junk foods or sin tax (heavy tax on junk foods).

d **Education and sports–youth:** Promoting physical activities–exercises and yoga in schools and work-place and in colleges.

e **Women and child development:** National nutrition policy—food security and promoting traditional foods, improving infant and young child feeding practices (IYCFP).

f Prevention of household air pollution by use of clean fuel/energy in kitchen. Govt gives subsidies on LPG to BPL families.

g Town and country planning for parks and open spaces.

h Control of outdoor air pollution by legislation.

At Community Level, whole of Society by Health Education and Health Promotion

Prevention of emergence of risk factors of NCDs in population by adopting healthy lifestyles beginning from early childhood period, continued during adolescence and maintaining healthy lifestyles during rest of the life (lifecycle approach) are most appropriate. Begin communication and education on healthy living, healthy food habits during preschool period at home and at *Anganwadi* centre, continued at schools, in colleges by teachers and peer groups, by employers at workplace followed by active ageing. Family holds primary responsibility in shaping and development of healthy life-styles in their offsprings. Multi-media approaches/multi-sectorial approaches for education and communication be adopted for developing healthy lifestyles.

Healthy Foods/Healthy Diets

Eating habits get established during early childhood period. Parents and school teachers hold key position to promote healthy eating habits (diversity of foods).

- Avoid eating fast/junk foods and use of carbonated drinks.
- Increase intake of protective foods such as green leafy vegetables, fresh fruits (400 g per day) and sprouts.
- Consume whole grain cereals, mixed cereals and pulses, seasonal vegetables, and nuts.
- Avoid fatty-sugary and salty foods. Limit salt consumption to less than 5 g per day. Refined carbohydrates–maida, bread, etc., excess sugar, excess of saturated fats and fried foods increases the risk of NCDs particularly CVD and diabetes. Whole grain cereals and pulses are good for health, these foods provide fibres and lower cholesterol levels.
- Use unsaturated fats or oils such as groundnut, soya bean and sesame oil and sunflower oil, and moderate consumption of *desi* ghee, vanaspati and animal fats. Vegetarian diets are safer and better. Excess eating of junk foods and use of carbonated drinks and refined carbohydrates (noodles, fried fingers, burgars, potato wafers, sweets and samosa) can lead to overweight and obesity in children and adults. Encourage moderate consumption of dairy and flesh foods.

Promote Physical Activities and Exercises at Home, Schools and Workplace

Promote physical activities and exercises right from early childhood period to avoid overweight and obesity. Regular excercise (moderate to vigorous) for 5–7 days per weak along with yoga and meditation by all can prevent obesity. At least 30 minutes of moderate intensity physical activity per day is good for heart to prevent CVD, 45 minutes per day to stay fit and 60 minutes per day for weight reduction along with healthy eating. Patients or sick should seek advice of their physician for excercise. Physical activity reduces the risk of coronary heart disease, type 2 diabetes, stroke, colon and breast cancers.

Weight Control—Obesity an Epidemic

Overweight and obesity is a disease in itself and a risk factor for CVDs, diabetes and hypertension and cancers (breast and colon). Weight control measures consist of eating sensibly and eating healthy foods and regular physical activities. Keep your BMI between 18.5 and 22.9. BMI between 23 and 24.9 is considered as overweight and BMI of 25 or more than that is obese grade BMI. Nearly 10% of rural and 25% of urban adults are obese. Nearly 25% of children in urban areas are overweight and 10% are obese and hardly 20% of Delhi adolescents took on to any physical exercise (Anoop Misra). As per NFHS-5 in India 24 % of women and 22.9 % of men were overweight or obese in age 15 years and above in 2019–21.

Tobacco Use

Tobacco causes 1 million deaths in India per annum. It is a global killer. Tobacco use in any form is harmful to health. Tobacco use is a risk factor for development of CVDs, cancers, COPD, blood pressure and many other diseases. In India, 28.6% adults and 8.5% of minors aged 13–15 years use tobacco and habit of use of tobacco begins during childhood/adolescent period. Education programmes in the community to develop smoke-free and tobacco-free society can go a long way in primordial prevention. Parents in the family and school teachers are the role models for young children. Quitting smoking and tobacco use at any stage is beneficial for health, heart and lungs.

Avoid Use of Alcohol

Alcohol consumption is a risk factor for oesophageal cancer, liver cancer and cirrhosis, stroke, homicide and motor vehicle accidents. By supply reduction and demand

reduction in the community by education, and by legislative measures alcohol use can be controlled. Dependence and harmful use of alcohol is prevalent in 4.6% of adults in India, and in some areas it is much higher (Punjab, AP and Goa).

Primary Prevention in NCDs—Behaviour Change Communication (Health Promotion and Specific Protection)

Once the risk factors or "unhealthy lifestyles" have been established or emerged in the population attempt is made to prevent the development of CVDs and other NCDs in persons having these risk factors. Purpose of primary prevention is to **limit** the **incidence** of NCDs in population by modification of known risk factors by **behaviour change communication**. There are two approaches in primary prevention of NCDs: 1. Population based approach; 2. High-risk approach.

1. Population-based Approach or Interventions

Population-based approach focuses on risk factors reduction in whole population of infants, children, adolescent, youth, and reproductive age group and old people. Population-based strategies for NCDs are much more beneficial, cost effective, sustainable and make high impact. Population wide behavioural risk factors modification and adoption of healthy lifestyles as norms for entire population (such as Very cost effective, high impact and feasible intervention: "**best buys** advocated by WHO" include tobacco control, dietary salt reduction, use of alcohol, fats and sugar, promoting physical activity and hepatitis B vaccine, HPV vaccine, etc.) could prevent large proportion of NCDs in whole population. Moreover, relationship between behavioural risk factors and development of NCD events is continuous and most NCDs occur, in people, at middle range (or modest elevation) of multiple risk factors, who are not normally judged as high-risk persons. Axiom—"a large number of people who are exposed to small risk may generate many more cases of NCDs than a small number or minority exposed to high-risk" (Rose). Therefore reduce mean blood pressure of population, mean blood sugar levels, mean salt intake and mean cholesterol levels in population to ultimately reduce incidence and burden of NCDs by massive/aggressive health promotional activities for all in all age groups. Population-based strategies that seek to shift the whole distribution of risk factors to the left have the potential to control population incidence. Population-based approach does not require any screening programme and it treats the determinants (underlying causes of NCDs).

Specific Protection by Immunization

HPV (human papillomavirus) vaccine against prevention of cervical cancer is available. Bivalent HPV vaccines are effective and safe but these have been introduced in a few states. Global strategy for cervical cancer elimination has been launched by WHO in 2020. There occur 96,000 cervical cancer cases and 60,000 deaths every year in India. Hepatitis B vaccine prevents chronic hepatitis and liver cancer hence a "best buy". Protection against environmental risk factors for cancer such as aflatoxin, asbestos and contamination of drinking water can be effective prevention strategy. Tobacco control can prevent tobacco-related cancers.

Competency addressed: The student should be able to:
CM 10.2: Enumerate and describe the methods of screening high-risk groups.

2. High-risk Approach—Screening of NCDs

In the national strategy of control of NCDs more emphasis is on screening of individuals above 30 years of age for "Risk assessment" in this approach attempt is being made to screen out high-risk individuals by **periodical medical check up** at regular intervals. Those individuals who show abnormal values are prescribed individualized programme directed at modifying or reducing or eliminating the risk factors and thus preventing CVDs and other NCDs in **minority of people**. Screening of risk factors is a costly affair. High-risk approach benefits minority of people who are at risk of NCDs. The efforts expended on measuring risk factors in individuals, is therefore, questionable (Robert Beaglehole). Screening for risk factors such as measuring blood pressure, glucose, waist circumference and BMI, overall check up cost time and lot of money hence a resource intensive activity. In contrast population based strategies that seek to shift the whole distribution of risk factors to left, have the potential to control population incidence by lowering the risk in the entire population.

Opportunistic Screening

Strategy for early detection of chronic NCDs consists of opportunistic screening of persons above the age of 30 years at the point of primary contact with any healthcare facility, be it a village, sub-centre, PHC, CHC, district or tertiary care hospital. Opportunistic screening identifies behavioural risk factors by history taking (tobacco use, diets, physical activity, alcohol use, fuel use) and BP and glucose measurement. Opportunistic screening has in built component of mass awareness generation, self screening and screening by trained persons. Individual counseling and lifestyle management and referral of high-risks are other components of opportunistic screening programme.

Population-based Screening for NCDs[5,6]

Screening of hypertension, diabetes and three common cancers (oral, breast and cervix) with fixed periodicity helps early detection of NCDs.

Purpose of screening in NCDs is to identify risk factors, high-risk persons and to detect a disease at preclinical stage or to detect syndrome at early stage. Screening focuses on apparently healthy people in target age group of 30 years and above. Screening is not a final diagnosis. Screening

of risk factors or high-risk persons is a costly affair. Screening must be supported with proven interventions and services close to the community. Screening of NCDs is an integral part of comprehensive primary healthcare at sub-centre (health and wellness centre).

Focus: All men and women age group 30–65 years.

Frequency: Once a year for diabetes, hypertension and obesity in persons above 30 years.

Once in five years for oral, breast and cervix cancers in persons 30 to 65 years.

Who will screen: ASHAs, ANM under the supervision of LHV and medical officer and mid-level provider. These workers are trained in oral visual examination, clinical breast examination, and visual inspection using acetic acid (VIA) for cervical cancer screening. On a day about 30 persons can be screened.

Population Enumeration

First step in the process of screening is active enumeration of population of persons over 30 years of age in each household/family by ASHA; on individual health card. About 37% of persons in population are above 30 years of age (1850 persons in 5000 population).

Risk assessment screening: ASHAs will complete **community-based assessment checklist** (CBAC) of risk factors assessment by scoring system. Risk assessment includes questions on age, tobacco use, alcohol use, waist measurement, physical activity, family history of diabetes, hypertension and heart disease (Table 8.49).

A score above 4 indicates that a person may be at risk of NCDs and needs to be prioritized for attending weekly NCD day. A score below 4 implies low risk. Low risk score does not mean that individual is to be excluded from screening, as NCDs could exist even in the absence of risk factors. The scoring is not a point of elimination but a means to highlight risk factors. In addition, the tool includes questions related to symptoms for cancer cervix, breast and oral cancers, epilepsy and COPD so that such cases can be identified and referred to appropriate centres. Screening for cervical cancer should take place at SC or PHC, i.e. at **health and wellness centre**.

If the symptoms of shortness of breath, coughing more than 2 weeks, blood in sputum, difficulty in opening of mouth ulcer/patch/growth in the mouth that has not healed in two weeks, any change in tone of voice, lump in breast, blood stained discharge from the nipple, change in size and shape of breast, bleeding between periods, bleeding after menopause, bleeding after intercourse and foul smelling vaginal discharge are present the person is referred to medical officer of nearby facility. ANM undertakes blood pressure and glucose measurement and refers cases with high BP and blood glucose, and symptoms requiring investigations for cancer to appropriate facility for confirmation and initiation of treatment and follow-up thereafter.

Cancer Component of NCDs[7]

The cancer control component of the programme has more than 29 regional cancer centres, and tertiary care centres (TCC) The National Cancer Registry Programme has population-based cancer registries to provide data on incidence, mortality rate and survival rates of cancers.

Burden: The international agency for research on cancer, the GLOBCAN project has predicted that the cancer burden due to oral, breast and cervical cancers in India will rise from one million cases in 2012 to over 1.5 million by 2035. Overall burden due to all cancers in India is 2.6 million 5 years prevalent cancer cases.

Common cancers: The three most commonly occurring cancers in India are those of breast, uterine cervix and oral cavity. Together they account for approximately 34% of all cancers and hence public health priority in India. The odds of incurring catastrophic hospitalization expenditures are about 160% higher with cancers than communicable diseases.

Deaths: About 7.84 Lakh deaths occur per annum in India due to cancers, most cancers, over 75 to 80% are detected late in advance stage when the prognosis and survival are poor. Screening programmes detect cancers at an early stage when the prognosis and survival is good. Five years survival rates for early stage cancers are as under:

	In early stage	*In late stage*
Oral cancers	60.2%	3.3%
Breast cancers	76.3%	14.9%
Cervical cancers	73.2%	7.9%

Warning Signals for Cancers

C—Change in bowl and bladder habits
A—A wound that does not heal
U—Unusual bleeding or discharge
T—Thickening or lump in the breast
I—Indigestion or difficulty in swallowing
O—Obvious change in wart or mole
N—Nagging cough or hoarseness of voice.

CANCER—SCREENING OF COMMON CANCERS AND REFERRAL

Screening Methods

Cervical cancers: Visual inspection with acetic acid (VIA). 3–5% of acetic acid is applied on the lip of the cervix, a white patch developing after one minute of application indicates positive VIA test. The test can be performed by trained ANMs/Nurses/Doctors.

Breast cancer: It is the commonest cancer in women. Method of screening is clinical breast examination by visual inspection and palpation. Self-examination is best examination.

Table 8.49: Community-based assessment checklist (CBAC) form for early detection of NCDs

Part A: Risk assessment

Question	*Range*		*Circle any Write score*
1. What is your age? (in complete years)	30–39 years 40–49 years 50 years and above		0 1 2
2. Do you smoke or consume smokeless products such as Gutkha; or Khaini?	Never Used to consume in the past/sometimes now Daily		0 1 2
3. Do you consume alcohol daily?		No Yes	0 1
4. Measurement of waist (in cm)	Female <80 cm 80–90 cm >90 cm	Male <90 cm 90–100 cm >100 cm	 0 1 2
5. Do you undertake any physical activities for minimum of 150 minutes in a week?	Less than 150 minutes in a week At least 150 minutes in a week		1 0
6. Do you have a family history (any one of your parents or siblings) of high blood pressure, diabetes and heart disease/stroke or cancer?		No Yes	0 2
Total score			

A score above 4 indicates that the person may be at risk for these NCDs and needs to be prioritized for attending the weekly NCD day

Part B: Early detection: Ask if patient has any of these symptoms

B1: Women and men	*Yes/No*	*B2: Women only*	*Yes/No*
Shortness of breath		Lump in the breast	
Coughing more than 2 weeks		Blood stained discharge from the nipple	
Blood in sputum		Change in shape and size of breast	
History of fits		Bleeding between periods	
Difficulty in opening mouth		Bleeding after menopause	
Ulcers/patch/growth in the mouth that has not healed in two weeks		Bleeding after intercourse Foul smelling vaginal discharge	
Any change in the tone of your voice			

In case the individual answers *yes* to any one of the above mentioned symptoms, refer the patient immediately to the nearest facility where a medical officer is available

Part C: Circle all that apply

- Type of fuel used for cooking—LPG firewood, crop residue, cowdurg cake, kerosene, coal.
- Occupational exposure: Industries with smoke, gas, dust, brick kiln, glass factory, etc.

Oral cancer: Detection of pre-cancerous **lesions** in oral cavity such as leucoplakia and erythroplakia by visual examination of oral cavity.

Inclusion criteria: Persons above the age of 30 years with periodicity of every five years. Self-examination and reporting of any non-healing lesion in oral cavity is best practice.

The suspected cases of cancer are referred to PHCs which are linked to district and each district is linked to nearby tertiary cancer care centre (TCC) facility to provide referral services and outreach services.

Secondary Prevention Against NCDs

This level of prevention applies to persons who have developed NCDs. Aim of secondary prevention is to reduce prevalence of NCDs in the community.

The Strategy of Secondary Prevention in NCDs

Early Diagnosis and Prompt Treatment

By opportunistic screening and population-based screening for common NCDs and cancers.

Packages of services at various levels (Table 8.50).

Access to Affordable Treatment/Medicines

District NCD cells: 684 dist NCD cells are set up. **NCDs clinics** have been set up at community health centres (CHCs) and district hospitals. The CHCs and district NCDs clinics provide comprehensive care and management of cardiovascular diseases, strokes, diabetes, hypertension, and common cancers (oral, breast and cervical cancers) in the OPD, and indoor on all working days of the week. CHCs and district hospitals have been strengthened by providing additional contractual staff and laboratory facilities. At the district level cardiac care unit with 2–4 beds has been set up. Cases from villages, sub-centres, PHCs are referred to PHC, CHC and district for diagnosis and management and follow-up. Package of wide ranging services include—awareness generation, lifestyle management, free diagnostics and drugs and surgical interventions.

These clinics have been linked to tertiary cancer care centres of tertiary hospitals for advanced treatment. Apart from treatment these clinics undertake lifestyle management and counselling services. Free diagnostics and drugs are supplied for treatment of NCDs.

Home-based care: Bedridden patients are provided home-based care by nurses **available at CHCs**.

Tertiary Prevention in NCDs

This level consists of disability limitation and rehabilitation of advanced cases of NCDs. This level manages complications and sequelae of NCDs, like renal, retinal, strokes and haemorrhages, diabetic foot and palliative or terminal care in cancer. Rehabilitation consists of physical, emotional and psychological as also occupational rehabilitation. Home-based and community-based rehabilitation is a preferred strategy for NCDs.

Surveillance of risk factors of NCDs: Regular, ongoing collection, compilation, analysis and interpretation of data on NCDs and their risk factors help to plan, monitor and evaluate the programmes of NCDs. It should be part of IDSP. Ten voluntary targets on NCDs can be evaluated by periodic surveillance of risk factors of NCDs.

National Multisectoral Action Plan for Prevention and Control of NCDs 2015

Vision: All Indians to enjoy the highest attainable status of health and well-being and quality of life at all ages, free of preventable NCDs, avoidable disability and premature deaths.

Goal: Reduce preventable morbidity, avoidable disability and premature mortality due to NCDs.

Strategic areas and key outcomes

- **Integrated multisectoral coordination**—between eduction, agriculture, youth, and sports, food industries, town and country planning, transport and women and child welfare.

The convergence and linkages with ongoing interventions of National Health Mission including National Tobacco Control Programme, National Mental Health Programme, National Programme for Healthcare of elderly, oral health and deafness prevention, TB elimination, adolescent/school health and RCH programme to achieve public health goals in an integrated manner by national multisectoral action plan.

There is a growing risk of NCDs among children as 2% of children under five were overweight or obese and 4% of school children were overweight or obese, 5% of adolescents were obese or overweight. One in ten school age children and adolescents were pre-diabetic with fasting plasma glucose more than 100 mg and less than or equal to 126 mg per dl, and 1% of school age children and adolescents were diabetic, 3% of school age children and 4% of adolescents had high total cholesterol and high low density lipoprotein, while 26% school age children and 28% of adolescents had low high density lipoprotein. Five percent of adolescents were classified as hypertensive. Thus, NCDs start during childhood period and, therefore, prevention of NCDs must start during early childhood period by families. *(Reference: Comprehensive National Nutrition Survey 2016–2018.)*

Convergence of different sectors is a public health challenge. Ministry of Health and FW must take a lead not only to evolve plans but ensure their implementation at ground level. Beginning must be made from childhood period where families and *Anganwadi* centre take responsibility to inculcate healthy behaviours—healthy eating, physical activities, no tobacco use. These activities are then continued in schools and at workplace.

Table 8.50: Package of services for NCDs

Health facility level	*Packages of services*
Sub-centre	• Health promotion for behaviour change and counselling. 'Population-based/opportunistic' screening of common NCDs including cancers (breast, cervix and oral) • Awareness generation of early warning signals of common cancers and other risk factors of NCDs • Referral of suspected cases to PHC/CHC/nearby health facility. Follow-up of patient put on treatment
PHC	• Health promotion for behaviour change and counselling. 'Population-based/opportunistic' screening of diabetes, hypertension and three common cancers (oral, breast, and cervical by VIA) • Clinical diagnosis and **treatment** of **common** NCDs including hypertension and diabetes, referral of complicated cases of DM/HTN to CHC/DH. • Identification of early warning signals of common cancers • Referral of suspected cases to CHC/DH and follow-up of patient put on treatment • Prevention and health promotion including counselling. Early diagnosis through clinical and laboratory investigation
CHC daily clinic at CHCs	• Diagnostics facilities: Blood sugar, total cholesterol, lipid profile, blood urea, creatinine, X-ray, ECG, USG (to be outsourced, if not available) 'opportunistic' screening of common cancers (oral, breast and cervix) • Management of common NCDs • Referral of complicated cases to district hospital/higher healthcare facility
District hospital Daily clinic OPD and indoor facility	• Diagnosis and management of cases of CVDs, diabetes, COPD, stroke and cancer (outpatient, inpatient and intensive care) including emergency services particularly for myocardial infarction and stroke • Laboratory investigations and diagnostics: Blood sugar, lipid profile, KFT, LFT, X-ray, ECG, USG Echo, CT scan, MRI, etc. (to be outsourced, if not available) • Referral of complicated cases to higher healthcare facility. Health promotion for behaviour change and counselling. 'Opportunistic' screening of NCDs including common cancers (oral, breast and cervix) • Follow-up chemotherapy in cancer cases, rehabilitation and physiotherapy services
Medical college	• Mentoring of district hospitals, early diagnosis and management of cancer, diabetes, CVDs and other associated illnesses, training of health personnel, operational research
20 Tertiary cancer are centres and state concer institutes	• Mentoring of district hospital and outreach activities, comprehensive cancer care including prevention, early detection, diagnosis, treatment, palliative care and rehabilitation • Training of health personnel, and • Operational research

Expected Outcomes

- The programme and interventions would establish a comprehensive sustainable system for reducing the rapid rise of NCDs, disabilities and deaths due to NCDs. Broadly, following outcomes are expected.
  - Reduction in exposure to risk factors, lifestyle changes leading to reduction in NCDs
  - Improved quality of life
  - Early detection and timely treatment leading to increase in cure rate/control and survival
  - Reduction in prevalence of physical disabilities including blindness and deafness.
- Providing user-friendly health services to elderly population.
- Reduction of death and disability due to trauma, burns and disasters.

New Initiatives for Control and Prevention of NCDs

- Intervention for prevention and control of rheumatic heart disease (RHD) under NPCDCS and RBSK:
  - For prevention and control of RHD: *Rashtriya Bal Swasthya Karyakram* teams would be used to generate awareness and screen suspected cases and refer them to nearest facility—district early intervention centre (DEIC).
- Integration of AYUSH with NPCDCS:
  - Yoga as an intervention is being encouraged for prevention and management of common NCDs.
- Integration of TB elimination with diabetes as co-morbidity (bi-directional screening).
- Integration with RTI/STI for cervical cancer, HPV and HBV vaccine programme.

WHO Global Action Plan and Monitoring Framework for Prevention and Control of Non-communicable Diseases by 2025

The WHO Global action plan provides road map to attain ten voluntary global targets to be achieved by 2025 including 21 indicators for prevention and control of non-communicable diseases by a set of very cost effective interventions (best buys).

Time bound Targets and Outcomes[8] Adopted by MOH and FW

1 25% relative reduction of premature mortality from cardiovascular diseases, cancer, diabetes and chronic respiratory diseases by 2025 (*referred to as 25 × 25*).

2 At least 10% relative reduction in the harmful use of alcohol.

3 10% relative reduction in prevalence of physical inactivity.

4 A 30% relative reduction of mean population intake of salt/sodium.

5 A 30% relative reduction in prevalence of current tobacco use in person aged 15+ years.

6 A 25% relative reduction in the prevalence of raised blood pressure or contain the prevalence of raised blood pressure.

7 Halt the rise in diabetes and obesity.

8 At least 50% eligible people receive drug therapy and counselling (including glycaemic control) to prevent heart attacks and strokes.

9 An 80% availability of affordable basic technologies and essential medicines to treat major NCDs.

10 Household indoor air pollution 50% relative reduction in household use of solid fuels as a primary source of energy for cooking.

NATIONAL NCD MONITORING SURVEY 2017–18 IN ADULTS AND ADOLESCENTS[9]

Assessment and Management of Hypertension

Amongst the 10592 adult respondents aged 18–69 years, 28.5% had raised blood pressure, of which 27.9% were aware of their raised blood pressure status. Of those who were aware, 52.1% were on treatment and of those who were on treatment, 44.4% had their blood pressure in control (systolic BP <140 mm Hg and diastolic BP <90 mmHg) (Fig. 8.18).

Assessment and Management of Diabetes Mellitus

Amongst the 9581 adult respondents aged 18–69 years, 9.3% had raised blood glucose including those on medication, of which 45.8% were aware of their raised blood glucose status. Of those who were aware, 78.8% were on treatment of raised blood glucose, and amongst them 32.7% had their blood glucose in control (fasting blood glucose <126 mg/dl) (Fig. 8.19).

Figures 8.20 and 8.21 summarize the prevalence of risk factors associated with NCDs amongst adult and adolescents. Probability of dying from any of CVD, cancer, diabetes, COPD between age 30 and 70 was 21.90% in 2019.

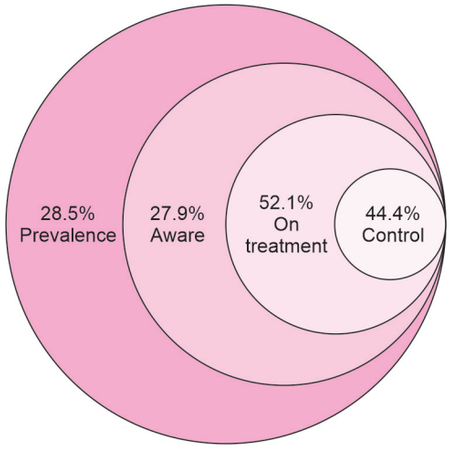


Fig. 8.18: Assessment and management of hypertension among adult (18–69 years)

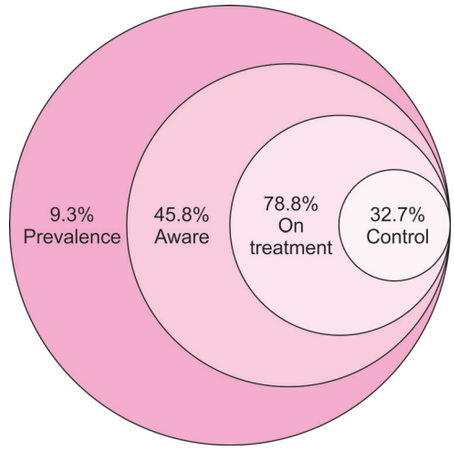


Fig. 8.19: Assessment and management of diabetes mellitus among adult (18–69 years)

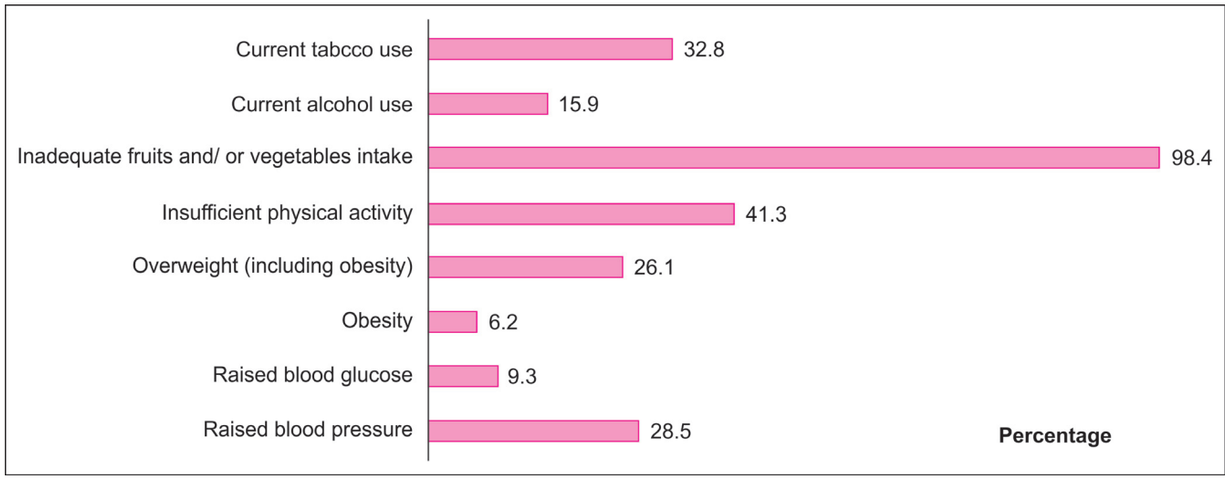


Fig. 8.20: Summary of prevalence of risk factors associated with NCDs among adults (18–69 years)

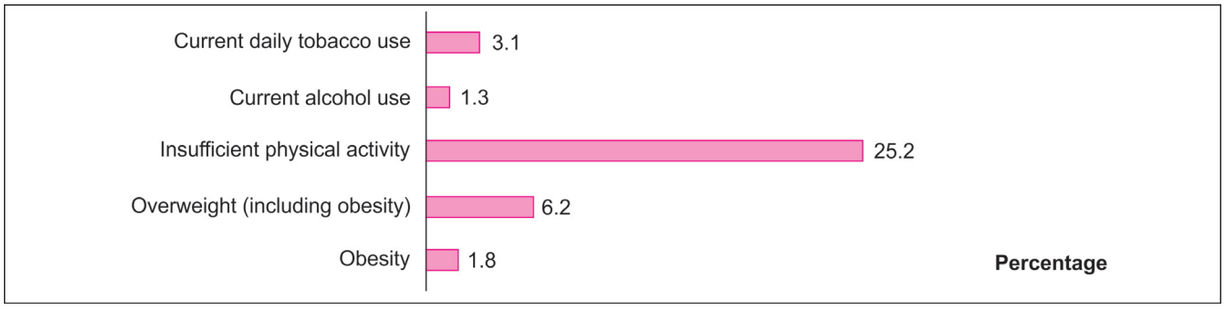


Fig. 8.21: Summary of prevalence of risk factors associated with NCDs among adolescents (15–17 years)

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ACCIDENTS AND INJURIES: HIDDEN EPIDEMIC

PANDEMIC OF ROAD TRAFFIC ACCIDENTS (RTA)

Increasing mechanization in agriculture and industry, induction of semiskilled and skilled workers in various operations and rapid increase in vehicular traffic have resulted in morbidity, mortality and disability due to accident and trauma. Overcrowding due to rise in population and lack of awareness and poor implementation of essential safety precautions result in an increasing number of accidents. Apart from accidents, the vehicular

traffic causes air pollution, which adds to the woe of respiratory and **heart diseases** and **deaths** which may outnumber **accidental deaths. Noise pollution** is another hazards of road traffic. Road traffic accidents are "hidden epidemic" which though a priority, has received much less attention.

Spectrum of Accidents

1 Road traffic accidents (RTA)
2 Industrial accidents
3 Domestic and peridomestic
4 Railway accidents
5 Agriculture accidents
6 Intentional or suicidal injuries.

The spectrum may not cover the total range of accidents; but for the purpose of management and prevention of accidents this may be helpful. Road traffic injuries are leading cause of morbidity and mortality the world over.

Goal: United Nations Sustainable Goal by 2030 To halve global number of deaths and injuries from RTA.

Epidemiology of RTA

Human beings, the **vehicles** and **environment** make 3 components of the **epidemiological triad** within which safety is shared responsibility.

Extent of Problem

Accidents and injuries are global problem. These are common in developed and developing countries. Injuries represent 12% of global burden of disease, the third most common cause of overall mortality and the leading cause of death amongst 5–29 years old. More than 50 million people are severely injured and 1.35 million get killed on the world's roads each year.[1]

United Nations General Assembly declared 2021–2030 as the decade of global road safety.

Mortality

According to WHO Global status report on road safety for 2018, road traffic injuries accounted for 2.1% of all global deaths and ranked as 8th leading cause of death. WHO data shows that in 2016 nearly 1.35 million people died as a result of road traffic injuries. This represents an average of 3242 persons dying each day around the world due to road traffic accidents. In addition to these deaths, up to 50 million people globally are estimated to be injured or disabled each year due to RTA[2] (non-fatal injuries). Road traffic mortality rate was 15.6 per lakh in 2019.

Age, Sex and Road Traffic Accidents (RTA)

Over 87.4% of RTA deaths occur in age bracket 18–60 years (economically active age group). It kills young people in their prime of life, costing significant economic losses to country. In 10–24 years (young people), RTA has become number one killer in the world which accounts for 10% of deaths in this age bracket. Deaths due to RTA outnumber in men as compared to women, because of use of vehicle and road, exceeds for men (Fig. 8.22).

Using epidemiological evidence from national studies, conservative estimates can be made of ratio between road deaths, injuries requiring hospitalization treatment, and minor injuries as being 1:15:70 respectively in most countries.

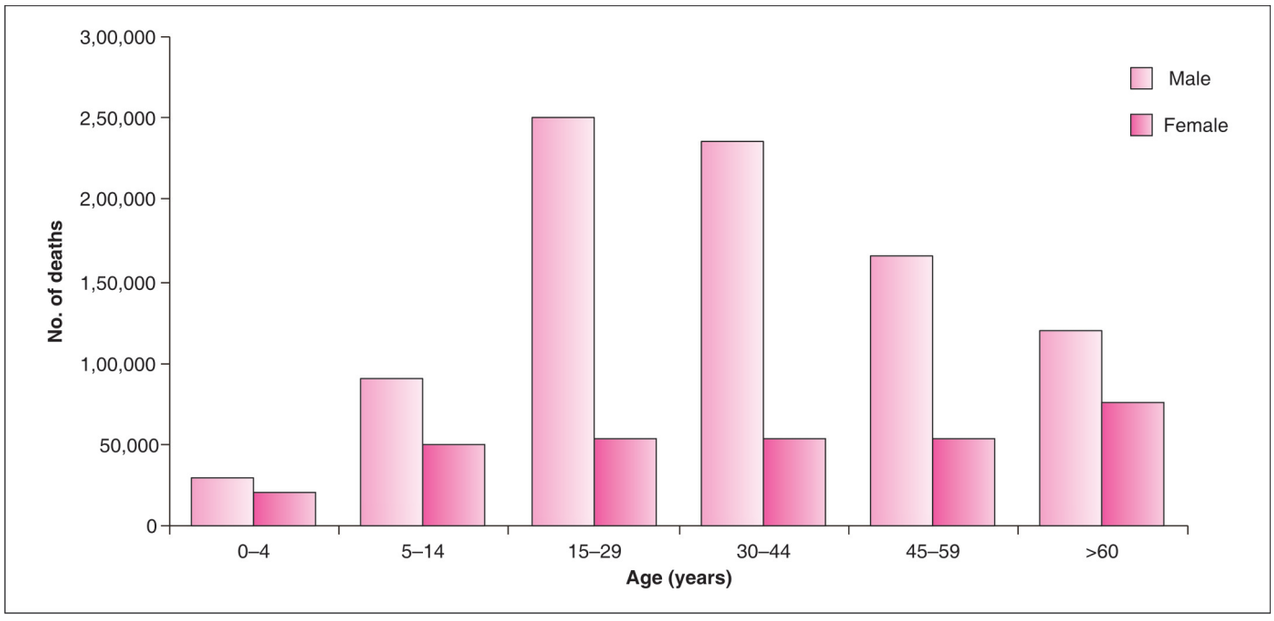


Fig. 8.22: Road traffic deaths by sex and age group in the world (2002). *Source:* World Bank Report, 2004

Economic Loss

Nearly 3 to 5% of GDP is lost due to RTA. The trauma due to RTA is enormous and besides loss of human life it requires economic expenditure to manage trauma emergencies. One-third or even more beds in emergency may be occupied due to trauma and injuries and much of the scarce resources get spent to manage trauma emergencies.

RTA in India

Trend of RTA in India (Table 8.51)

A total of 420,000 road accidents were reported by states/UTs during the year 2021 which claimed 153,000 lives and caused 371000 injuries. Road accidents have been on decline since 2016 except for marginal increase of 0.46 % in 2018. Significant decline in number of accidents, injuries and deaths in year 2020 could be attributed to enforcement of stringent amended Road Safety Motor Vehicle Act of 2019 which hiked penalties for traffic violation[3]. However this is an underestimate as all injuries are not reported to police.

Table 8.51: RTA deaths in India[3]

Year	*Total accidental number of road*	*RTA deaths*	*Number of persons injured*
2008	484704	119860	523193
2009	486384	125660	515458
2010	499628	134513	527512
2011	497686	142485	511394
2012	490383	138258	509667
2013	486476	137572	494893
2014	489400	139671	493474
2015	501423	146133	500279
2016	480652	150785	494624
2017	464910	147913	470975
2018	467044	151417	469418
2019	447002	151113	451361
2020	366138	131714	348279
2021	420000	153100	371000

Overall mortality due to RTA in India in one block (rural area) was 2.80% in the year 1996 and it is expected much more in urban areas.[4]

Non-communicable disease and injuries have been projected in India to increase manyfold (Fig. 8.23).

Burden of Injuries in India

World development report 1993 estimated DALYs losses due to injuries at 9% and this has increased further to the level of 12% in 2016. It is attributable to growth of population, urbanization, mobility and growing number of vehicles. In Delhi alone, the population of vehicles has grown tremendously.[5,6]

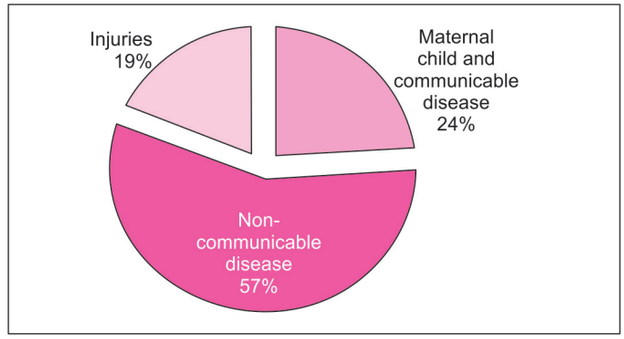


Fig. 8.23: Disease burden estimate in India (2020). Source: WHO, 1996

Who gets killed in RTA?

In India, pedestrian, bicycle, and motorized two-wheelers accounted for 73% of road traffic deaths in 2020. Over 78% of pedestrian in Bombay, 53% in New Delhi, were killed in RTA (WHO, 2004). These groups are most vulnerable to RTA deaths and it is clear indication that policies and programmes must focus/target these groups (Table 8.52).

Risk Factors

Motor Vehicles

Growing number of motor vehicles—number of cars, buses, trucks and two-wheelers have tremendously increased over the years. Overpopulation of motor vehicles is posing a great risk factor in RTA. In USA, 779 vehicles are available per 1000 persons against 34 in India. Motor vehicles are heavily concentrated on city roads which have limited space. In addition, non-motorized traffic has also increased (like cycles and carts).

Table 8.52: Proportion of road users killed at different locations in India (figures in %) WHO, 2004 and 2020

Type of road users	*Mumbai*	*New Delhi*	*Highways*	*India 2020**
Lorry/trucks	2	2	14	11
Bus	1	5	3	4
Car	2	3	15	7
TSR	4	3	–	–
MTW (2–3 wheels)	7	21	24	34
HAPV	0	3	1	–
Bicycle/cyclists	6	10	11	6
Pedestrian	78	53	32	33
Others (unspecified)	–	–	–	5
Total	**100**	**100**	**100**	**100**

TSR: Three wheeled scooter; MTW: Motorized two-wheelers; HAPV: Human powered vehicles; a statistical summary of 11 locations not representative for whole country (tractor fatalities not included).

* TRIPP May 2020 IIT Delhi WHO collaborative centre.

Pedestrian and cyclist population have increased at an alarming rate in developing countries including India. In India, the vehicle traffic is going to escalate with rise in income level and improvement of economic status. However, predominant modes of travel remains walking, cycling and use of public transport. The needs of pedestrian and cyclists have to prevail over the needs of others because of their vulnerability.

Roads Network

Development of network of roads or other form of transport as railways is a challenge. Roads have been constructed in residential areas and if all sorts of traffic flow through residential areas it has profound effect on health of people-like **accidents**, air **pollution** and **noise pollution**. Planning and construction of road for different purposes and different vehicles is in the process of development and it is imperative need. At present in developing countries, all sorts of traffic are mixed-up (pedestrian, cyclists, two-wheelers, bullock carts, other carts, cars, buses, trucks) and result into a chaos. Better planning of roads and land use led to efficient flow of traffic on major routes bye-passing urban residential areas, and with built- in safety measures has reduced RTA.

Road Users

In low income countries young people are predominantly involved in road crashes. Older people will be dependent on public transport or will walk. Providing safer and shorter pedestrian routes and safe and convenient public transport can reduce RTA.

Crash Risk Factors of RTA

Drivers and Road Users

Speed: Speed thrills but it kills. Rash driving on road by young people predispose them to RTA. Speed limits fixed by the authorities must be observed. Cameras on main crossing have been installed to check the speed. Speed means loss of control, improper overtaking and misjudgement leading to fatal accidents. Risk between speed and crash has been well established. Super-bikes and stunts and race on road can lead to fatal accidents. Traffic rule violation and over speeding was major killer accounting for 75% of deaths.

Pedestrian and Cyclists

They get mixed with high speed vehicles and they are unprotected and exposed to risk of accidents. Road safety rules are generally poorly observed by pedestrian and the alcohol use impairs the judgement.

Age

Young drivers and riders run more risk of crash accidents. Young often tend to be over-confident, less experienced, run with high speed and use of alcohol makes the worse combination of risks.

Alcohol

Alcohol and driving should never be mixed. Increased use of alcohol and other drugs in drivers expose them to the risk of accidents as the judgement gets impaired and control over vehicle is lost due to the effect of alcohol and other drugs. National maximum legal blood alcohol concentra-tion is 30 mg/100 ml.

Fatigue

Long distance driving and inadequate sleep leads to fatigue. Driving while feeling sleepy is risky.

Mobile Telephones—Handheld Telephone Set

Driving with handheld mobile telephones has become a fashion, it is risky and misuse of mobile telephones. It affects the reaction time and maintenance of lane hence more risk of RTA. In many countries, use of handheld mobile phones have been banned.

Habit of use of Safety Belts and Helmets

Nearly 80% of car occupants and 67% of two wheelers riders killed in RTA did not wear seat belts and helmets. Use of safety belts is picking-up but many drivers and occupants of vehicles do not use seat belts. Seat belt use reduces the impact of accident. Similarly, motorized two-wheelers do not use crash helmets and non-use of bicycle helmet adds to the risk of fatal head injuries. The use of light during daytime by two-wheeled vehicle reduces chances of accidents.

Travel

Travel if you must. Unnecessary travel and joy ride and choice of less safe travel modes is a habit with adolescents. Teenagers below the age of eligible age of licence, drive two-wheelers and cars and risk their lives as also lives of others on road. Parents have to curb this habit.

Vehicle Condition

The pedestrians are most at risk of accidental deaths. Cycles and motorized two-wheelers are mostly involved in accidents and are most risky and unstable vehicles. Public transport system vehicles are in bad conditions because of poor maintenance and poor upkeep. Road worthiness (lighting, breaking, handling and speed management) of vehicles must be ensured to prevent RTA. Old vehicles are being phased out. The new vehicles (cars) must confirm the standards adopted by advanced countries to prevent accidents and to prevent the menace of air pollution.

Environment

Visibility

Poor visibility due to foggy conditions or smog of vehicles or dust storms decreases the visibility. At night, driving

needs extra-precautions as vision is seriously affected by head lights. Pedestrians, cyclists and mixed traffics like bullock carts or camel carts, tractors often get hit by motor vehicles as they do not observe the rules and often these have no lights/indicators.

Poor Road Conditions

Uncovered sewer and flooding of roads, breaches and pits make the road conditions worse and may result in severe accidents. Speed breakers and bumps are meant for cutting speed preventing accidents, but poor marking and visibility of speed bumps and breakers result into severe accidents and injuries to occupants in particular. At many places speed breakers are car breakers and vehicle breakers. Crossings and intersection of highways, with poor demarcation and absence of indicators and lights result in severe and serious accidents. Sharp bends and blind turns and unfamiliar routes are other risky conditions. At times, roadside objects such as trees, poles and other rigid objects such as road signs tend to be safety problems. The design of roads and road network is a critical factor in RTA.

Intentional Injuries (Suicide)

RTA deaths account for 40% of all injury deaths worldwide and share of suicidal death is next only to RTA. Intentional injuries group that include self-inflicted injuries and suicide, violence and war account for an increasing share of burden, especially among economically productive young adults.

Nationwide data on intentional injuries is not available, such injuries are reflected and mixed with total injuries. Suicide rate is one of the indicators of mental health status of a territory. In a limited study done in one rural community development block in Haryana, the proportion of suicidal deaths to total deaths was 6.67% and it ranked as 6th leading cause of mortality. It speaks of level of unrest, unemployment, unhappy married life and other social problems. Suicidal deaths were due to use of poisoning predominantly celphos tablets (aluminium phosphide), burns, hanging and railway accidents, drowning, etc. Over 1.34 lakh suicide deaths were reported in 2018 (National Health Profile India, 2020). WHO in 2012 reported 2,58,075 suicidal deaths in India. Nearly 1% of population reported high suicidal risk. Suicidal death rates are the highest in India in the world (12.7 per lakh population in 2019).

Home Accidents

Children are at risk in and around the home and on the roads. Home injuries include burns and scalds, cuts, choking by swallowing small objects, poisoning, falls, drowning, animal bites and injuries due to unsafe playing. It necessitates safe environments for young children in home and in the vicinity of home, safe play and safe toys and keeping medicines and harmful substances out of reach of young children. Similarly, in preschool activities safe play methods and safe toys be used to prevent accidents.[7]

Prevention of Accidents

Education and Awareness on Road Life Savers

It is the first step in the direction of bringing behaviour change through effective communication on road safety measures. This should be ongoing activity in schools, colleges and should form integral part of formal and non-formal education programmes. Awareness generation on safety of RTA in masses by organized programme through network of television, radio and press is in place.

WHO recognized road injuries as a global epidemic and devoted world health day 7th April, 2004 to theme "road safety is no accident" and in collaboration with World Bank launched the world report on "road traffic injury prevention" to help nations to develop their national plans on road safety and prevention of RTA. Through this effort WHO, focused on building awareness.

In response to RTA epidemic in 2010, UN general assembly adopted **decade long action** for **road safety** (2011–2020). A Global Action Plan provides a road map towards **Goal** of reducing and stabilizing predicted levels of road traffic deaths around the world. Cost effective solutions under Global Action Plan include:

i Road safety management
ii Safer roads and mobility
iii Safe vehicle
iv **Safer road users** (changing road users behaviour on key risk factors).
v Improved post-crash response and hospital care (trauma centres).

Regulations for Safe Road Users

Government has responsibility to regulate the behaviour of road users. Human beings are human beings, their behaviour needs to be controlled through education and by regulation through Stringent Amended Road Safety Motor Vehicle Act, 2019. Which hiked penalties for traffic violation as well as electronic enforcement. Licensing for driving should be strictly regulated, driving tests, medical fitness to drive, enforcing speed limits, enforcing use of **safety belts, helmets**, child restraints, handheld mobile phones, and **regular** inspection of vehicles and to prevent **alcohol impaired** driving. Regulations are most often defied than observed. Self-regulation of behaviour is fundamental to save oneself and save others on the road. Government should set and enforce uniform vehicle safety standards.

Improving Public Transport System

To decrease the number of vehicles on the road, the safe, efficient and affordable public transport system must be

developed by the government. Improving public transport system is under way through provision of adequate roadworthy transport and developing metro-railways in metropolitan cities. Government alone will not be able to provide fleet of adequate and efficient transport system. Privatization is partial answer to the problem. If people develop confidence in public transport system, they will avoid use of personal vehicles. Other innovative and user-friendly methods to reduce the vehicle population on the road should be developed. Developing habits of walking and encouraging cycling is an opportunity to **lose weight** and **prevent obesity**, however, safe lanes for **pedestrian** and **cyclist** are essential. Human population and population of vehicles need to be controlled and stabilized; it is a dire necessity/need.

Pedestrians

Since pedestrian, cyclists, and motorized two-wheelers are affected maximally, their needs should have prime focus to prevent RTA. To prevent crash from happening, separating pedestrian from cars and trucks, by creating barriers and fences, building guard rails, widening shoulders and eliminating "black spots". Shortest routes, subways and overbridges for pedestrian to cross road safely helps prevention of accidents. Behaviour of pedestrian is important and this can be modified through mass campaigns.

Personal Behaviour

Wearing helmets and seat belts saves life. One should develop habit of safety. Driving without alcohol and with safe limit of speed for self and others on the road, prevents accidents. Road safety education and counselling should be part of school curriculum and adolescent health programme.

Safe Vehicles

Technological improvements in car include impact absorbing front ends, collapsible steering column, seat belts, integral head rests, air bags and child seats. Crash resistant vehicles can be built. World will witness many more advance technologies. One worry is to control vehicular population or traffic on road and use **safe fuels** to prevent air **pollution** and **noise pollution**. Air pollution in the long run may lead to more deaths than trauma due to increased morbidity of respiratory illness and heart diseases.

Safe Roads and Mobility

Roads are always risky. Risks can be reduced by having safe roads and smooth movement of traffic. In the first instance, the vehicular traffic should be regulated during peak hours and risky hours. Many developments have ensured this—such as adequate traffic lights at crossings, placing barriers between traffic moving in opposite direction, broadening of roads, four lanes highways, one-way traffic and to eliminate highway intersections and marking safety lines and providing warning signals, etc. have helped to reduce RTA. Building flyovers and bye-pass roads and developing national highways are positive in many ways but growing population needs to be controlled. Road designs must take into considerations the needs of all road users. Nearly 73% of RTA deaths occur among pedestrians, cyclists and motorcyclists.

Post-crash Response Management of Accidents

To a large extent, RTA are preventable. Premature deaths and morbidity are avoidable to a great degree. The epidemic of RTA in India and other developing countries is still at an early stage and we can learn lessons from the developed countries and from within our own country.

Trauma Management

Accidents can be minimized but cannot be eliminated altogether. Trauma on road will occur due to human errors and to some extent failure of vehicle. Trauma management is essential component of saving **lives** and limbs and preventing disabilities and providing rehabilitation services.

Self-help and Local Help

Self-help during trauma and help of local persons or co-passengers is the first response. First-aid measures, such as dressing for bleeding and safe and prompt transportation of injured to nearby health facility within golden hour can save lives.

NATIONAL PROGRAMME FOR PREVENTION AND MANAGEMENT OF TRAUMA AND BURN INJURIES

EXTENT OF PROBLEM

Globally in 2015, injuries caused 1.35 million deaths accounting for 2.1% of all deaths. Road traffic accidents are the eighth leading cause of deaths. In India, during the year 2019 out of estimated total 44,9002 accidental deaths, 151,113 were on account of RTA.

Trauma care facilities in governments hospitals on national highways have been developed to provide trauma care within an ambit of golden hour.

Objectives of the Programme

To establish a network of trauma care facilities on national highways in order to:

- Reduce incidence of preventable deaths due to road traffic accidents by observing golden hour principle.
- To develop referral and communication network between ambulances and trauma care facilities for optimal utilization of services.
- To develop National Injury Surveillance Centres.
- To develop trauma registry centres (injuries and burns)

- To educate and train people on **Good Samaritan** (someone who helps an accident victim), guidelines.

Programme of Trauma

- Network of trauma centres have been developed in Govt hospitals along the golden quadrilateral highway corridor covering 5846 km connecting Delhi to Kolkata, Chennai to Mumbai. Delhi as well as North to South and East to West corridors covering 7716 km connecting Kashmir to Kanyakumari and Silchar to Porbandar, respectively.
- District trauma centres have been developed in most of the districts located on highways or nearby to highways. As per supreme court order of 2017 every district will have trauma care centre.

Types/Categories of Trauma Centres

The scheme provides for 3 categories of trauma care centres, viz. LIII, LII and LI:

- The level III trauma centre is designated to stabilize the patients and manage the trauma victims and refer the trauma victim to level II and level I.
- The level II provides definite care to severe trauma victims.
- The level I provides highest level of definite and comprehensive care to patients with complex injuries.

Financial assistance of ₹ 4.8–16 crores has been provided to strengthen the manpower, building, equipment, communication network, legal services and data entry operator in existing state government hospitals. One advance life support ambulance is augmented by Ministry of Surface Transport at each of trauma care centers, while National Highway Authority of India (NHAI) is providing one basic life support ambulance at a distance of every 50 km of the national highways. Capacity building for trauma care will continue as "National programme for trauma care" under the umbrella scheme. "National programme for prevention and management of trauma and burn injuries" till March 2020.

Research

Data on RTA and impact of safety measures need to be generated. Police and Bureau of Crime under Ministry of Home Affairs should collect data, analyze and generate adequate information to improve the system of road safety. It is a multisector endeavour. Data collection on physical circumstances of accidents, features of vehicles involved and their movement, characteristic of road users, such as use of alcohol or drug, nature of initial injuries sustained and their subsequent evolution. Police officials and officers need to be trained to collect such data and disseminate it on regular basis to effect improvement. Health sector can collect regular information on nature and extent of trauma necessitating development of improved trauma centres and services at various levels.

Surveillance: Programme for injuries registry and surveillance is being developed.

The Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology in New Delhi has contributed much to a better understanding of the road injury problems of vulnerable road users and to identify possible intervention in low income and middle income countries. District, state and national Integrated Road Accidents Database (IRAD) help for better planning for prevention of RTA.[8]

NATIONAL PROGRAMME FOR PREVENTION AND MANAGEMENT OF BURN INJURIES (NPPMBI)

"Burn" is a major public health problem all the world over. In India alone, every year around 7 million people suffer from burn injuries, out of which 7 lakh need hospitalization and 2.4 lakh become disabled. Approximately 1.4 lakh people die of burn injuries every year, making burn injuries as second largest group of injuries.

Objectives of the programme

i To establish network of burn units with adequate infrastructural facilities for burn management and rehabilitation in all identified Government Medical Colleges and district Hospitals.

ii To reduce incidence, mortality and morbidity due to burn injuries.

iii To improve awareness among general masses and vulnerable groups especially the women, children, industrial and hazardous occupational workers.

iv To carry out research for assessing behavioural, social and other determinants of burn injuries for planning, monitoring and evaluation.

***Components*:** The programme consists of two major components, i.e. establishing dedicated burn units at 70 medical colleges and 25 burn wards at district hospitals. During 12th plan district hospital component will be implemented through NRHM division whereas; medical college component will be part of "Human resource in Health and Medical Education Scheme". Fund sharing between centre and states is 60:40. The programme is to be continued under the umbrella scheme "National programme for prevention and management of trauma and burn injuries".

The main components are

- Prevention programme (IEC)
- Treatment and rehabilitation
- Training
- Monitoring and evaluation
- Research.

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BLINDNESS

EPIDEMIOLOGY OF BLINDNESS

Definition of blindness: Presenting visual acuity <3/60 in better eye with available correction, and for lay persons, it is further simplified as "inability to count fingers in daylight at a distance of 3 metres". The latter definition can be used by health workers, to *screen* the cases of *blindness* at the village level.

- *Visual impairment:* Presenting visual acuity, <6/18 in better eye with available correction
- *Severe visual impairment:* Presenting visual acuity <6/60–3/60 in better eye with available correction.

Global Prevalence

The blindness is a global problem. Recent estimates of World Health Organization suggest that there are 40 million people, who are blind worldwide and that more than 90% of them live in developing countries. Nearly one-fifth of them are in India. In 2013, WHO adopted universal eye health: Global action plan 2014–19 with the aim to reduce prevalence of avoidable visual impairment by 25% by 2019 compared to the baseline prevalence of 2010.

New Estimates of Blindness in India, 2018[1]

Until now under national programme of control of blindness in India, using a visual acuity cut-off of <6/60 in the better eye, the number of blinds estimated were 13 million in India.

Now India has adopted WHO criteria to define blindness. WHO defines blindness as "Inability to count fingers at a distance of 3 metres, i.e. visual acuity of less than 3/60 (Snellen) or its equivalent. Going by new definition the population of blind people in India will reduce to 8 million in 2017".

Estimated prevalence of blindness in population in 2018 was 0.36% down from 1% in 2007, and that of severe visual impairment was 0.35%. National survey (2016–2018) further estimated that in 2017 there were 4.7 million blinds and 4.69 million were having severe visual impairment, making a total of 9.48 million people needing priority attention.

Incidence of Blindness in India

Every year we add on 2 million blinds in the total pool of blindness, which is the incidence rate of blindness in India. Three-fourths of these blinds in India live in rural areas needing restoration of their vision. Rural blinds can be reached through primary healthcare set up. Therefore, the blindness control programme has to be an integral part of primary healthcare.

Causes of Blindness in India[2] in 2001 Survey: *Cataract, Refractive Errors and Glaucoma*

Untreated cataract (62.6%) continued to be the major cause of curable blindness in India. Uncorrected refractive errors were responsible for 19.7% of the blindness. Other important causes of blindness included glaucoma (5.8%), posterior segment pathology (4.7%), corneal opacities 0.9% and others 5.1%. Estimated childhood blindness/low vision is at 0.8/1000.

Trends of Blindness

Trends of prevalence of blindness and visual impairments in persons aged 50 years and above (Table 8.53).

Over the years the prevalence of blindness among persons aged 50 years and above has reduced considerably. Blindness as defined by presenting visual acuity <3/60 in better eye, has reduced from 5.3% in 2001 to 3.6% in 2007 to 1.99% in 2019. Visual impairment has reduced from 32.3% in 2001 to 24.8% in 2007 to 13.73% in 2019. Prevalence of functional low vision was 1.03% and that of blindness <3/60 (using pinhole) was 1.75%.

Prevalence of Blindness and Visual Impairment in Aged 0–49 Years

Prevalence of blindness was 0.52 per thousand and visual impairment was 4.43 per thousand in this age group.

Table 8.53: Trends of blindness (PVA <3/60 in better eye) and visual impairment (PVA <6/18 in better eye) in persons aged 50 years and above from 2001 to 2019

Year of survey	*Prevalence of blindness (%)*	*Prevalence of visual impairment (%)*
2001	5.30	32.30
2007	3.60	24.80
2019	1.99	13.76

National Blindness Survey in Population 2018–19

Causes of Blindness

Cataract continues to be major cause of blindness and responsible for 66.2% of blindness. The other important causes of blindness were corneal opacity (7.4%), cataract surgical complications (7.2%), posterior segment disorders excluding diabetes retinopathy and age-related macular degeneration (5.9%) and glaucoma (5.5%). Refractive error was the most important cause of visual impairment and second most important cause of blindness in 2001 survey, but the current survey showed that refractive error is not an important cause of blindness. Corneal blindness emerged as second important cause of blindness in 2019 survey. Besides this the proportion of blindness due to complications of cataract surgery have also increased. Principal causes of visual impairments were untreated cataract (71.2%) and refractive errors (13.4%) and cataract surgical complications 5.9% (Table 8.54).

Causes of Blindness and Visual Impairment in Population Aged 0–49 Years

Major causes of blindness in this age bracket was non-trachomatous corneal blindness (37.5%). Causes of visual impairment were refractive error (29.6%), untreated cataract (25.4%), all globe/CNS abnormalities (15.5%), and non-trachomatous corneal opacities (14.1%).

Types of Blindness

a. Preventable Blindness (Trachoma, Vitamin A Deficiency, Phthisis and Onchocerciasis)

Blindness due to smallpox infection has been eradicated. A blinding malnutrition due to vitamin A deficiency has been significantly reduced and nearly eliminated but problem of vitamin A deficiency still exists in certain pockets. Vitamin A prophylaxis programme as a part of primary healthcare continues to eliminate blindness due to vitamin A deficiency. Keratomalacia has almost disappeared in India, and bitot spots declined to the level of 0.7% in the year 2001 in children below 6 years of age. Infection like, trachoma has been controlled in the country due to improved socio-economic conditions and access to primary healthcare. Programme of trachoma control has been made an integral part of blindness control programme since 1976.

b. Curable Blindness

Cataract is an example of curable blindness and its prevalence is very high in India. Untreated cataract is major cause of social and economic blindness in India even in 2018 survey.

c. Avoidable Blindness

It is the sum total of preventable and curable blindness. In India, 93–96% of blindness is avoidable.

Table 8.54: Causes of blindness and visual impairment in persons aged 50 years and above and 0–49 years 2019

*Age group/ principle causes**	*50 years and above (%)*		*0–49 years (%)*	
	Blindness	*Visual impairment*	*Blindness*	*Visual impairment*
1. Cataract untreated	66.2	71.2	0	25.4
2. Corneal opacity (non-trachomatous)	7.4	1.8	37.5	14.1
Corneal opacity (trachomatous)	0.8	0.2	0	0
3. Cataract surgical complications	7.2	5.9	0	1.4
4. Glaucoma	5.5	1.4	0	0
5. Other posterior segment disease	5.9	2.8	0	2.8
6. Phthisis	2.8	0.4	12.5	1.4
7. Diabetes retinopathy	1.2	0.8	0	0
8. ARMD	0.7	0.8	0	0
9. Aphakia uncorrected	1.7	1.0	0	0
10. Refractive errors	0.1	13.4	0	29.6
11. All other globe/CNS abnormalities	0.5	0.3	25.0	15.5
12. Other undetermined	–	–	25.0	9.9
Total	**100**	**100**	**100**	**100**

* Source: National Survey on Blindness 2016–2018

Social and Economic Blindness

The prevalence of *social blindness* in persons above 50 years age group (vision <3/60 in the better eye, which corresponds to the WHO definition of blindness) is around 1.99%. The inability to count fingers at a distance of 3 meters (with the better eye) with best correction is used to define social blindness. Since this level of visual impairment curtails the day-to-day movement of an individual and prevents social interaction with family and peer groups it is also referred as WALK VISION. There are wide inter-district variations in the prevalence of both social and economic blindness.

The overall prevalence of *economic blindness* is 3.95% (blindness 1.99% plus severe visual impairment 1.96%) (one eye <6/60–3/60, fellow eye <6/60 NPL). Since this level of vision prevents a person from earning his wages, it is also referred to as WORK VISION (presenting vision <6/60).

Sex

Females have higher prevalence of both social and economic blindness as well as low vision as compared to males. This is because of more exposure of females to indoor air pollution.

Urban Rural Distribution

Urban areas have low prevalence of economic and social blindness as compared to rural areas. Prevalence is higher in poor and illiterate.

Age

Prevalence of blindness of all types increases with advancing age.

Literacy

Persons educated beyond high school have lower prevalence of blindness as compared to illiterate.

Cataract Surgery

Blindness is a big social problem in India, besides being an economic problem. Restoration of sight increases self-reliance and increases longevity and productiveness. In view of the high prevalence of blindness in India and its social relevance, the Government of India initiated Blindness Control Programme in India in 1976.

NATIONAL PROGRAMME FOR CONTROL OF BLINDNESS AND VISUAL IMPAIRMENT (NPCBVI)

8

National Programme for Control of Blindness (NPCB) was launched in the year 1976 as a 100% centrally sponsored scheme. Later on it was named as NPCBVI. The control of blindness was accorded high priority and included in the Prime Minister's 20-point programme; emphasis on camp approach was one of the highlights of this programme.

Problem: High prevalence of blindness in general population in India 1.38–1.49% in 1974 and 1986 respectively and in 2001–2002 it declined to 1.12% and it further declined to the level of 1.0% in 2006–2007 and reduced to 0.36% in 2019.

Goal: The goal of blindness control programme was to reduce the prevalence of blindness from 1.4% (1974) to 0.25% by 2025 AD. The goal has not been achieved, as level of blindness in the country was 1.0% as per prevalence survey of 2006–2007. As per survey in 2015–2018 the prevalence of blindness is 0.36% in India.

Objective of NPCB

The objectives of the programme are:

- To reduce the backlog of avoidable blindness through identification and treatment of curable blinds at primary, secondary and tertiary levels.
- "Eye Health for All" and prevention of visual impairment through provision of comprehensive universal quality eye care services. Covering diseases other than cataract, viz. diabetic retinopathy, glaucoma, corneal transplantation, vitreoretinal surgery, childhood blindness including retinopathy of prematurity (ROP).
- Strengthen and upgradation of regional institutes of ophthalmology (RIO) to centres of excellence.
- To develop additional human resources for providing high quality comprehensive eye care in all districts of the country.
- To improve quality of service delivery.
- To secure participation of voluntary organizations, and private practitioners in delivering eye care and to enhance community awareness on eye care and lay stress on preventive measures.
- Control of corneal blindness including establishment of eye banks and their networking.
- Increase and expand research for prevention of blindness and visual impairment.
- Setting up of multipurpose district mobile ophthalmic units.

Reduction of Backlog of Curable Blindness

By two approaches: *Eye camps* and *fixed facility* for *eye surgery*.

Implementation of Programme

National Programme for Control of Blindness (NPCB) was launched in the year 1976 as 100% centrally sponsored programme. The activities under this programme included upgradation of medical colleges and district hospitals, development of mobile eye units, recruitment of required

ophthalmic manpower and provision of various ophthalmic services.

Eye Camps (Reach Out Strategy)

Eye camp approach has been used to cover inaccessible rural, tribal and difficult areas. Mobile eye clinics were added in various states to augment eye care services primarily to focus on cataract surgery. Eye camps have been very popular and India has longest and largest experience of eye camps. Eye camps were organized by voluntary agencies in a big way. Lions clubs, Rotary clubs and many Non-Governmental Organizations (NGOs) organized eye camps to cover the backlog of cataract surgery. Support of NGOs, voluntary organizations and private practitioners has been significant as over 61% of backlog was covered by these agencies and government sector could reach only to 39% of needy blinds. Blindness programme has achieved strong public–private partnership. All the voluntary agencies and NGOs were provided funds by the government at fixed rate of ₹ 150 per case.

Camp surgery has its limitation, over the years, it served the compelling needs and trend has now shifted to fixed centre approach. Dependence on eye camps has now been reduced except in remote and tribal areas.

Fixed Centres (Reach in Strategy)

The government has given substantial financial help to upgrade the eye services at the district, sub-district and medical college hospitals, besides hospitals of NGOs. The country is now self sufficient to tackle the problem of blindness.

A national survey was conducted in 1986–1989 to evaluate the programme, which revealed a prevalence rate of 1.49%, hence there was no decline and prevalence levels remained unaltered from 1976 to 1989. Revised strategy was evolved. In 1994, World Bank assistance for NPCB was obtained for states (Andhra Pradesh, MP, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh and J & K), which performed poorly.

DISTRICT BLINDNESS AND VISUAL IMPAIRMENT CONTROL PROGRAMME (DBVICP)

DBCP was revamped in 1994 to give it a new push. District blindness control societies (DBCS) were established in each district and funds were directly provided to DBCS by the central government.[3] Since the launch of national rural health mission (NRHM), DBCS have merged with district health mission.

The main objectives of DBCP are

1 To achieve the goal of 0.3% level of prevalence of blindness.
2 To achieve excellence in eye care services resting on high quality patient care.

The primary purpose of DBCS is to plan, implement and monitor all the blindness control activities in the district under the overall guidance of the state/central organization for the NPCB.

Composition of DBCS

District collector/magistrate is the Chairman of the DBCS and the chief medical officer is the Vice Chairman. District programme manager is the coordinator and member secretary and chief ophthalmic surgeon or head of ophthalmology of medical college is the technical advisor. The medical superintendent, district education officer, project Director, DRDA, ophthalmic surgeon of mobile eye unit, President of Indian Medical Association and 3 representatives of NGOs, district mass media officer and practising ophthalmic surgeons are the members. There should be at least one women and one SC/ST member in the DBCS. The membership of non-officials should be for one year only.

Expenditure

The total expenditure on drugs and consumables should not exceed ₹ 150 × number of cataract operations performed in the government sector. Standard lists of consumables have been evolved.

Key Functions of DBCS

1 To assess the magnitude and spread of blindness in the district by means of **active case finding** village-wise to be recorded and maintained in blindness registers.
2 To review periodically and monitor the implementation of the district action plan.
3 To prepare a list of voluntary agencies and private hospitals/practitioners and actively involve them in the programme. DBCS should coordinate activities of the government, non-governmental and private sectors in the field of eye care in the district.
4 To motivate people to pledge their eyes for donation by utilizing all available media.
5 Provision of free spectacles to old persons suffering from presbyopia to enable them for near work.

Microplanning at District Level

Each district should evolve a microplanning for preparing a district action plan through resource mapping by following steps.

Line listing of blind persons by active screening (50+ years) in each village of the district. Screening can be done by trained health staff, involvement of NGOs, *Panchayat* and volunteers (after one day training). This would lead to village-wise registers of blind persons.

Mapping of eye care infrastructure: By plotting all fixed facilities and eye surgeons in government, voluntary

and private sector available within the district to know available trained manpower in the district to undertake cataract surgery (ICCE or IOL).

Allocate targets: Each eye surgeon should be given 700 cataract operations per year.

Considering the objective of clearing the backlog of cataract blind persons now the minimum target is to achieve 400 cataract surgeries per 100,000 populations per year.

Technical targets: It is expected that minimum of 30% of operations should be performed by IOL surgery and 70% of the total by conventional surgery but this will depend on demand of the clients.

Social targets: As there is higher prevalence of cataract amongst women, it is expected that more than 50% of all operations shall be for women.

Social class: On the basis of census population percentages of operations performed on SC/ST and minorities should match with the proportion of these population groups. In fact, there is an evidence that prevalence of blindness is higher in such classes.

Economic criteria: As defined by DRDA percentages of people living below poverty line should invariably be covered with free cataract surgery. There is an evidence to show that the prevalence is higher in such classes and programme must reach poorest people.

It is advisable to have equitable distribution of services to each community development block and each primary health centre. Assign targets to each PHC and each block.

Targets by eye care facilities: Various norms have been fixed on the basis of eye beds, eye surgeons. These are minimum norms and efforts should be made to enhance the output. Operation per surgeon per year 700, operations per bed per year 50 operations.

Emphasis is on quality of eye surgery. Better options are using operation theatres constructed and maintained as per specifications to avoid infections and postoperative complications. Therefore, the current trend of conducting surgeries in camp conditions has been reversed. Now most surgeries are performed in hospitals. Camps should only be held if it is must or area is difficult. Camps should have conditions for safe surgery.

Reach in strategy: It is suggested that 75–80% of total target must be achieved through institutions and hospitals to ensure quality of service. Patient should be referred to identified hospital as per geographical access. *Reach out strategy* (camps) should be meant for remote and inaccessible or difficult areas without compromising quality aspect.

Major Performance Indicators

Against the target of 6 to 7 million per annum, 5.8 to 6.3 million cataract operations have been performed per annum, thus achieving 90–96% of target from year 2009 to 2019. Over 88 lakh children in schools have been provided free spectacles per year against the target of 9 lakh.

Achievements

Percentage of cataract surgeries where IOL was implanted increased from 20% in 1997–1998 and to 94.2 in 2017–2018. Minimum target for cataract surgery rate per lakh population was set at 400 per year. The states of Gujarat, Punjab, Tamil Nadu, Andhra Pradesh, Maharashtra, Delhi and UT of Puducherry have attained the rate of 400 operations per lakh population. Bihar and Assam were the lowest performing states.

School Screening Programme for Refractive Errors

Around 6–7% of children aged 10–14 years have problems with their eyesight affecting their participation and learning at school. Children are first screened by teachers and later on confirmed by ophthalmic assistants. The teachers can use the 6/9 optotype ('E' card with "4E". The size of 'E' in the card is equal to 6/9 optotype of Snellen's chart) to categorize the normal and abnormal children. All children unable to pick up the 6/9 optotype with either eye are then referred to nearby PHC/CHC. School teachers are able to identify 80–90% of children with poor vision by this method. Corrective spectacles are prescribed or provided free of cost to the poor. School eye screening programme is very weak and is done in the absence of parents and mostly by **ophthalmic assistants** who are trained for eye work for one year after plus two and are posted at community health centre.

Development of Infrastructure

Construction of eye wards, operation theatres, dark rooms was undertaken during the 9th plan in the states covered under the World Bank assisted Cataract Control Blindness Project to enhance capacity of eye care in public sector. State-of-the-art the pieces of equipment were also provided under the project.

Training

Since 1996–1997, training of eye surgeons in IOL surgery was taken up. 100 faculty members of medical colleges were trained as trainers. This was followed by training of district eye surgeons in IOL surgery. So far, 1525 eye surgeons have been trained in the country. Training of nurses, ophthalmic assistants and teachers is also supported.

IEC Activities

Special campaigns for mass awareness were undertaken during eye donation fortnight and World Sight Day (2nd Thursday of October). IEC material and training manuals are produced centrally and disseminated to the states. Currently 5–7 lakh donated eyes are collected per annum in India. Eye banks have been established and hospital

retrieval programme is the main strategy for collection of donated eyes, which envisages motivation of relatives of patients and accident victims.

Support to Voluntary Organizations

Since voluntary organizations play key role in NPCB, the DBCS were established all over the country. Till date 575 DBCS have been set-up. Decentralized mechanism is working through DBCS. Many of the eye units with NGOs have been upgraded besides establishing eye banks.

Sentinel Surveillance Units (SSUs)

25 SSUs have been established (under NPCBVI) in various medical colleges with the objective to study the cataract **outcomes** by review of cataract surgical records (CSRs) and to conduct survey and monitor the pattern of eye morbidity in the hospital and in the community. These units have generated useful information, which has been fed back to (NPCBVI) for improving the quality of services. Now 73.4% cataract operated had very good outcomes.

Vision 2020: The Right to Sight[4]

- *"Vision 2020:* The Right to Sight" is a global initiative launched by the WHO and a task force of International NGOs to combat the gigantic problem of blindness in the world. It was launched in the year 1999.
- ***The right to sight initiative:*** A global initiative has been launched to control avoidable (preventable plus curable) blindness by the year 2020. India is committed to this initiative. Plan of action for the country has been developed in line with Global initiative with following main features:
- ***Target diseases:*** Cataract, refractive errors, childhood blindness, corneal blindness, glaucoma, diabetic retinopathy and trachoma to combat blindness.
- ***Human resource development:*** Augmenting middle level ophthalmic personnel and increasing the capacity and skills of available human resource in various areas of ophthalmology besides development of professional eye care managers, etc. One eye surgeon for every 5 CHCs has been proposed under NRHM.
- ***Infrastructure development:*** Proposed four-tier structure includes centre of excellence (20), training centres (200), service centres (2000) and vision centres (20,000).
- ***Eye banking services:*** Strengthening of eye banking services and collection of donated eyes.

Trachoma Elimination by 2020—Global Trachoma Mapping Project has been Initiated in 29 Countries

An estimated 146 million people have the active infection with the microorganism *Chlamydia trachomatis*, for which antibiotic treatment is indicated. There are approximately 10.6 million adults with in-turned eye lashes (trichiasis/entropion) for which eyelid surgery is needed to prevent blindness. An estimated 5.9 million adults are blind from corneal scarring due to trachoma. Trachoma: A neglected tropical disease is a second most common cause of blindness in sub-Saharan Africa, China and Middle-Eastern countries. Trachoma is to be controlled through implementation of **SAFE** strategy integrated into primary healthcare.

S: Surgery by trained paramedical staff for trachoma trichiasis (TT).

A: Antibiotic treatment (either tetracycline eye ointment or oral azithromycin) for children with active disease.

F: Facial cleanliness promotion—to reduce transmission.

E: Environmental improvement, including personal hygiene: To increase access to clean water and improved sanitation as part of primary healthcare.

Active trachoma prevalence in India has come down to 0.7% in children aged one to nine years much below the elimination target of less than 5% (WHO). Thus, active trachoma in India stands eliminated awaiting WHO certification. However, sequelae of trachoma are prevalent to the extent of 3.5 per 1000 persons above the age group 15 years, higher than WHO standards of 2 cases per 1000 people. India is committed to eliminate active trachoma and its sequelae by 2020. (The Tribune, Chandigarh/ Monday/11 December 2017, Aditi Tandon.)

In line with Global initiative of "Vision 2020 the Right to Sight" India has set a goal to reduce prevalence of blindness from current level of 0.36 to 0.25% by 2025.

Refractive Errors

In India, this was the second most common cause of blindness in 2001. Refractive errors were cause of visual impairment in 29.6% of persons below the age of 50 years in 2018 (Table 8.52).

The provision of refractive services and low vision care for patient by:

1. ***Screening:*** Identification of individuals with poor vision which can be improved by spectacles or other special devices.
2. ***Refraction:*** Evaluation of the patient to determine what spectacles or devices may be required.

Vitamin A prophylaxis programme is there to prevent blindness due to vitamin A deficiency. Mega dose of vitamin A given to children between 9 months and 5 years of age has reduced the blindness due to vitamin A to a significant extent. Similarly, immunization against measles prevents blindness. Ophthalmia neonatorum is preventable.

New Initiatives

- Provision of setting up of 400 multipurpose district mobile ophthalmic units.

- Provision for distribution of 10 lakh spectacles at ₹ 100 per spectacle to old persons suffering from presbyopia.
- Launching "standards of eye banking in India 2020"
- Focusing on other causes of visual impairment like-diabetic retinopathy, retinopathy of prematurity, corneal blindness, glaucoma and childhood blindness.

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2 GOI. National Survey on blindness 2001–2002. NPCB Quarterly Newsletter 2002; 1(2).

3 GOI. National programme for control of blindness highlights. Guidelines for District Blindness Control Society. New Delhi: Ophthalmology division DGHS, MOH and FW; 1994.

4 GOI. National Programme for Control of Blindness in India. The "Right to Sight" plan of action DGHS, MOH and FW, GOI; New Delhi.

Competency addressed: The student should be able to:
CM 8.2: Describe and discuss the epidemiology and control measures including use of essential laboratory tests at the primary care level for common cancers.

CANCERS

EPIDEMIOLOGY OF CANCERS

Demographic transition in India has resulted in rise in life expectancy. Life expectancy in India has increased to 70.7 years for females and 68.2 years for males (RGI). The proportion of aged above 60 years has risen from 7.4% in 2001 to 11% by 2021.

Non-communicable diseases have risen in India because of change in lifestyles and longevity. Cancer is one of the non-communicable diseases, will emerge as a leading morbidity (disease) in the future. Right now, India has one of the lowest rates of cancer in the world.

Cancer Burden and Patterns in India in 2018

- There occur an estimated 1.392 million new cancer cases, 7,84,800 cancer deaths every year and there were 2.26 million 5-year prevalent cases in India's population of 1350 million in 2018 (world cancer report 2018).
- Cancer patterns in India are dominated by high burden of tobacco-related oral cancer, head and neck cancers in men and cervical cancer in women, both of these cancer types are associated with l**ower socio-economic status.** Cervical cancer trend is declining in India.
- The burden of cancer types associated with overweight, obesity, physical inactivity and sedentary lifestyles, such as breast and colorectal cancers are increasing and these cancers are associated with **high socio-economic status**, in most developed states in India and urban population. Analysis of ICMR 7 years data of 96 hospitals based concer registries indicates that overall cancer cases rose from 1.15 million in 2019 to 1.392 million in 2020 and projected to rise to 1.569 million in 2025—a rise of 12.8%. Age group 45–64 was affected most. Tobacco-related cancer cases were 48.7% of all cases.

Hopes

Around 40% of all cancers in India are *preventable*. These cancers are attributable to tobacco consumption by chewing and smoking. If tobacco consumption is totally stopped, 40% of cancer load can be reduced. It is a question of changing lifestyle or behaviour through effective education and communication. Nearly 30% of cancers in India are *curable* by early detection and prompt treatment or intervention. Early detection of cervical cancers, breast cancer and oral cancer offers a good chance of cure.

Patients with all sort of chronic diseases thought to be 'cancers' by majority of people of district Bathinda and adjoining areas (in Punjab) board Bikaner express train popularly known as "cancer express train" by local people for treatment of their illnesses at Bikaner medical college and return by the same train next day. This practice is prevalent since long.

Common Cancers in India (Globcan 2012)

The most common cancer in India or *Indian cancer* is oral cancers (oral cavity, pharynx, tongue and lips) attributable to tobacco consumption. Oral cancer accounts for 7.2% of all cancers.

Breast cancer is the commonest cancer among females followed by cervical cancer. These two cancers account for 26.4% of all cancers in women.[1]

An Atlas of Cancer in India[2]

ICMR has prepared atlas of cancer in India which maps the cancer in India—highlighting that mouth, tongue, pharynx and nasopharynx cancers are the world's highest cancers in India related to tobacco (Fig. 8.24).

Since National Cancer Registry Programme data emanates from selected urban areas and only one rural registry that covers part of one district, it would be difficult to provide valid estimates of burden of cancer in the entire country, where over 66% of population lives in rural areas.

Incidence Rate

On an average, about one in 10 Indians could develop cancer in their life time and one in 15 Indians will die of



Fig. 8.24: An atlas of cancer. Aizawl has world's highest incidence of lower pharyngeal and tongue cancers in men. New Delhi has world's highest incidence of gallbladder cancer in women. Wardha has world's highest incidence of mouth cancer. Puducherry has among the world's highest incidence of mouth and tongue cancers among men. Kohima has one of the world's highest incidences of nasopharyngeal cancer

cancer. Estimated number of new cancers diagnosed in India every year are 1.392 million. Cancer incidence rate is generally expressed as age adjusted or age standardized (according to world standard population) incidence rate per 1,00,000 persons for all anatomical sites.

Cancer incidence can also be expressed as crude rates, age adjusted rate and truncated rate. Crude incidence rate is the total number of new cancer cases in a particular year per 1,00,000 population in the defined geographical area. Crude rates represent the actual burden of illness in the country and changes in it over time.

Truncated age adjusted incidence rate (TR): This is similar to age adjusted rate except that it is calculated for the truncated age group 35–64 years of age. Over 60% of cancers occur in this age bracket hence screening of cancer in age group 30–65 is an appropriate strategy.

Leading Sites of Cancer in India

Alcohol and Tobacco Related Cancers (TRCs)

Sites of cancer that have been associated with use of tobacco (tobacco-related cancers—TRCs) include oral cavity, pharynx (including oropharynx and hypopharynx, oesophagus, larynx, lung and urinary bladder).

Overall, among males, cancer of sites associated with use of tobacco and alcohol are the most frequent. Cancer of the lung is numerically the number one cancer. It is the leading site in Delhi, Mumbai and Bhopal, wherein it constituted around 10% of cancer of all sites. It is the second and third leading site among males in Bengaluru and Chennai, respectively.

Based on currently available data, in registries in all continents, males in Bhopal have the highest age adjusted incidence rate (8.8 per 1,00,000) of cancer of tongue. Similarly, the rates of cancer of the oral cavity in both males and females in all urban registries are among the highest in the world.

In women, cancers of the cervix and breast together account for over 40% of cancers in urban women and over 65% of cancers in the rural registry in Barshi. The age adjusted incidence rate (8.9 per 1,00,000) of cancers of the gallbladder in Delhi, women is one of the highest in the world. The reasons are being investigated and most probable reasons are **obesity,** and excess of fats in diet and consumption of **junk foods** and sedentary lifestyle.

Though India has one of the lowest rates of cancers in the world, the current projection suggest that the total cancer burden in India for all sites will double by 2026 because of increasing longevity, greater exposure to environmental carcinogens due to industrialization, use of fossil fuels, the use of wide variety of chemical agents in industry and agriculture and the continued use of tobacco.

- The most frequent cancers among Indian males are those of mouth/oropharynx, oesophagus, stomach and lower respiratory tract. In women, cancers of cervix, breast, mouth/oropharynx and oesophagus are common.
- Tobacco-related cancers (especially cancer of oral cavity, lung) breast and cervix form more than 50% of the overall cancer burden in the country.

An increase in tobacco smoking instead of chewing might lead to rise in incidence of lung cancer, which is more difficult to detect and treat.

Causes and Risk Factors in Oral Cancer

The chief cause implicated in oral cancer is prolonged chewing of tobacco, zarda, pan and pan masala. In India and other parts of South East Asia, chewing of tobacco mixed with pan is believed to be the cause of high rate of mouth cancers. Heavy smoking and drinking, apart from poor oral hygiene and jagged teeth and ill fitting dentures have been incriminated for continuous injuries and oral cancers. In some parts of India, teeth are cleansed with toothpastes containing tobacco. Thus, oral cancers are related to unhealthy lifestyle of chewing tobacco plus smoking and drinking.

There is no 'safe limit' to alcohol consumption and even a small amount may increase the risk of cancer—accounting to over 4% of all cancers (WHO).

Risk Factors in Cervical Cancers

1 Early marriages, early childbirth and too many births.
2 Promiscuity in her or her partner and having multiple sex partners.

3 Poor hygienic practices and low socio-economic status.
4 Reproductive tract infection/sexually transmitted infections. HPV infection is one of the most common sexually transmitted infections.

Human papillomavirus (HPV) is associated with >95% of cervical cancers which is second most common cancer in women.

There is strong aetiological association between human papillomavirus (HPV) and cervical cancer. Persistent infection with oncogenic HPV is **necessary cause** for cervical cancer. Almost 7.9% of women in general population are estimated to harbour cervical human papillomavirus (HPV) at any given point in time, 82.5% of invasive cervical cancers are attributed to this virus. The four common oncogenic HPV types: HPV 16, 18, 31 and 45 are responsible for cervical cancer.

Risk factors in *breast cancer* include unmarried women, delayed marriages, low fertility, obesity, high fat diet, lack of exercise, high oestrogenic status and family history of breast cancer. However, breastfeeding is protective against breast cancer. Breast cancer in urban females of high socio-economic status is on rise due to late marriages and obesity.

NATIONAL CANCER CONTROL PROGRAMME (NCCP) IN INDIA

The Cancer Control Programme was initiated in 1975–1976 as a central sector project. Based on the baseline information of cancer registries, it was modified and renamed as National Cancer Control Programme (NCCP) in 1985 and further revised in 2004. National Cancer Control Programme has been now integrated with diabetes, cardiovascular diseases and strokes in the year 2011. The objectives of NCCP were:[3]

1 Primary prevention of tobacco-related, breast and cervical cancers, by health education through government and non-governmental organizations and legislation against tobacco.
2 Early detection of cancers especially oral, cervix, and breast by population based screening programme.
3 Developing and strengthening of existing cancer treatment facilities through regional cancer centres, medical and dental colleges/tertiary cancer centres.
4 Increasing access to palliative care in the terminal stage of cancer.

Cost Effective Strategies—Best Buys as per WHO

1. For Primary Prevention and Primordial Prevention, Focus is on Total Population or Targeting Most Vulnerables—School Children and Adolescents

These measures include **prevention of establishment of tobacco habits/culture (smoking, chewing and snuffing)** in the community. Educating young children in the family through role model of parents in the family and continuing the educational activities in preschool, school and college level. Tobacco-free society should be aimed at. School teachers should become ideal role models. Similarly, mass media and child to child programme and school health programme can play effective part in health education. Celebration of no tobacco day on 31st May every year can reinforce the drive against tobacco use. Mass media and indigenous media apart from counselling in hospitals and clinics and interpersonal communication can help build mass movement against tobacco use.

Tobacco Control

"Tobacco is a killer, we need a broad alliance against tobacco, calling on a wide range of partners to halt the relentless increase in global tobacco consumption (pandemic of tobacco)". Most nations follow now WHO Framework Convention on Tobacco Control (FCTC), governing—tobacco taxation, smoking prevention and treatment, illicit trade, advertising, sponsorship and promotion and product regulation. It was a milestone in the history of global public health. We have legislation which bans tobacco advertising and health warning appears on each pack "Smoking is injurious to health". Basically, it requires adoption of healthy lifestyles. Indian Government passed a comprehensive Cigarettes and Other Tobacco Products Act (COTPA) in 2003. This Act deals with a complete ban on advertisement of all tobacco products in all media, ban on smoking in public places and ban on sale of tobacco products to persons below the age of 18.

Specific Protection–Best Buys—Vaccines Against Cancer

Global strategy for elimination of cervical cancer has been launched by WHO in 2020. Cervical cancer is preventable and curable.

There is no specific protection against cancer, except hepatitis B vaccine (which prevents chronic hepatitis and liver cancer), avoiding sunrays can prevent skin cancers and avoidance of carcinogens can prevent cancer. Similarly, human papillomavirus (HPV) vaccine is available against cervical cancer and cervical pre-cancers. Bivalent (HPV 16 and 18) and quadrivalent HPV vaccines (qHPV) are available which are safe and effective introduced in the programme in India in some states (Punjab, Delhi and Sikkim). The first indigenous qHPV against Cervical Cancer –CERVAVAC by SII Pune is under review by NTAGI. Three doses of vaccine (0, 1 and 6 months) by intramuscular injection into deltoid area are given. The best immune response is observed in younger age groups (9–13 years) before the onset sexual debut. However, since all sexually active women continue to remain at risk of acquiring an HPV infection hence all

women in 10–45 years can benefit from vaccination. Cervical cancer vaccine (HPV vaccine) for girls between 9 and 14 years (before they are exposed to HIV)—would be provided in schools as one time catch-up campaign followed by routine introduction under UIP in 2023. Screening for cervical cancers should be continued in spite of HPV vaccination. WHO has recommended two-dose schedule by intramuscular route between 9 and 14 years at an interval of 6 months and 3 dose schedule at 0, 1–2 and 6 months if vaccination is initiated after 15 years. WHO has Launched Global strategy for cervical cancer elimination. Occupational risk factors for cancer such as aflatoxin and asbestos and contamination of drinking water can be included in effective preventive strategies

Encouraging green leafy vegetables, fruits and dietary fibre provide protection against cancers. Consumption of junk foods and harmful use of alcohol leads to **obesity**—a risk factor in cancer.

2. Early Detection Strategies

The objective is to detect pre-cancerous lesions. The secondary prevention is directed towards those persons who have been exposed to risk factors and have developed the pre-cancer and cancer lesions. Self-help is best help. People are being educated to suspect cancer themselves and report to the nearest facility of their own. Fortunately oral cancers, breast cancers and cervical cancers are easier to diagnose by visual examinations, speculum examination, and self-examination of breast. The people should be aware of warning signals of cancer.

Self-examination of breast and oral cavity helps early reporting of cases. "3 minutes, three fingers once in 30 days" can help women to detect breast cancer herself. Early diagnosis measures include "Pap smear" test for precancerous lesions of cervix, mammography for breast cancer, X-rays, ultrasonography and CT scan for lung cancer and endoscopies plus FNAC for other sites besides study of markers of tumours.

The NCCP envisaged Pap smear and VIA test for all women above 30 years of age at least once in 5 years. When backed-up with good follow-up services such interventions are cost-effective. An alternate to Pap smear screening test—a combination of visual inspection with acetic acid (VIA) and lugol iodine (VILI) is acceptable in rural settings.

In India, unfortunately only 1.9% of women have undergone a screening test for cervical cancer and only 0.9% for breast and oral cavity examination. Only 1.2% of men have ever undergone an oral cavity examination for cancer

National Cancer Registry Programme (NCRP)[4,5]

The National Cancer Registry Programme was initiated by the ICMR in 1981–1982 to generate information on cancer for better planning and evaluation of NCCP.

Early Detection and Prompt Treatment of Cancer at Stage I or State A and 5-Year Survival in Common Cancers

Cancer of breast	76.3%
Cancer of cervix	93.2%
Cancer of vocal cords	60%

Objectives

1. To generate data on cancer incidence and trends over a period of time or disease burden due to cancers.
2. To know geographical variation of cancer incidence in the country and the associated risk factors for effective control measures specific to a region.
3. To evaluate the effectiveness of cancer control strategies in the country.
4. Epidemiology and operational research activities can be based on evidence-based data generated through cancer registry.

Mechanism

A **Hospital-based registries** are located within identified hospitals. Under NCCP, these have been set-up at Dibrugarh, Thiruvananthapuram, Chennai, Mumbai, Bengaluru and Chandigarh. Hospital-based cancer registries (HBCR) have no denominator of population at risk. Incidence rate cannot be derived from such data. However, cancer extent, stages, therapy and survival rate information are more reliable from such data.

B **Population-based cancer registries:** Under the NCCP these registries have been set-up at Madras, Mumbai, Delhi, Bengaluru, Bhopal, Ahmedabad and other big cities and at one rural site at Barshi in Maharashtra (expanded rural registry).

It covers mainly urban population which is 12.8% and coverage of rural population is 0.06%. The total coverage of population is 3.3% only.

The 29 population-based cancer registries provide valuable epidemiological data on incidence of cancer in the population, crude incidence rate for all ages, age adjusted standardized incidence rates, annual age adjusted (world population) incidence rates, etc. Truncated incidence rate is age adjusted rate based on age specific rates in age group 35–64 and adjusted to world population. More than 60% of cancer cases in the registries are in this age group.

These registries (29 cancer registries) provide information on common cancers in India and geographical variation of occurrence of cancers and nature of cancers for effective control measures.

3. Increasing Access to Palliative Care (Relates to AETCOM 4.4)

Three goals of cancer control programme are prevention, early detection and diagnosis, and prompt treatment and

the fourth goal is palliative care. Palliative care is "prevention and treatment of suffering". The focus here is quality of life. WHO defines palliative care as the "active total care of patients whose disease is not responsive to curative treatment".

There comes a time, despite our best efforts and all of modern advances in medicine, we have to admit that we have nothing more to offer to patients with advanced and terminal cancer to control their disease. These unfortunate individuals have lost their battle against cancer, but still living human beings broken in body, mind and soul. Where we send them to die? At home, in hospital or hospice! **Hospice** is specialized intensive care unit and has a trained team where each patient is special, right to the very end and hence best place for terminal care of cancer patients. Principles of palliative care include:

- Relieve the patient of pain and fear of pain.
- Management of other symptoms specific to the cancer.
- Management of psychological problems in a patient with cancer.
- Management of social problems and family problems.
- Management of spiritual problem.

This is a support system to help families cope during illness and death.[5–6]

Palliative care is being provided through the hospices in India (Shanti Avedna Ashram, Mumbai). Terminal care to cancer patients could be at home, hospital or hospice. When treating physician feels that no further active treatment of cancer is going to help to control the disease, he must shift over to palliative care, which is humanitarian service free of cost, relieving pain and agony and providing emotional support till the sufferer dies. Selfless care is provided away from hospitals at institutions called hospices.

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NATIONAL ORAL HEALTH PROGRAMME (NOHP)

Definition: As defined by FDI "oral health is multifaceted and includes but not limited to the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and free from pain, discomfort and disease of craniofacial complex."[1]

Problem (Oral Disease Burden)

The prevalence of oral diseases is very high to the tune of 90% at the age above 35 years. The major oral health problems in India are dental caries (decay), gum diseases (periodontitis), malocclusion and oral cancers.

1 ***Dental decay (dental caries):*** In India, dental caries has been consistently increasing in both prevalence and severity over the past five decades. This can be attributed to shift in dietary pattern towards more refined foods (fast foods and junk foods) and poor oral hygiene. About 70–80% of children and 60% of adults suffer from dental caries. The prevalence of dental caries varies from 52 to 80% in India.[1] The average number of decayed, missing and filled teeth (DMFT) per child at the age of 16 is about 4 in rural areas and 5 in urban areas, with almost no dental restorative help available particularly in the rural and deprived areas.

2 ***Gum and periodontal diseases:*** These are most prevalent oral disease affecting almost 80–90% of adult population and also most frequent cause of tooth loss. The main cause is plaque due to poor hygiene and lack of brushing. Initially it is painless, in the long-run it becomes chronic, self-destructive, leading to gradual tooth loss and mostly people accept it as the disease of old age. A large segment of adult population is toothless due to crippling nature of dental diseases. Hardly 50% of people use toothbrush and toothpaste.

3 ***Oral cancer:*** Oral cancer is the most common cancer in India, hence oral cancer is called Indian cancer; as 35–40% of all body cancers diagnosed are oral cancers. The major culprit is tobacco chewing smoking and alcohol use. Oral cancer is preventable cancer.

4 ***Malocclusion:*** About 30% of children suffer from mal-aligned teeth and jaws affecting proper functioning of dentofacial apparatus and aesthetics.

5 Prevalence of *dental fluorosis* in children (at 12 and 15 years) is 6%.

Majority of population in the country lack knowledge about dental diseases and its relation to general health.

Over 80% of dentists are clustered in urban areas catering to 36% of population. About 64% population, which lives in rural areas has been neglected. There is no dental surgeon posted at the primary health centres (PHCs)

in most of the states. There is acute shortage of manpower and equipment at community health centres (CHCs) and even at district level hospital.

Preventive and promotive oral healthcare is more relevant to rural areas, it will save economic burden.

Large number of dental problems: Dental caries, periodontal diseases, malocclusions and oral cancers are preventable by simple actions by the people themselves by adopting healthy lifestyles and practices right from early childhood period and to maintain these practices as part of life to enjoy sound status of oral health and better smile.

National Oral Health Programme (NOHP) was initiated in project mode in 1998 and department of dental surgery, AIIMS, New Delhi, was chosen as nodal agency to implement it.

The aim of NOHP: To improve the oral health of the masses and to prevent/reduce burden of oral diseases in the country.

Long-term Goals[2]

- 50% of 5–6 years old to be free of dental caries.
- To bring down the DMFT (decayed, missing and filled teeth) in school children (between 6 and 12 years) to less than 2.
- 85% should retain all their teeth up to the age of 18.
- Reduction of high prevalence of periodontal diseases to lower prevalence level of 40% from existing prevalence of 90%.
- To achieve 50% reduction in levels of edentulousness between the age of 35 and 44.
- To achieve 25% reduction in levels of edentulousness at the age of 65 and above.
- To achieve 50% reduction in the present level of malocclusion caused by oral habits in children.
- To reduce the number of new cases of oral cancers and precancerous lesions from the existing level of 9 per lakh.
- Finally to provide oral healthcare for all.
- To establish database monitoring system on oral health.

Objectives of National Oral Health Programme (NOHP)

Government of India has taken a new initiative in 12th Five-Year Plan to launch National Oral Health Programme in 200 districts (50 districts per year) with the following objectives:

- Now the programme is operational in 36 states/UTs.
- Improvement in the determinants of oral health, e.g. healthy diet and oral hygiene.
- Reduce disparity in oral health accessibility in rural and urban population.
- Reduce morbidity from oral diseases
- Strengthening of existing healthcare delivery system in India at primary and secondary levels.
- Integrate oral health promotion and preventive services with general healthcare system and other sectors that influence oral health.
- Promotion of public and private partnership.

Strategies for Implementation

a Oral health education to masses through mass media and information, education and communication channels, for behaviour change communication.

Oral health education to school children and school dental health programme.

b Training of teachers, health staff, *Anganwadi* workers and dental surgeons on the strategies of oral health programme.

c To strengthen oral health services set-up at various district and sub-district to begin with.

d Logistical support.

e Comprehensive programme management.

f Monitoring and evaluation.

g Legislation against tobacco.

NOHP Constitutes Two Separate Activities

1 Activities at state level which is under the umbrella of National Health Mission (NHM).

2 Tertiary level activities at central level.

NHM Component

This component supports

- Setting up of dental care units at sub-district and district level
- Manpower support (dentist, dental hygienist and dental assistant and dental technicians).
- Equipment including dental chair and consumable for dental procedures.
- 3650 dental care units have been approved. National Resource Centre for tobacco cessation and oral health for children and elderly at MIDS Delhi and PGIMER, Chandigarh approved.

The centre for Dental Education and Research at AIIMS New Delhi is National Centre of excellence and 3 National Resource/centres have been set up for capacity building.

Tertiary Component

This component supports State and Central level activities such as

- Designing IEC materials for education
- Organizing national, regional and nodal officers training programmes to enhance programme management skills.
- Preparing state/district level trainers to train the paramedicals in healthcare delivery.
- Tobacco Cessation Centres in 301 Dental Colleges.

a. Oral Health Education

This is the major strategy under NOHP. This would cover:

- General population
- Targeted population of school children.

Approaches

i For general population to disseminate information/ messages and action by people themselves on oral health through mass media like television, radio, print and folk media and through education material.

ii The information, education and communication material (IEC) on oral health have been produced by AIIMS and Central Health Education Bureau and distributed in an organized manner to masses through the system of healthcare (PHCs, CHCs and urban health set up). An education film on oral health *Kirpaya Muskuraiye* has been produced by nodal agency (AIIMS, New Delhi).

iii The school children have been specifically targeted for oral health promotion programmes like demonstration of regular brushing, rinsing, and gargling techniques, regular dental check-ups and atraumatic restorative techniques for treatment, pit and fissure sealant on pilot basis adequate diet and avoidance of cariogenic food (fast foods or junk foods). In addition, chapters on oral health have been included in school textbooks of primary school children.

b. Training

It includes general oral heath training to all the healthcare staff and special training to nodal officer on oral health programme. The short-term in-service training of teachers, health workers, health supervisors has been undertaken and the area assigned to them for launching of educational activities in schools and community and refer cases for further investigation and treatment. *Anganwadi* workers will inculcate brushing habits by involving parents in her *Anganwadi* set-up as part of non-formal pre-school education activities. AIIMS has prepared oral health training manuals for teachers and health workers for their training and orientation.

The dental surgeons in the district were trained to impart training to health workers and teachers for organizing oral health activities in their respective areas.

c. Legislation

Indian Government has passed a comprehensive Cigarettes and Other Tobacco Products Act (COTPA) in 2003, which has been discussed under tobacco control programme.

Strategies in Urban and Rural Areas

- Involving and reorienting dentists, teaching staff posted in the dental colleges, hospitals as well as private practitioners for 2 weeks refresher courses for primary prevention of oral diseases. This can be started after the training of dentists from various states for the implementation of the NOHP in the rural areas is completed.
- The dentists of school health schemes and RBSK and RKSK are operative in large number of urban and rural areas; this could serve as good nucleus, after training, for services in urban areas.

WHO Strategy on Oral Health

WHO strategies and approaches for better oral health in 21st century focus on modifiable risk factors such as tobacco use, cariogenic diets (excessive use of sugar, fast and junk foods, carbonated drinks), abuse of alcohol, oral hygiene and use of oral health services. The approach integrates oral health promotion with prevention and control programmes of non-communicable diseases in primary healthcare.[3]

Population-based screening of common cancers—Breast, cervical and oral cancer has been launched as part of comprehensive primary healthcare at HWC/PHC/CHC and DH.

Reorientation of Dental Education in India

Community dentistry component in all of 305 dental colleges can be made more dynamic, active and viable. From the Planning Commission, NITI Aayog special funds can be allocated to each dental college for adopting one district to implement oral healthcare programmes, but these programmes would have to be standardized, monitored, evaluated and accountable. Basic dental curriculum needs to be preventive and community need-based.

Training of trainer is essential on oral health policy and 2 teachers from each dental college would be imparted training on strategies under National Oral Health Programme. These doctors would be responsible to organize reorientation programmes in their own colleges.

At the moment, the services for rural areas and urban slums are almost negligible. Community dentistry departments also do not exist in most of dental colleges. A few departments of community dentistry, which exist in the country, undertake minimum preventive programmes, which are not sustainable, and no impact is visible, as there is no continuity of service or programme. Over the years, evidence-based "information" on oral health has accumulated in the country but this is largely confined to dental clinics, hospitals, dental colleges/institutions, libraries, with dentists and a few schools. The challenge is to communicate the present knowledge and information to all schools, families, homes and community for appropriate actions. The information, which can promote/improve the oral health of millions of young children, school children, adolescent and youth, pregnant women and older people, is the information which must become available to all school children, families and communities for appropriate action. Therefore, the biggest challenge before us is to accept the challenge of communication of "facts on oral health" to all, in rural, tribal and remote areas. Nodal agency has imparted training but the status of implementation and monitoring reports indicating progress of action is wanted till now. Nevertheless, NOHP lays down firm foundations for future activities and it is a challenge

for dentist community to accept and excel.[4] The 12th Five-Year Plan focuses on neglected area of oral health services as one of the thrust areas. DCI has commissioned a nation-wide survey on dental health manpower and pattern of diseases to help policy formulation.

Developing Surveillance System in Oral Health

The Stepwise approach developed by WHO can be followed to capture modifiable risk factors such as unhealthy lifestyles—use of tobacco, excessive intake of sugar, fast foods, oral hygiene practices and use of oral health services as also source of drinking water on regular basis for appropriate actions. These risk factors can be gathered by questionnaire method (step 1).[5] Oral diseases were officially included in a recent United Nations declaration (Sept 2011) in the list of non-communicable diseases.

NATIONAL PROGRAMME FOR PREVENTION AND CONTROL OF DEAFNESS

Hearing loss is most common sensory impairment in human today. World over it is fourth leading cause for years lived with disability (YLD) after depression; polio, and filaria responsible for 24.9 million YLD globally.

In India, there are approximately 63 million people who are suffering from significant auditory impairment as per WHO estimates.

Problem in India

- NSSO estimated (2001) prevalence of severe to profound hearing loss of 291 per lakh of population.
- Estimated prevalence of hearing loss was 6.3% in Indian population as per WHO estimates (2003).
- The estimated burden of hearing loss in school going age group in India is 26.4 million at the prevalence level of 6.3%.

Over 50% causes of hearing impairment are *preventable* including hearing loss caused by infection of the ear (ASOM and CSOM), secretory otitis media, traumatic and rubella deafness, noise-induced hearing loss and ototoxicity. Common causes of all degrees of hearing loss in India are given in Table 8.55.

Table 8.55: Common causes of all degrees of hearing loss in India

Causes	*Prevalence %*
Ear-wax	15.9
Chronic suppurative otitis media (CSOM)	5.2
Serous otitis media	3.0
Dry perforation	0.5
Congenital deafness	0.2
Non-infectious and other unknown causes	10.3

Objectives

1. To *prevent* the avoidable hearing loss on account of disease or injury.
2. Early identification, diagnosis and treatment of ear problems responsible for hearing loss and deafness.
3. To medically rehabilitate persons of all age groups suffering from deafness.
4. To strengthen intersectoral linkages for continuity and rehabilitation programme.
5. To develop institutional capacity for ear care services by providing equipment, material and training of personnels.
6. Creation of *district level data base* for the programme.
7. To facilitate *need-based research*.

Long-term Objective

To reduce the total deafness burden by 25% of existing burden by the end of 12th Five-Year Plan.

Strategies

1. To strengthen the service delivery for ear care
2. To develop human resource for ear care services by training of grassroot workers.
3. To promote public awareness through appropriate and effective IEC strategies with special emphasis on prevention of deafness.
4. To develop institutional capacity of the district hospital, community health centres and primary health centres in respect of ENT/audiology infrastructure.

These strategies were piloted in 25 districts of 10 states and one UT to begin with. The programme is being implemented through existing primary healthcare delivery system with adequate referral support developed at district level. At present it covers 595 districts in 36 states and UTs.

The components of the programme are

i. Manpower training and development—for prevention, early detection and management of hearing impairment and deafness cases.
ii. Capacity building—for district hospital, CHC and PHC.
iii. Service provision at all levels.
iv. Awareness generation—IEC and BCC activities.

The levels of prevention of hearing loss would include

***Primary prevention*:** This includes health education, immunization against measles, mumps and rubella, infections and prevention of acute respiratory infections.

***Secondary prevention*:** Screening for early detection and prompt treatment, management of acute respiratory infection by standard treatment protocols besides surgical interventions.

***Tertiary prevention*:** Provision of hearing aids and rehabilitation (speech and hearing therapy)[6].

NATIONAL ORGAN TRANSPLANT PROGRAMME (NOTP)

NOTP has been approved in 12th Five-Year Plan for carrying out the activities as per transplantation of Human Organs and Tissues Act.

OBJECTIVES

- The main objective of the programme is to organize a system of deceased organ and tissues procurement and distribution for transplantation.
- To promote deceased organ and tissue donation and prevent organ trafficking.

Components

Under the Programme "National Level Organization—National Organ and Tissue Transplant Organization (NOTTO)" we have:

- Component of national networking.
- National registry
- National biomaterial centre and facility of cadaver and tissue retrieval being set up at Safdarjung hospital. Similar networking system and tissue banks have been developed as regional organ and tissue transplant organizations (ROTTO) at Mumbai, Chennai, Kolkata and Chandigarh and Assam.

Policy and criteria for allocation of various vital organs has been approved.

Competency addressed: The student should be able to:
CM 8.6: Educate and train health workers in disease surveillance, control, treatment and health education.

Objective: The learning objective of this skill is how to train and educate paramedical health teams on the job and continued education to achieve goals of Public health surveillance.

EDUCATING AND TRAINING OF HEALTH WORKERS IN DISEASE SURVEILLANCE, CONTROL, TREATMENT AND HEALTH EDUCATION FOR CCDs AND NCDs

All primary healthcare workers are usually in contact with the community. It is normally at this level that the first opportunity for epidemiological surveillance occurs and need for prevention and control activities may first be noted. Health workers identify syndromes and ensure prevention and control measures. Their training and continuing education is critical and vital.

The purpose of training is: To continually improve the knowledge, skills and competencies of health workers in disease surveillance.

Health workers and supervisors have been trained under Integrated Diseases Surveillance Programme (IDSP). Two days induction training of male and female health workers and their supervisors was conducted at CHC level by trained medical officers with the support of district surveillance officer. The content of training included: Overview and introduction of surveillance syndromic description, filling up of form or data collection, transmission of data, collection of specimens, biosafety issues and basic response to outbreaks at local level. Medical officers are responsible for in service training, on the job training and continued education of health teams. The principle of training is learning core competencies on collection of data, compilation of data, analysis and interpretation of data for local action, early detection of unusual events and reporting these events to medical officers/supervisors and ensuring early response to outbreaks before the arrival of rapid response team. Sub-centres, PHCs and CHCs in rural areas and urban health centres and hospitals in urban areas are the reporting units under IDSP. Target diseases included under IDSP are mainly communicable diseases. Health workers village volunteers, key informants are conducting syndromic surveillance. Health workers identify cases based on presenting symptoms such as fever of less than 7 days, fever more than 7 days, cough more than 2 weeks duration with or without fever, loose watery stools of less than 14 days, jaundice cases less than 4 weeks, acute flaccid paralysis in less than 15 years of age and unusual symptoms leading to deaths and hospitalization. Workers submit weekly report on every Monday on form S to health supervisor/medical officer. Medical officers and health supervisors are responsible for continuing education of health workers and provide feedback to reporting workers/units on the quality of data its accuracy, completeness and timeliness. By this mechanism health workers have been made responsible to provide treatment of principal diseases (diarrhoea, ARIs, and fevers), early detection of diseases and outbreaks, prevent outbreak, basic response to outbreak prone diseases by immunizations, regular chlorination, vector control and regular education of people by home visits, group meetings, inter-personal communication, on village health and nutrition day at *Anganwadi* once a month.

Policy Shift

Now under National Health Policy 2017, there is paradigm shift from "selective primary healthcare" to "assured comprehensive primary healthcare" through upgradation of sub-centres and PHCs to health and wellness centres.

In Service Training and Continuing Education of Health Workers on Non-communicable Diseases

Health workers of sub-centre and their supervisors and ASHAs were given in-service modular training for 3–5 days duration at community health centre on NCDs. Trained health supervisors and medical officers were the key trainers. On the job training and support is being provided by medical officers of PHC and the supervisors.

Since task of control of CCDs, NCDs, RCH and FP and nutrition problems have been delegated to sub-centres workers, their support system must be in place for expected outcomes. Health and wellness centres are now providing. Preventive and promotive services for non-communicable diseases (NCDs): Screening cum education of hypertension, diabetes, obesity and 3 common cancers (breast, cervical and oral). Health workers are now able to identify high-risk persons by community-based assessment checklist. ASHA, ANMs promote healthy behaviours at community and household level. Health and wellness centres now provide integrated services for RCH, family planning, CCDs, NCDs and nutrition free of cost to all. Sub-centres have been strengthened by provision of mid-level providers, equipment, material and essential medicines for NCDs.

Health Promotion/Health Education for Behaviour Change and Counselling

Behaviour and lifestyle changes through health promotion is the key component of screening programme at sub-centre (health and wellness centre). Various approaches are being used for effective communication by camp approach, interpersonal communication, posters and banners to educate people in community, household, schools, *Anganwadis* and workplace settings. Key messages being communicated include: Consumption of healthy foods, increase physical activity, avoid tobacco and alcohol and warning signs of common cancers: Sub-centres conduct population-based screening/opportunistic screening of all persons above the age of 30 years for early detection of common NCDs and referral of suspected cases to PHCs/CHCs, and follow-up of cases at community level apart from management of lifestyles. They submit regular reports on NCDs every month.

Expected Outcome

The student identities syndromes under surveillance and records the contents of training of health workers under IDSP. Student interprets the quality of data collected by workers on form 'S' and community based checklist for training needs assessment and continued education.

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Competency addressed: The student should be able to:
CM 8.7: Describe the principles of management of information system.

HEALTH MANAGEMENT INFORMATION SYSTEM (HMIS)

Definition

HMIS is defined as a system that provides up-to-date, reliable complete and timely information to health managers, at various levels. It helps to make well-informed management decisions about programme performance and operations. Information is required to plan, operate, monitor and evaluate health and management services.

HMIS is an important management as well as an epidemiological tool, which supports the management to **make sound decisions** for policy formulation and interventions. Most of the information reaches the programme managers in the form of routine statistical and management 'reports'. These reports, which are generally standardized in format and produced on a regular basis, constitute most visible part of health management information system.

The health management information system is organised around **key indicators** that measure a programme's progress towards its goals. It is a systematic way of collecting, compiling and analysis of data to information and its interpretation, for action, reporting and using data at all programme levels.

The data and information are not synonymous. What is information? The information is the outcome of data analysis. Raw data becomes information when it is analysed, information is interpreted for action. The timely information thus generated is used for action and decision-making at all the levels of management like home-based or client-based records and information → village-based → sub-centre → PHC → CHC → district → state and national level. Information is needed at all these levels.

A formal system of reporting has been established in the health system. Every month a service delivery monthly progress report from the lowest level, i.e. 'sub-centre' and village level '*Anganwadi* centre' is processed and transmitted to a higher level, i.e. PHC → CHC → district → state → central government.

Uses and Users of HMIS

The main uses of the HMIS

i To support **decision-making** and taking actions.

ii To assess community **health needs,** e.g. community needs assessment approach under RCH can make use of HMIS for preparing sub-centre action plans, e.g. who need immunization? and how many need it?

iii To **prioritize** the **health needs,** e.g. under community needs assessment approach (CNAA) we prioritize or segment the eligible couples who need services for sterilization, spacing by contraception or priority is given to economical weaker sections.

iv To **assess** the **performance** of health workers or institutions like: Sub-centre → PHC → CHC → district or state and grading thereof.

v To monitor programme operations, Gap analysis and evidence based course correction.

vi To **evaluate** the programme or to measure its success and failure.

vii For better **planning** and implementation of services and programmes at local level.

Users: HMIS should be used at local level hence, we have to build information use culture at the grassroots level—sub-centre and PHCs. Right now, health workers depend on formulae to prepare their action plans and they borrow the birth rate of the state and apply this to assumed population of sub-centre to get a magic figure of antenatals, births, eligible couples, etc. If they have HMIS in operation, they can rely on it for planning the services at local level and sharing the information with local community.

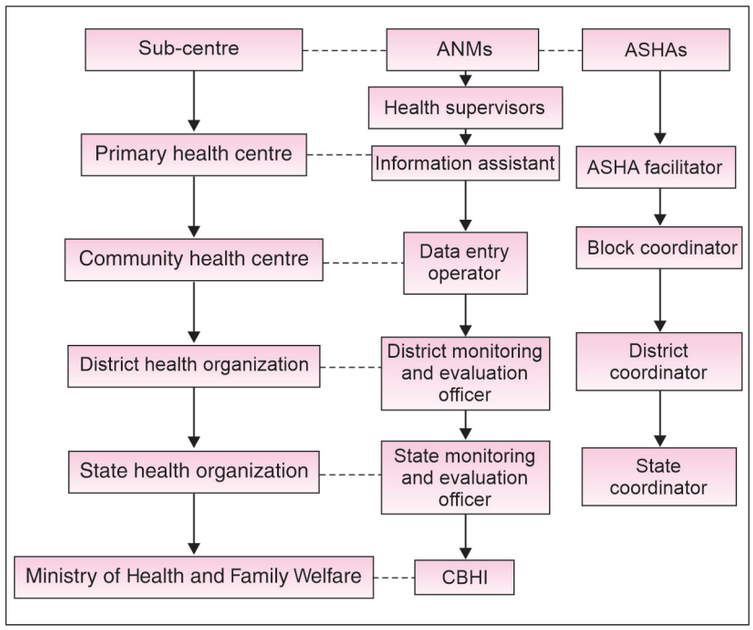
Health System Organization

The routine reports and information flow from village to national level as indicated in Flowchart 8.2. It is one-way traffic mostly.

DEVELOPMENT OF HMIS IN INDIA—CASE STUDY[1]

The deficiencies in information support to health for all (HFA) strategies in the country were identified as early as late 70s. It was decided to devise and implement effective management information and evaluation system (MIES) in the health sector. It was also envisaged that the information system would reduce the unnecessary load of paper work by the peripheral health workers and streamline the system to avoid duplication of information or its unnecessary generation. The National Health Policy adopted by the Parliament in 1983 stated that "appropriate **decision-making** and **programme planning** in the health and health-related fields is not possible without establishing an effective "health information system". A nationwide organizational set-up should be established to produce essential health information". It was also envisaged that this information system should be able to provide necessary support for local management of the healthcare so as to pave the way for effective decen-

Flowchart 8.2: Information flow in HMIS in health system



tralization of activities. Exercises in development of more effective HMIS continued. After a test run a comprehensive HMIS model was evolved in 1992. As many as 13 registers were designed for sub-center level. The ANM was collecting and recording service utilization data in 13 different registers. Government of India, MoHFW consolidated these registers into one register called Village-wise Integrated Reproductive and Child Health Register (IRCHR) in 2008–09 when HMIS version 1.0 started functioning with district level reporting. Gradually HMIS was revamped in 2019–20. The process of integration of service registers continued, and a new integrated RCH register version 2.0 was developed in 2021 and launched in June 2022. Essentially the new IRCHR version 2.0 further integrates many service records into one consolidated register. This obviates the need for ANMs to collect and maintain information on various aspects like family planning, maternal health, child health, immunization, mortality data, etc. in multiple registers often resulting in entering similar information in many registers resulting in duplication of ANMs efforts and of course money on printing.[1]

All types of government health facilities and private hospitals are mapped as SC/PHC/CHC/SDH/DH across the country. 2.17 lakh health facilities were mapped spread over in 747 districts. Data for service delivery is entered every month by 5th of following month.

New HMIS 2.0 Launched in 2020–21[2]

The new HMIS has been developed with the technical support of WHO. Now HMIS Logo is developed. It has many new features and is very effective in monitoring national health programmes. New features include real time data entry and real time monitoring of the system, comparability with multiple devices such as mobile, Tab, etc. Integration with other portal through API, Interactive Dashboards, GIS integration with layer of village and National Identification Number (NIN) and Local Government Directory (LGD) compliance with unique identification of health facilities up to village/block level.

HMIS captures around 400 data elements of service delivery on monthly basis and captures around 700 elements of infrastructure and human resources on annual basis with updation on monthly basis. Daily data entry started with effect from April 2020.[2]

Integrated Village-wise RCH Register—RCH Portal

It is a step forward to integrated health information platform (IHIP). New HMIS 2.0 is developed with additional features in 2022.

The data reporting formats of Mother and Child Tracking system (MCTS) were upgraded in 2017 and further upgraded in 2022 so that more comprehensive reproductive and child health (RCH) related information may be captured. These formats are called **Integrated RCH Register version** 2.0 updated and released in 2022.

Integrated RCH Register (IRCHR) Version-2.0

It collects village or ward wise, for two financial years, information on coverage area profile- Population of the village, total number of eligible couples, estimated number of pregnant women, estimated number of infants, and children (1–2) per annum. It also provides information on available human resources at village level. This way it helps to assess annual workload and preparation of workplan. It has 5 sections as follows:

Section-A

Provides information on-Eligible Couples/Pregnant Women registration and tracking of services month wise throughout their reproductive span. It also gives an account of maternal, neonatal and infant deaths besides home based neonatal care and postnatal care and coverage levels.

Section-B

Provides information on Child Registration and tracking of Services of under six children, home based care of young children with "red flag sign" of development issues and mortality and its cause in young children. It makes use of revised Mother and Child Protection Card for tracking of children first 3 years of life and beyond.

Section-C

It is ASHA incentives Format-based on their performance month-wise.

Section-D

It provides details of each immunization session for monthly reporting of vaccine doses received and returned and stock position of syringes and contraceptives…

Monthly HMIS Reporting Format (Sub-centre—SC) April 2022

Year	Month .....
Name of CHC/PHC	Name of sub-centre .....
Urban PHC	Name of ANM .....
Population of S/C	Mobile No .....

Sl. no.	*Data items*	*Numbers reported during the month*
PART A	**REPRODUCTIVE AND CHILD HEALTH**	
	Line-Listing of services	
M1	Antenatal care (ANC)	
M2	Deliveries	
M3	Pregnancy outcomes	
M4	Postnatal care	
M5	Family planning	
M6	Child immunization	
M7	Childhood diseases	
M8	National Vector borne disease	

PART B	HEALTH FACILITY SERVICES
M9	Patient services-outpatients
M10	Laboratory testing (services)
M11	Stock related data
PART C	**MORTALITY DETAILS**
Details of deaths reported with Probable Causes (Neonatal, infants, child and maternal)	
In view of Revised Integrated RCH Register Version-2.0 the reporting format of HWC-subcentre is likely to incorporate new elements.	

RECORDS AND REGISTERS

At present, all the national health programmes have their independent HMIS; however, at the level of village and sub-centre, the reports are generated by sub-centre health team. Now under national programmes on NCDs the reports of NCDs are being generated at the level of sub-centre. The key registers at sub-centre level are:

Records, Reports and Registers at Sub-Centre

Now many registers have been combined into one register called as: "Integrated RCH Register Version 2.0"

There is life long tracking system of beneficiaries during reproductive span of women, through infancy, early childhood period, school age, adolescence, adulthood, and old age for comprehensive Primary healthcare services with support of secondary and tertiary health services. The Ayushman Bharat Digital Mission provides a single platform to access various services through digital records. The other essential records/registers are as under:

- Births and deaths register
- Stock register
- IDSP register
- Sub-centre OPD register
- Passive surveillance of malaria/vector borne diseases
- Register/Records of various national health programmes/campaigns/surveys like malaria, TB, leprosy, blindness, NCDs,
- Home visit diary
- Account register for united money.

Records/registers for ASHA: ASHAs are also maintaining survey and service registers separately. Household survey, eligible couple, antenatal, births and deaths, immunization, home-based newborn care card, daily diary, household visits, drugs and stock, VHSND meeting, oral pills/condoms/pregnancy test kits besides community-based assessment checklist (CBAC) form for early detection of NCDs, and family folder and individual health record.

Similarly, *Anganwadi* workers of ICDS have eleven set of registers like household survey register, birth and death register, beneficiary register for mother and children, immunization, growth charts and weight book and stock registers.

IDSP Format

Reporting Format for Syndromic Surveillance (Form S) Under Integrated Disease Surveillance Project

The health worker is required to transfer the information from the 'register for syndromic surveillance' to form S (reporting format for syndromic surveillance). The information in the registers of the AWW, village volunteers and non-formal providers will also be transferred to the form S, at the sub-centre. Each reporting unit will be assigned a unique identifier or ID No. which will be filled in by the district surveillance unit and the health worker should leave this space blank. The health worker will fill the information on reporting week (copy the information from the 'register for syndromic surveillance').

Form S will be provided in triplicate (three copies). The first and second pages of form S (colors yellow and green respectively), will be separated from the third page (color—blue). The third page (blue color page) will be retained by the health worker and the first and second pages (yellow and green) will be given/sent to the medical officer of the supervising PHC on the Monday, following the end of a particular reporting week.

Reports

The sub-centres ANMs, *Anganwadi* workers and ASHAs are the responsibility centres for HMIS and they prepare monthly reports. The sub-centre report provides information on inputs (health workers, material equipment, monthly stock position of drugs, vaccines received, functional status of equipment, etc.). It also provides information on processes and outputs or performance in terms of antenatal care, natal care, pregnancy outcome, postnatal care, newborn care, referral services, STI/RTI detection, immunization, disease surveillance, contraception services, malaria and tuberculosis output, and data on impact indicators like births and deaths. It also has information on interaction with the community, besides general information on population and eligible couples—parity-wise and age-wise. Similarly, *Anganwadi* worker provides useful information on health and nutrition services and impact measurement.

This information is generated every month and sent to PHC. The feedback on this information is provided at the sector level (circle) monthly review meeting of health workers, *Anganwadi* workers (AWWs), ASHAs and their supervisors.

Information assistant at PHC level and data entry operator at CHC level compile the information and transmit the data to district programme officer online every month.

Similarly, sub-centre action plans are evolved at the level of sub-centre once a year and submitted to higher

levels. Monthly single updated reporting format for sub-centre and equivalent institutions has been evolved to provide regular data/information to guide actions and decision-making.

Since the routine reporting and information system is inadequate, the policymakers and health administrators make use of other systems of information like: (SRS, NFHS-1–5, census, sentinel data, hospital data and special data generated through surveys and studies). National Nutritional Monitoring Bureau, Hyderabad, generates data on dietary consumption and nutritional status. Similarly, universities and medical colleges generated tremendous and robust data on maternal and child health under the banner of ICDS, which was fed back to the system to improve the content and quality of services for women and children.

Challenge is to make **use of data** locally and develop a mechanism that data which are collected, have a lot of meaning to be **used** at local level for improving programmes performance and work schedules.

The most important source of HMIS is routine regular reports collected every month at local level which forms the basis for making local **decisions** and **actions**. The most common problems with routine reporting system are:

- These are incomplete and coverage of population may not be total, particularly in urban areas.
- Quality of information is poor in respect of causes of death and weighing of children.
- The information is **seldom used** at local level by the health workers or by team leaders (medical officers).
- The information is not shared with the community. The sub-centres should report on performance to *Panchayats*, hospitals to *Rogi Kalyan Samitis* and District Health Mission to *Zila Parishad*. Annual district report card on people's health must be prepared and shared with people.
- The information is used as compliance and for transmission of reports to higher level only.
- The feedback to health workers who collect huge or voluminous data is not available and consequently there is no sustained motivation.
- The initial training and continuing education of health workers and medical officers is weak, not much emphasis laid on HMIS.
- There is a tendency to over-report the performance and figures are inflated quite often.
- Data gathered under RCH, NRHM and other programmes are seldom looked into, seldom analysed, poorly understood, and not acted upon locally for decision-making or to improve the quality of services. The system remains data driven rather than action driven.
- The planning and management staff rely primarily on "gut feeling" to formulate ad hoc decisions rather than seek pertinent database information support.
- The supply of registers and reporting formats are erratic and frequent stock-outs is a common feature.
- Integrated RCH register version 2.0 and Mother and Child Tracking System (MCTS) are the latest in their introduction. Thus, HMIS is an area with full of challenges.

ACTION

The system is data driven, reports are seldom read, least understood and data collected locally are seldom used for planning and evaluation purposes.

There are frequent changes in the system as and when a new programme comes, a new reporting format is introduced and sometimes workers are required to prepare separate reports for each programme, e.g. child survival and safe motherhood programme, universal immunization and EPI, reproductive and child health and much before this maternal and child health and family welfare programme had introduced special set of formats for reporting data and information, besides NCDs program.

The supervisors and team leaders have a tremendous role to make improvements in the HMIS. During their supervisory visits, monthly meetings or other periodical meetings, the sample check of household survey and verification of reports and records and spot correction can help to improve the quality of records. Community itself can monitor the quality of records maintained at the level of village or sub-centre. Community-based monitoring is a new beginning under NRHM. People have right to information and mothers or parents themselves can share the information of records and health and nutritional status of their children at the *Anganwadi* and sub-centre. It is wise if the health information of an *Anganwadi* and sub-centre is displayed at the village/community centre or at village headman's office for dissemination. This would generate a cycle—people may seek more information and that leads to improvement of system of information. The health workers, *Anganwadi* workers during each contact with the client/community (home visits—*Mahila Swasthya Sangh* meetings) should share the valuable information with each home and village community and stay connected with each home—linking homes with dynamic health system or facility for continuum of services.

Geographic information system (GIS): This envisages creation of an electronic database of healthcare facilities, educational institutions, training centres and other healthcare establishments in India. This database will be used for mapping the health facilities using geographic information system for wider dissemination through CBHI website. National informatics centre will provide GIS mapping of government health facilities. The concept can be applied to endemic fluorosis and safe sources of water supply and many other areas of interest/diseases of national significance. GIS enabled HMIS application was launched in March 2016 to depict data on dynamic maps. New features added to HMIS portal include:

- Grading of CHCs and PHCs
- Provision of automatic alerts for sensitive data items.

- Ayushman Bharat Digital Mission (ABDHM) National Digital Health Mission (NDHM) has been set up to create database of containing health records of all citizens by providing a unique ID (Digital Health Ecosystem).
- Photographs of health facility.
- Use of Artificial intelligence (AI) to generate health data: AI is being used to—identify presence of ST Elevation MI (STEMI) from transmitted ECG.

Over 1.17 Lakh Health and Wellness Centres are telemedicine enabled for treatment, referrals and follow up at higher facilities.

Causes of Death Statistics

The causes of death statistics are essential to capture the leading killers diseases in order to control these diseases. Causes of death till 1994 were being generated by SRS by using lay diagnosis reporting system from rural areas under model registration scheme, however, the scheme was suspended. It has now been revived to capture causes of death by verbal autopsy, since 1999 in urban and rural areas.

Over 75% of the 95 lakh annual deaths in India occur at home and majority of these do not have certified cause. Nearly 22 % of causes of death were medically certified in 2020 (CRS). Recognizing the need for better data, the government has undertaken the world's largest study to track the causes of death in the country called the "prospective study of one million deaths in India". The study spanned over 16 years (1998–2014). This is known as "million death study" (MDS) undertaken by sample registration system. The verbal autopsy (VA) called "RHIME" or representative, resembled, routine household interview of mortality with medical evaluation method to determine the causes of death. Causes of neonatal mortality in India in 2005 as per million death study (MDS) were prematurity and low birth weight 14%, birth asphyxia and birth trauma 8%, neonatal infection 12%, neonatal tetanus 1%, diarrhoea 1% and others 7%. Causes of child mortality—pneumonia 16%, diarrhoeal diseases 13%, other infectious diseases 11% and others 17%.

Cause of death is also obtained from hospital statistics, as these deaths are attended by physicians (doctors) hence, the causes are more reliable but unfortunately many of the hospitals do not adhere to ICD classification of diseases and deaths, hence, value of an important source of data get lost.

MOTHER AND CHILD TRACKING SYSTEM (MCTS) AND REPRODUCTIVE CHILD HEALTH PORTAL AND ANM ONLINE (ANMOL)

- MCTS is web-based name-based tracking system to provide ready reference regarding the status of service/ vaccination delivered to pregnant women and children.
- The Health Ministry has rolled out an upgraded version of MCTS called RCH portal which is designed for early identification and tracking of the individual beneficiary throughout the reproductive lifecycle and lifetime (Cohort) and to promote, monitor and support the reproductive, maternal, newborn and child health (RMNCH) plus adolescent programme delivery and reporting.

The MCTS/RCH portal is capturing data of beneficiaries, which is used by multiple applications like e-Janma (Karnataka), ANMOL, MCTFC, Kilkari, mobile academy and direct transfers of JSY benefits and payments to ASHAs.

Mother and Child Tracking Facilitation Centre (MCTFC)

MCTFC functions at NIHFW. It validates and verifies records of beneficiaries and health workers. The centre contacts the service providers and recipients of mother and child health services to get their feedback on various initiatives like JSSK, JSY, RBSK and contraceptive distribution by ASHAs.

New Initiatives–Ayushman Bharat Digital Mission (ABDM)

Under the ABDM, citizens are able to create their Ayushman Bharat health account numbers, to which their digital health records can be linked. This enables creation of longitudinal health records for individuals and improves clinical decision making by healthcare providers. This would improve equitable access to quality healthcare, encouraging the use of technologies such as telemedicine and national portability of health services. National Health Authority will be the implementing agency.

Most of the digital health solutions like ANM online (ANMOL), The Health and Wellness Centre Portal, Nikshay, i-GOT, Mera Aspatal, Online Registration System (ORS), e-Rakatkosh, Electronic vaccine network (eVIN), Integrated Disease Surveillance Programme, etc. have proven to be useful in data generation for **decision making** at various levels. However these solutions have continued to develop in fragmented manner. The ABDM envisages a unifying platform to provide a single window to patient centric healthcare. A unique 14 digit randomly generated health ID number for individuals facilitates to seek healthcare anywhere in the country. ABDM is a kind of digital highway connecting various players across the healthcare ecosystem. Loss of medical records and repeat tests will be minimized as citizens will have access to their medical history through digital records. Ascertaining the availability of doctors, hospital beds and medicines will become easier with a single ecosystem helping citizens efficiently find the service they need. ABDM also helps Public Health and Policy decision making.

ANM ON LINE (ANMOL)

Department of Health and Family Welfare has developed a tablet-based application called ANMOL. it allows ANMs to enter and update the service records of beneficiaries on

real time basis. ANMOL acts as a job aid tool to the ANMs by providing them readily available such as due list, dashboard and guidance based on RCH data entered. This standardizes the maternal and child care services provided by ANMs who are able to generate work plan and also in planning of VHND along with vaccines and logistics required. This ensures more prompt entry and updation of data as well as improvement in data quality, since the data is being entered "at source". Another important component of the ANMOL is audio video counselling to enhance awareness of beneficiaries. But ANMOL is no substitute for regular contacts with beneficiaries and involving them in work planning and participation in the programme. ANMOL is supported by UNICEF.

CIVIL REGISTRATION SYSTEM (CRS)



The details of the number of births and deaths occurring annually is very important not only for predicting the future course of population dynamics but also for a planned social and economic development of the country. Without the knowledge of such events any type of planning has to rely either on guess estimates of these events or on some indirect estimates provided by the demographers. In fact, CRS has a vital role to play in this respect and there may not be any viable alternative to it. The sample registration system (SRS) of Registrar General of India (RGI) has become the best alternative to obtain satisfactory estimates of vital rates at the state and national level, but not at the level of smaller administrative units like districts, tehsils and blocks. By no means, however that this can replace or serve the purpose for which CRS is evolved. CRS gives data not only at the national level but also at the district and sub-divisional levels which are the basic units for the planning and implementation of health and family welfare services as well as several development programmes.

DEFICIENCY OF CRS

The vital events of births and deaths are grossly under registered. CRS does not provide complete information. We have to adjust CRS data by some indirect techniques for estimating the correct levels of fertility and mortality. Mention may be made that neither of these can help in providing the accurate information about the vital events at the district nor at lower level of administration. **In order** to make it **compulsory to register all births and deaths**, an **Act was made (Birth and Death Registration Act, 1969)**.

Birth and Death Registration Act, 1969[3]

The registration of births and deaths has been made compulsory at the place of their occurrence with local registrar under whose jurisdiction it had occurred, throughout the country.

Responsibility of Reporting of Events

For domiciliary events the responsibility for reporting is assigned to head of the household or nearest relative or oldest adult male person. In case of institutional deliveries/ deaths, the medical officer in-charge of the institution and in respect of events in a jail, the jailors are responsible.

Responsibility of Registration

Local registrars have the responsibility to register these events. In rural areas, the registrars are *Panchayat* secretary, in-charge/revenue official/block development officer/primary health centre in-charge/health inspector/ teacher of government school. It varies from state to state. Village *Panchayat* holds the responsibility of registration of events and in its absence other agencies have been made responsible to register the events as indicated.

In urban areas, municipal committee/corporation holds the responsibility to register the events.

Structure

Local registrars—rural and urban areas as above. These agencies report the events to district registrar who happens to be District Health/Medical Officer or District Statistical Officer or Deputy Commissioner/Collector or District *Panchayat* Officer. The district registrars report the events to chief registrar at the state headquarter. In most states, chief registrars are director health services beside economics and statistic chief at the state.

Birth and Death Certificates

Procedures for Registration

Events of birth and death should be registered within prescribed period of 21 days of occurrence, with the local registrar. After 21 days but with late fee, after 30 days and within one year with written permission of prescribed officer (usually district registrar) by producing an affidavit, after one year of occurrence by an order of executive magistrate with prescribed late fee.

Soon after the registration of birth or death, the registrar has to issue an extract (birth certificate) to the informant free of charge. Extra copies of the certificate can be obtained on payment of certain fee as prescribed in the state rules. Birth certificate now can be issued at PHC level.

Registration of Name of Child

Birth of a child can be registered even without the name of the child, if birth of a child was registered without name it can be entered into the register within 12 months of registration without any fee. After 12 months but within

15 years of registration with fee of ₹ 5.00. The registrar will issue a fresh certificate with name of the child.

Registration of birth and death of Indian citizens occurring outside India: The Indian Consulates register the births and deaths of Indian citizens occurring outside India as per provisions made in the Citizens (Registration of India Consulate) Rules, 1956 under the Citizenship Act, 1955 and issue the birth and death certificates.

Maintenance of Records

Birth and death registers are permanent records and have to be retained forever. These registers along with the forms relating to the entries therein are retained by the registrar in his office for 12 months, after the end of calendar year to which they relate. Thereafter such registers and forms are transferred for safe custody to the designated officer. In rural areas, the registers are transferred to the district registrar and in urban areas; they are kept in municipalities/ corporation office.

Important

The events are to be registered at the *place of occurrence* and not at the *place of actual residence* of mother in case of birth and of person who died in case of death. Reliable data on actual level of birth and death (rates) are available from sample registration system (SRS), which collect this information for the usual *resident population*.

Live Birth Report

It gives information on date of birth, sex, name of child, place of birth, permanent residential address, father's and mother's name, their literacy occupation and religion, age of mother in completed years at confinement, order of birth, number of live births including the birth registered, type of attention at delivery and the informant.

Death Report

It gives information on date and place of death, name of deceased, name of father/husband, age, sex, marital status, occupation, religion, nationality, permanent residential address, cause of death, whether medically certified (yes or no), kind of medical attention received if any and the informant.

Uses

Registration of births and deaths is a statutory activity. It has got civil, legal and statistical uses. It is useful for school admission, employment, foreign travel, mutation of property, death benefits, etc.

- It provides vital statistics (birth rates and death rates on continuous basis) at local level.
- Helps in formulating policies and programmes on health, fertility, family welfare, maternal and child health, safe motherhood, universal immunization. These records can be used effectively in the actual implementation of healthcare and family planning programmes at field level to accord priorities to eligible couples of high parity or non-acceptors, priority for spacing methods of contraception and for universal immunization.
- Causes of death help to formulate preventive programmes and interventions to reduce incidence of avoidable deaths of infants, young children maternal and other deaths.
- Besides these birth and death rates help to assess or measure the impact of health services or programme on reduction of fertility and mortality. It also helps to assess the healthcare needs of population especially of mothers and children, for delivery, postnatal care, etc.

Deficiencies in Registration Data

The common deficiencies are:

- Incomplete coverage of population and area.
- Under-registration of events.
- Quality of records in respect of causes of death is poor, besides incomplete information and not adhering to time schedule.

Target is to register 100% of births and deaths.

The level of birth registration has improved from 82.4% in 2011 to 92.7% in 2019 and 81.2% of births were institutional. Death registration has improved from 66.4% in 2011 to 92% in 2020.[5, 6]

Reasons

As 66% of population lives in rural areas, there is lack of appreciation and awareness. Access to registrar may not be easy. The cause of death is difficult to ascertain as deaths are not attended by qualified/trained person in rural set-up.

SAMPLE REGISTRATION SYSTEM (SRS)

Objective: The SRS is a large-scale demographic sample survey based on dual record system with the main objective of providing reliable official estimates of vital rates, at natural division level for rural and at state level for urban areas.

Coverage: It covers the entire country. The survey provides official estimates of birth rates, death rates, infant mortality rate and other fertility and mortality indicators and data on causes of death annually on continuous basis at the national and sub-national levels.

Need: In the absence of dependable data from civil registration, the office of Registrar General India, initiated a scheme of sample registration of births and deaths in 1964–1965.

The Main Components of SRS[4]

1 **Baseline Survey:** The purpose is to obtain resident population of the sample unit. The baseline survey is carried out prior to the start of continuous enumeration. This involves preparation of notional map of the area,

house numbering, house listing and filling up of household schedule wherein the residential status of each individual and demographic particulars of each individual residing in the household, viz. name, sex, age, educational, marital status, relationship to head of household, etc. are collected. A list of pregnant women is also prepared at the time of baseline survey.

2 **Continuous (Longitudinal) Enumeration of Vital Events:** The resident part-time enumerators—generally *Anganwadi* workers and teachers record all births and deaths occurring within the sample unit, in respect of all **residents** in the area as well as to those of *usual residents* occurring *outside* the sampling unit. "A usual resident is defined as a person who has resided in a local area for the last 6 months or more or a person who intends to reside in that area for the next 6 months or more". The events in respect of visitors occurring within the sample unit are also listed but not taken into account while calculating rates. For ensuring complete netting, the enumerator uses different informants or sources such as village priest, barber, village headman and midwife, to get information on the occurrence of vital events. Enumerator also maintains a list of pregnant women. Enumerator further ensures visiting all the households once in each quarter in rural area and once a month in urban area to complete the registration of events of births and deaths.

3 **Half-Yearly Survey (HYS):** HYS is carried out independently in each sampling unit by a full-time **supervisor.** He visits each household in the sample unit and records the particulars of births and deaths in respect of all the usual residents in half-yearly period (January to June or July to December) under reference. Simultaneously he updates the household list, household schedule and pregnancy status of women. While carrying out this survey the supervisor does not have access to the birth and death records of enumerator.

4 **Matching:** The events collected by half-yearly survey are matched with those of events collected by enumerator. The events thus are classified as fully matched, partially matched and unmatched.

5 **Field Verification of Unmatched and Partially Matched Events:** Every unmatched and partially matched event is verified by a visit to the concerned household either by a third person or jointly by the supervisor and the enumerator. Thereafter an unduplicated count of births and deaths is obtained.

6 **Sample Design:** The sample unit in a rural area is a village or a segment of it, if the village population is 2000 or more. In rural area of bigger states (population of 10 million or more), NSS natural division is the first geographical stratification or in rural area of smaller states the stratification is done on size of village having population less than 2000 forming stratum I and village with population 2000 or more forming stratum II. In urban areas, the sampling unit is census enumeration block (CEB) with population ranging from 750 to 1000. In urban areas, the categories of towns/cities have been divided into four strata based on the size classes, in contrast to the six strata in the earlier sampling frame. Towns with population less than one lakh contribute stratum I, towns/cities with population between 1 and 5 lakh fall under stratum II, towns and cities with population 5 lakh or more form stratum III and four metrocities of Delhi, Mumbai, Chennai and Kolkata as separate strata, viz. stratum IV.

At present SRS is operational in 8841 sample units (4958 rural and 3883 urban) spread across all states and union territories and covers about 1.5 million households and 7.9 million population.

The information collected in respect of births include place and date of birth, whether live or still, whether singly or multiple, sex, mother's residential status, i.e. whether usually resident or visitor, age and religion, type of medical attention at delivery, etc. Information collected in respect of deaths include date and place of death, residential status, age, sex, marital status, religion and medical attention before death as also cause of death.

The estimates on birth rate, death rates, infant mortality rate for urban and rural areas are published half-yearly in sample registration bulletins by RGI.

THE MODEL REGISTRATION SURVEY OF CAUSES OF DEATH

The Model Registration Scheme (MRS) was meant for ascertaining causes of death in the rural area of the country. The fieldwork is done by the paramedical personnel (called field agent), stationed at PHCs. The field agent is usually a sanitary inspector or health inspector. In each state, the number of primary health centres selected for this scheme was based on a norm of at least one centre per million population. All the districts in a state are represented. From 1999 'survey of causes of death' has been merged with SRS and from 2001 onward it has become part of SRS Million Death Study (MDS) thus encompassing both rural and urban areas.

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CHAPTER

9

Demography, Vital Statistics, Population Stabilization and Medical Genetics

"People are not numbers, the most valuable resource of health of people is the people themselves, involve them in all national health programmes"

"Greatest asset of nation is its people."

Competency addressed: The student should be able to:
CM 9.1: Define and describe **principles** of demography, demographic cycle and vital statistics.

Demography is defined as composition and distribution of human population and changes in its size and composition over different time-periods. Population increases/decreases because of **births, deaths** and **migration.**

PRINCIPLES OF DEMOGRAPHY

India is a country of striking demographic diversity. Substantial differences are visible between states in achievement of basic demographic indices. The five states Bihar, MP, Odisha, Rajasthan, and UP that currently constitute nearly 40% of total population of India, are projected to comprise 42% of total population by 2021. In other words, these states alone will contribute an estimated 55% increase in population during the period 1996–2021 and beyond. Demographic outcome in these states will determine the timing and size of population at which India achieves **population stabilization** at "low birth rate–low death rate" from current intermediate transition stage of "high birth rate–low death rate" by repositioning family planning programme as RMNCH + A.

Population stabilization is to be achieved by implementation of reproductive and child health strategies universally with focus on increasing female literacy and status of women, decreasing infant and maternal mortality, improved health, nutrition, livelihood and ecological security for shared decision-making by couples.

Population Census

"Population **census** is the total process of collecting, compiling, analyzing or otherwise disseminating demographic, economic and social data pertaining, at a specific time, of all persons in a country or a **well-defined** part of a country". Census is conducted once in ten years in India.

It took thousands and thousands of years for the World Population to grow to 1 Billion then in 200 years or so it grew seven fold. In 2011, the global population reached 7 billion mark.

Current world population crossed the mark of 8 billion by mid November (2022) and is expected to rise to 9.7 billion by 2050. According to UN estimates. China, India and the United States are projected to remain three most populous countries for the next three centuries. China followed controversial policy of one child norm to reduce its population growth rate to 0.6% and ended its decades old policy in 2016 and permitted up to 3 children norms as the population of elderly rose and of the young declined.

Competency addressed: The student should be able to:
CM 9.1: Describe **demographic** cycle.

DEMOGRAPHIC TRANSITION/CYCLE

The population growth occurs due to excess of births over deaths and due to migration (immigration and emigration). There are several phases in demographic cycle.

"Demographic transition" denotes change in population size from a condition, in which both the birth and death rates are high, to another condition in which both of these rates are low. Before and after the transition, the population size is relatively stable. During the transition, however, it tends to **explode**, especially if mortality rates come down earlier and faster than birth rates do. Many of the developed countries have already reached the new equilibrium at a low level, whereas many of the developing countries still are at the beginning or somewhere within the transitional phase and thus are confronted with a **rapid population**

increase. These trends indicate the following major **changes** or transitions.

Phase I—Pretransition Stage (1901–1921)

The year 1921 is considered as "great divide" in the demographic history of India.[1] During 1911–1921, the population of India was *stable* at high death rate and high birth rate of 47 per thousand and 48 per thousand respectively. In this phase, birth rates and death rates were almost equal and negligible increase in population size. Out of the entire census till date, the average annual Exponential Growth Rate has been negative only for the decade 1911–21. During this interval, population declined marginally due to great influenza pandemic and two successive bad harvests (famine) in West Bengal (Fig. 9.1).

Phase II—Early Transition Stage (1921–1951)

The period from 1921 to 1951 was one of the "slow but steady" growth of population because of gradual reduction in mortality and fertility. There is hidden demographic crisis in this phase. Mortality and fertility though declined but the levels were still very high (Fig. 9.1).

Phase III—Mid-transition Stage (1951–2001)

It is a phase of rapid growth of population and occurs because of marked or rapid reduction in mortality rate, but the birth rate stays high, the *demographic gap* widens in this phase. India witnessed **population explosion** during this phase and continues to be in this phase—"High birth rate and low death rate" (Figs 9.1 and 9.3).

Phase IV—Late Transition Stage (2001–2021)

Mortality or death rate further falls and comes to minimal level because of development, birth rates also declines and *demographic gap* is somewhat narrowed and population grows at slow speed. India has reached to this stage in 2021 when replacement level of fertility was achieved. Thirty one states/UTs in India have already achieved below the replacement level of fertility of 2.1 or less then 2.1.

Phase V—Post-transition Stage

The "birth rates and death rates are low"—at optimal level and are nearly equal and the population becomes *stable* at lowest level of mortality and fertility. India is expected to achieve stable population by 2050 at the level of 1668 million for ahead of China's population which will drop to 1317 million by the middle of this century.

Phase VI—Declining Phase

The birth rates further decrease and become less than death rate. Romania and Hungary are passing through this stage.

NATIONAL DEMOGRAPHIC GOALS FOR 2025 AND BEYOND FOR POPULATION STABILIZATION

- To bring the total fertility rate to replacement level of 2.1.
- Achieve 100% registration of births, deaths and marriages and pregnancies. Promote delayed marriage for girls, not earlier than 18 and preferably after 20 years of age.
- Reduce infant mortality rate to 28 per 1000 live births.
- Reduce maternal mortality ratio to below 100 per 100,000 live births by 2025 and under 5 mortality to 23.
- Achieve population stabilization by 2045.

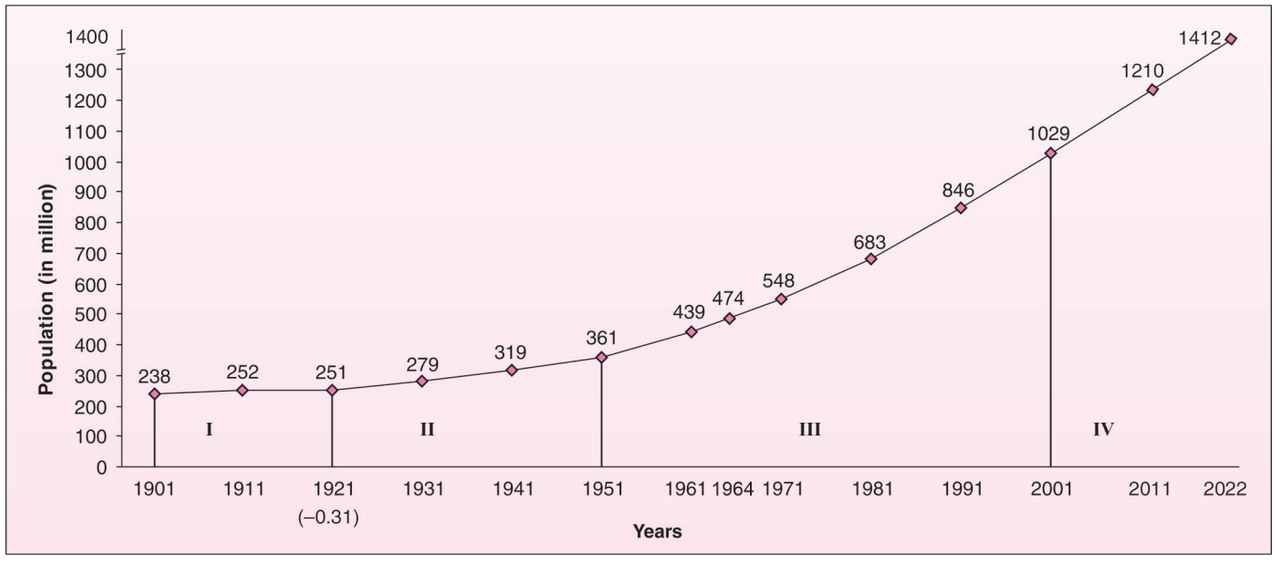


Fig. 9.1: Population dynamics and phases of demographic transition in India

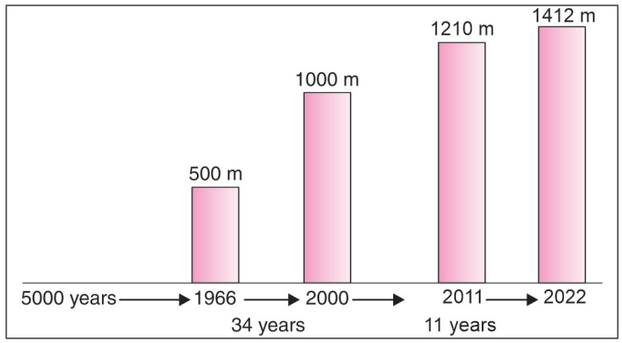


Fig. 9.2: Population explosion

Vital Statistics

Vital statistics deals with marriages, births, deaths, migration and natural growth rate of population in the country besides life expectancy at birth. It is dealt with subsequently in this chapter.

Competency addressed: The student should be able to:
CM 9.4: Enumerate and describe the causes and consequences of population explosion and population dynamics in India.

POPULATION EXPLOSION IN INDIA

With 2.4% of geographic land area, India has to support 17.5% of world population. It took several thousands years (5000 given here for the sake of convenience) before our population reached 500 million in 1966. India took 64 years to achieve first doubling from 238 (1901) million to 474 million in the year 1964.[2] The second doubling took only 34 years. Within a span of 34 years, the population got doubled and reached to the mark of 1000 million in May, 2000. This phenomenon in the history of demography in India has been described as "population explosion". During the first phase 1901 to 1921, the increase was very little as birth rate and death rate were very high and almost equal at 48 and 47 and increase was only one per 1000 per year. During the second phase of demographic transition from 1921 to 1951, the increase was slow and steady and India reached to the mark of 361 million as a result of decline in death rates. During the third phase of demographic transition 1951–2001, there was rapid growth of population in India and within a span of 50 years we increased almost three times. During this phase, there was steep decline in death rates and fertility rates also declined but at a slow pace (Fig. 9.3). As per census 2011, India is now home to 1210 million people[3] (Figs 9.1 and 9.2). The projected population is expected to increase from 1210 million in 2011 to 1412 million in 2022 and 1518 million in 2036- an increase of 25% in 25 years at the rate of 1% annually. India would surpass China Population of 1426 in 2023 with its projected population of 1429 million. The good news is that India's population is stabilising.

Competency addressed: The student should be able to:
CM 9.4: Describe population dynamics of India.

Population Dynamics of India

Population dynamics is the study of changes in population **size** and **structure**. The determinates of population growth are the number of births and deaths and the amount of

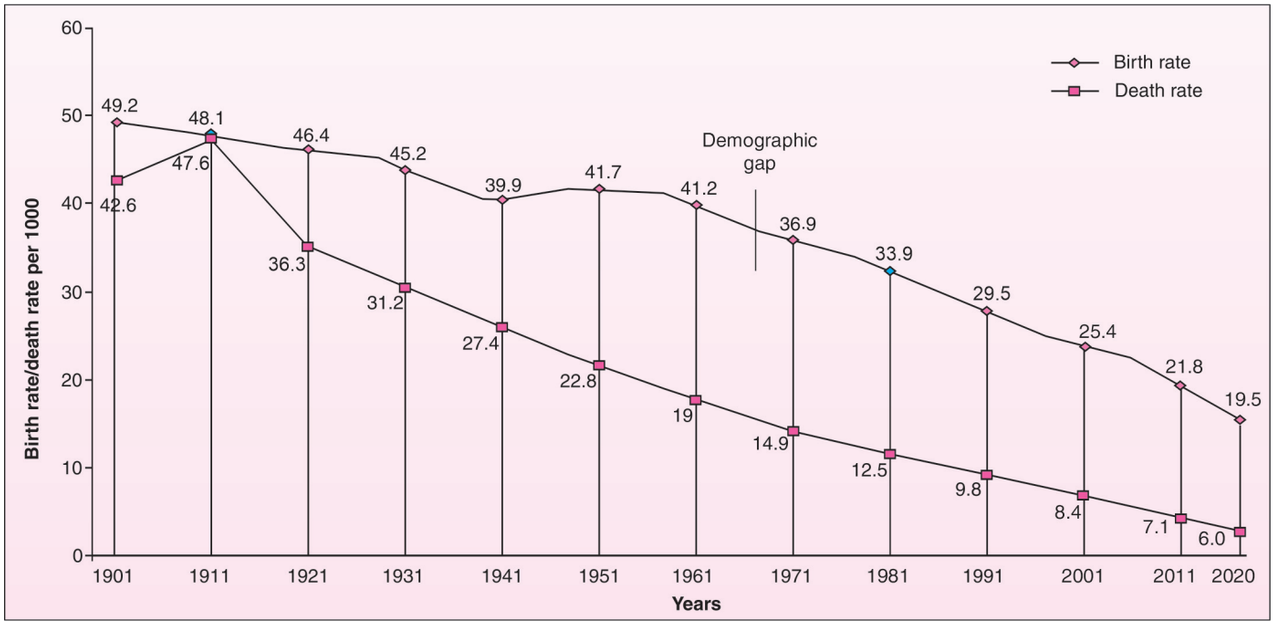


Fig. 9.3: Demographic transition in India

migration into and out of area. Population structure refers to age and sex structure and its distribution in geographical area. Change in fertility and mortality levels modifies population structure.

The population of young children below the age group of 0–6 years shows declining trends. During the year 1991, the proportion of children below 6 years was 15.9% and in the year 2011 it has declined to 13.1%. The decline has been to the extent of 2.8 points. The census (2011) confirms this decline due to declining fertility trends across the country. The base of the pyramid, which is constituted by 0–4 years age group of children is shrinking—a favourable and positive sign of success of family welfare programme. Similarly, the age group less than 14 years shows declining trend; India had 42% of population of children below 14 years of age in the year 1971 which has declined to 27% in 2021, as many states have achieved the replacement level of fertility.

The population in age group 15–59 is swelling and a rising trend has been observed from year 1971 onwards. The proportion of this age bracket which was 52% in 1971 has risen to 62% in 2021.

Population growth in India continues to be high on account of:

- The large size of the population in the reproductive age group is mainly responsible for population growth (estimated contribution 58%). An addition of 417.2 million in years 1991–2016 was anticipated despite substantial reduction in family size in several states including those, which have already achieved replacement level of TFR. This momentum of increase in population will continue for some more years because high TFR in the past have resulted in a large proportion of population being currently in their reproductive years. It is imperative that the reproductive age group adopts without further delay or exception the "small family" norm for the reason that about 45% of population increase is contributed by births above two children per family.
- Higher fertility due to unmet needs for contraception (estimated contribution 20%).
- High wanted fertility due to high infant mortality rate (estimated contribution 20%).
- Population of 60+ is consistently rising due to increased life expectancy.

Consequences

Our population has increased from 230 million in 1901 to 1210 million in 2011 and has crossed 1412 million on 11th July 2022. Currently it is growing by 16–18 million each year and likely to reach 1518 million by 2036. We have to ensure food supply, water and sanitation, shelter, schools, employment, health facilities, energy and other basic amenities for this massive population within limited resources. Managing health problems of elderly would be a challenge.

Stabilization of Population

Stable population: A population that has been growing at a constant rate over a number of years.

Stationary population: A population with no migration and for which crude birth rate is equal to crude death rate.

Zero population growth: Absence of growth in the population.

India launched the world's first national Family Planning Programme in 1952 for reducing birth rates "to stabilize the population at a level consistent with the requirement of national economy". The programme has been repositioned to not only achieve population stabilization but also to promote reproductive health and reduce maternal, infant and child mortality and morbidity.

Stabilizing population is essential requirement for promoting sustainable development with more equitable distribution. The vast number of people in India can be greatest asset if they are provided with means to lead healthy and economically productive lives. Population stabilization is a multisectoral endeavour requiring constant and effective dialogue among a diversity of stakeholders and coordination at all levels of the government and society. Spread of education and literacy, availability of affordable reproductive and child health services, **convergence of service delivery** at **village level**, participation of women in paid workforce, together with steady, equitable improvement in family income will facilitate early achievement of sociodemographic goals and population stabilization.

National Population Policy (NPP) provides framework for achieving goals to meet the reproductive and child health needs of the people of India.

Competency addressed: The student should be able to:
CM 9.2: Define, calculate and interpret demographic indices including birth rate, death rate, fertility rates.

Objective: Learning objective of this skill is to learn impact indicators of national family planning or RMNCH + A programme.

Demographic indices can be divided into two parts: Population statistics and vital statistics.

A. **Population statistics** deals with size, distribution, composition by age and sex, sex ratio, density of population, etc. as described below.

B. **Vital statistics** deals with birth rate, death rate and natural growth rate, life expectancy at birth, mortality and fertility rates (*described on pages 516–21*).

A. Population Statistics

Population Size

India is a country of diversity with 28 states, 8 Union Territories, 747 districts with 1412 million people in July 2022

varying in language, social customs and traditions. There are regions in the country with health profile comparable to developed countries and there are others that are way behind.

India's population as on the midnight of February 28–March 1, 2011 stood at 1,21,01,93,422, i.e. 1210 million higher than the 1192 million projection made by the experts. This makes India the second most populous country in the world, behind China (1426 million in Nov. 2022), and way ahead of the next most populous country the United States of America (332 million in April 2021).

India is projected to surpass China as the World's most populous country in 2023 (UN Report) becoming home to 1429 million people way ahead of China's population of 1426 million.

In India, population size is the key issue and major significant problem. **It is the single most important problem in the country.** India way back, in 1951 recognized the interrelationship between population and socio-economic development. Thus, the integration of population policies into the development process is now being increasingly recognized for "human resource development". Population neutralizes all the developments and because of these reasons, India was the first country in the world to launch official programme of National Family Planning Programme (NFPP) in the year 1952 to reduce birth rate and to stabilize the population at a level consistent with the requirement of national economy.

Distribution of Population

Uttar Pradesh is most populous state in the country, followed by Maharashtra, Bihar, West Bengal and Andhra Pradesh (Table 9.1).

URBAN RURAL DISTRIBUTION

Nearly 34% of population of the country is urban and the remaining 66% is rural population (Table 9.2). According to this distribution, it is evident that majority of India's population lives in rural areas spread over to 6,63,049 villages and many of these villages are difficult to access. Priority of allocation of resources including health must focus on rural areas to have adequate demographic impact. As per demographic norms, 66% of resources must flow to rural areas. Present scenario indicates that much more resources are concentrated in urban areas and quality of life is better in urban areas as most facilities are located in urban areas. The development indicators, fertility indicators, morbidity and mortality indicators are much better in urban areas than rural areas. The pace of urbanization in India is one of the slowest in the world. The urban population is growing in India at a slow pace and it is leading to unplanned urban growth resulting into urban slum areas with deplorable conditions. The plight of urban slum dweller may be worse than rural area. Statistics of urban slum may be statistic of shame in most slums. Urban poor people living in slum areas need to have organized services including health services. Though multiple health agencies work and are available in urban areas, yet the poorer are deprived of these facilities because of poverty and ignorance. Demographically, urban slums are deprived areas.

Table 9.1: Distribution of projected population of major states in India, in 2021

States	*Population in million*	*States*	*Population in million*
Andhra Pradesh	52.7	Karnataka	66.8
Assam	35.0	Kerala	35.4
		Madhya Pradesh	84.5
Bihar	123	Maharashtra	124.4
Chandigarh	1.2	Delhi	20.5
Chhattisgarh	29	Odisha	44.0
Gujarat	69.7	Punjab	30.3
Haryana	29.4	Rajasthan	79.2
		Tamil Nadu	76.4
Himachal Pradesh	7.3	UP	230.9
J & K	13.4	Uttarakhand	11.3
Jharkhand	38.4	West Bengal	98.12
India			**1361**

Table 9.2: Trends in urban population in India, 1901–2019

Year	*Percentage of urban population to total population*
1901	10.84
1911	10.29
1921	11.18
1931	11.99
1941	13.86
1951	17.29
1961	17.97
1971	19.91
1981	23.33
1991	25.71
2001	27.8
2011	31.16
2021	34.0

AGE AND SEX COMPOSITION

The large size of the population in the reproductive age group: 15–49 years (married females), which counts to over 205 million eligible couples responsible for population growth and 56.5% of them are currently effectively protected by modern contraceptives. Urgent steps are required to make contraception more widely available, accessible and affordable in rural and urban areas. The age pyramid reveals a story of high fertility and high mortality in younger age groups. The population above the age of 60 has risen to higher proportion to

demand the geriatric services (services for the aged). India has to gear up itself to provide resources for the services of aged people. The demographic trend will determine epidemiological trend of chronic diseases and burden of disease due to non-communicable diseases.

Population Pyramid of India (Fig. 9.4)

India is youngest nation in an aged world. The pyramid shows that India's population is young which is typical of developing countries with low life expectancy.

This pyramid being bottom heavy, reflecting large proportion of children, teenagers and young adults. With broad base at the bottom and tapering towards the top, indicating the effect of mortality in successive age groups. Nearly 27% of population is composed of children, below 14 years of age. The young structure of the population highlights the phenomenon of continued population growth in the country.

Thus, the dominant character of India's age and sex pyramid is, high mortality in younger age and females in reproductive age group and high dependency ratio in addition to growing proportion of 12% people above 60 years of age (Table 9.3).

There are positive signs that the broad base of pyramid has started shrinking. It denotes "in a population that is not affected by huge changes in age structure, adult migration or child mortality between two points of time, a significant fall of 3.08% in population of children in age group 0–6 years broadly indicative of fall in fertility during the period". Such a fall has occurred in a number of states and Union Territories during 2019–21. There is thus confirmation that fertility rates have been declining across the country. The decline appears well established in four Southern states and reasonably well established in Maharashtra in the west and Odisha and West Bengal in the east.[4,5]

The age distribution of the population of India has changed and these changes should determine allocation of resources in policy interventions. The population below 14 years of age (31% in 2011) has declined to 26.5% by 2021. The population in the age group 15–59 has increased to nearly 62% by 2021. The age group 60+ years has increased from 8.5% to nearly 12% by 2021. Thus, India will face the burden of chronic diseases and epidemic of non-communicable diseases due to increase in population of aged as a result of increased life expectancy. The pyramid would change its shape and a bulge will appear in its middle to signify enormous number of people in age group 15–59 to participate in reproduction pool.

Still the young age structure of the population holds the potential for the rapid population growth in the future unless special measures for more accelerated reduction in fertility are undertaken. These young children would add to the population of eligible couples in reproductive age group.

Consequences on health: The demographic transition in India has led to "epidemiologic transition" that is a long-term shift in mortality and disease patterns whereby large scale epidemics of infectious and parasitic diseases have disappeared and come under control. India is facing the epidemic of degenerative and man-made diseases, due to lifestyle changes, air pollution and accidents. The disease pattern and mortality pattern in India has changed drastically and non-communicable diseases have taken

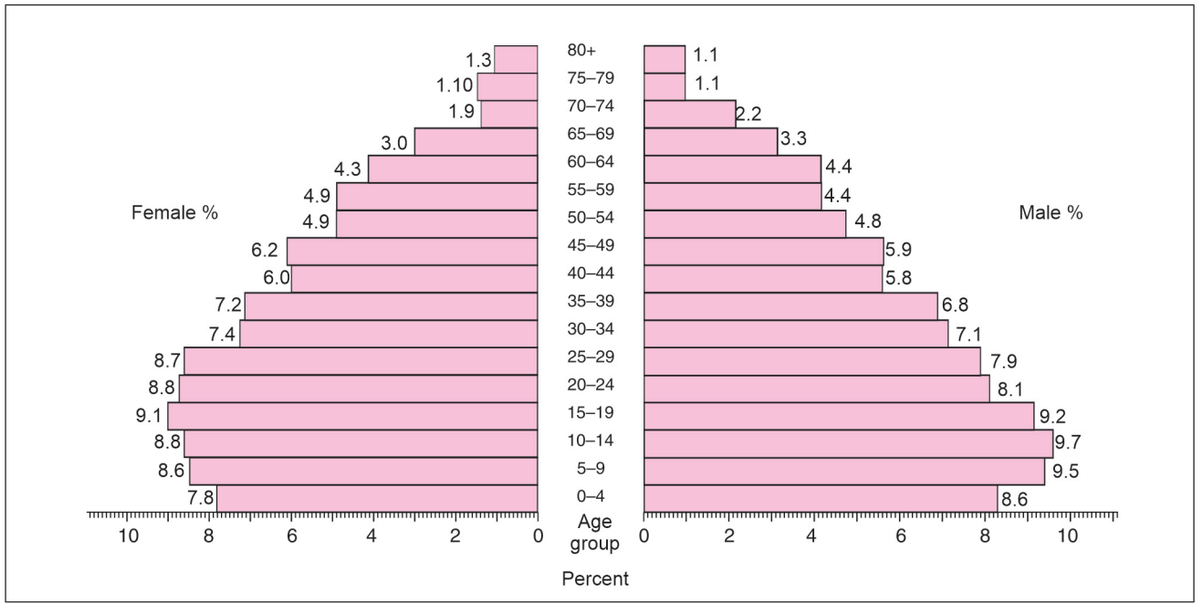


Fig. 9.4: Age and sex pyramid of India, 2019–21–NFHS-5

over, people now live longer and problem of management of elderly people has come to the fore.

Table 9.3: Household population by age, and sex NFHS–5 (2019–21)

Age groups	*Male*	*Female*	*Total*
0–4	8.6	7.8	8.2
5–9	9.5	8.6	9.1
10–14	9.7	8.8	9.2
15–19	9.2	9.1	9.1
20–24	8.1	8.8	8.5
25–29	7.9	8.7	8.3
30–34	7.1	7.4	7.3
35–39	6.8	7.2	7.0
40–44	5.8	6.0	5.9
45–49	5.9	6.2	6.1
50–54	4.8	4.9	4.9
55–59	4.4	4.9	4.7
60–64	4.4	4.3	4.4
65–69	3.3	3.0	3.1
70–74	2.2	1.9	2.1
75–79	1.1	1.0	1.1
80 and over	1.1	1.3	1.2
Total	**100.0**	**100.0**	**100.0**

Implications: The **rising population disturbs all the norms**. In health and ICDS sector, the rising population has increased the demand of sub-centres, primary health centres and community health centres and district hospitals. The population norms are difficult to meet because of rising costs. Further, the population is spread over to small villages, which are remote and not easily accessible. The coverage of services is affected badly due to rapid increase in population. Similarly, increasing slum population poses serious problems to establish primary healthcare services. Quality is the casualty in view of rapid increase in population. It is difficult to provide sustained quality services (water, jobs, food, houses, etc.) because of sheer number of clients who always outnumber against the meagre resources.

Demographic dividend: India has the world' largest young population. Over 65% of India's population is below 35 years of age. To harness the potentials of this segment for development is a challenging task. This in real sense is a demographic dividend for India's all round development. Full productive employment and decent work for all (Goal 8 of UN–SDG) is a challenging task.

India shares a distinctive feature of South Asian and Chinese population as regards the sex ratio, with a country's old deficit of females.

9

Competency addressed: The student should be able to:
CM 9.3: Enumerate and describe the causes of declining sex ratio and its social and health implications.

(a) THE OVERALL POPULATION SEX RATIO

The number of females per thousand males has been showing a secular decline, from 972 in 1901 to 943 in the year 2011. It is an important social indicator to measure prevailing inequity between males and females in society. The sex ratio represents the survival scene of women. It has registered a very marginal improvement from 927 in the 1991 to 933 in the 2001 census. This is a welcome feature of 2001 census results (Table 9.4). Overall sex ratio at national level has increased by 10 points since census 2001 to reach 943 in census 2011. Kerala has highest female sex ratio of 1084. The sex ratio has improved in a number of major states between 2011 and 2021. For the first time in India the overall population sex ratio of female has improved to 1020 in 2019–21 (NFHS–5). These include all the Southern States, Odisha, West Bengal, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Rajasthan and Assam. But it is worrisome to note that the sex ratio has declined in three major states Gujarat, J & K and Bihar an already low level in Punjab. One also notes decline in Himachal Pradesh and Haryana. Haryana had the lowest female sex ratio of 879 in the country (Table 9.4).

Table 9.4: Secular trends of sex ratio in India, 1901 to 2011

Years	*Sex ratio*	*Years*	*Sex ratio*
1901	972	1971	930
1911	964	1981	934
1921	955	1991	927
1931	950	2001	933
1941	945	2011	943
1951	946	2019–2021	1020
1961	941		

There has been slight increase in proportion of female population of the country from 48.26% in 2001 to 48.46% in 2011. Yet, the demographic divide between women and men continues to exist till date. Out of total population of 1210 million, we have 587.5 million population of female and 623.2 million males, it means some 35.7 million female were missing in India in 2011. Now the situation has improved in favour of females.

Causes of Declining Sex Ratio and their Social and Health Implications

Reasons for consistently low levels of sex ratio are

- Son preference
- Neglect of girl child resulting in higher mortality at younger age.
- Female infanticide, female foeticide
- Higher maternal mortality
- Male bias in enumeration to some extent

- Easy availability of sex determination tests and abortion services may also be proving to be catalyst in the process, which may be further stimulated by pre-conception sex selection facilities.
- Biased Family Planning Programme—undergoing sterilization after two males/one male child.
- Rapid fertility decline.
- Social problems—dowry problem, insecurity for girls, problem of marriages (imported wives) sexual abuse, etc. all of these make girl child as unwanted child.

Sex determination techniques have been in use in India since 1975 primarily for determination of genetic abnormalities. However, these techniques were widely misused to determine sex of the foetus and subsequent elimination if the foetus was found to be female.

DISTURBING SIGNS OF DEMOGRAPHY

(b) Declining Female Child Sex Ratio—CSR (0–6 Years)

One of the most disturbing features of demography is adverse sex ratio of female children as revealed through census 2011. Though the overall proportion of 0–6 children has been declining in India, a favourable trend indeed to attribute to the success of family welfare programme interventions, however, declining female child sex ratio or juvenile sex ratio (JSR) over the years is a disturbing trend. The most alarming and disturbing aspect of census 2011 report is sharp fall in sex ratio of female children (0–6 years) from 927 in 2001 to 914 in 2011, a significant decline of 13 points. The decline is even sharper in several states. Haryana, Punjab, Delhi and Chandigarh lead the dubious club, with adverse child sex ratio of 830, 846, 866 and 867 respectively. The bottom-most districts on child sex ratio lie in Haryana—Jhajjar being worst in India with meagre 774 girls per 1000 boys followed by Mahendragarh at 778.

However, increasing trend in child sex ratio was seen in states/UTs, viz. Punjab, Haryana, Himachal Pradesh, Gujarat, Mizoram, Chandigarh, Tamil Nadu and Andaman and Nicobar islands, but in all the remaining 21 states/UTs child sex ratio showed decline over the census 2001 (Table 9.5).

The general decline in the juvenile sex ratio (JSR) practically across the entire country must be viewed with concern. There is enough evidence from the field to indicate alarming spread of practice of female foeticide not only in the contiguous belt of Punjab, Chandigarh, Haryana, Uttarakhand, Himachal Pradesh, but also in Maharashtra and Gujarat, even more worrisome, in the much vaunted South, where the female fetus and infant were earlier not thought to be at great risk. In Tamil Nadu, for instance there is considerable evidence of the practice of female foeticide.

Child sex ratio (CSR) reflects both pre-birth and post-birth discrimination against girls. Therefore, sex ratio at birth (SRB) is considered to be more accurate and a refined indicator of the extent of sex selection.

Table 9.5: Adverse ratio of 0–6 female children

States	*1991*	*2001*	*2011*
J & K	–	941	859
Punjab	875	798	846
Haryana	879	819	830
Chandigarh	899	845	867
HP	951	896	906
Maharashtra	946	913	883
Delhi	915	868	866
Rajasthan	916	909	883
UP	927	916	899
Uttarakhand	948	908	886
AP	975	961	943
Karnataka	960	946	943
Tamil Nadu	948	942	946
Kerala	958	960	959
Bihar	953	942	933
Odisha	967	953	934
MP	941	932	912
Gujarat	928	883	886
All India	**945**	**927**	**914**

(c) Sex Ratio of Child at Birth (SRB)

Natural sex ratio at birth in India is 105 male per 100 female births. SRB is not influenced by post-birth factors such as mortality or neglect. The SRB for India has improved from 919 in 2015-16 to 929 in 2019-21 (NFHS-5)—A 10% rise.

Goal of 12th Plan: Improve the sex ratio for age group 0–6 from 914 to 950 by the end of 2030 by aggressive implementation of PC–PNDT Act.

Social and health implications of adverse sex ratio

i Increased mortality in female
ii Demographic imbalance problem of marriages as imported wives in Haryana and Punjab from other states.
iii Rise of violence and rape, crimes against women.

DENSITY OF POPULATION IN INDIA

Density of population is related to human activity. Density tends to be more in urban areas as compared to rural areas. Density of population is maximum in urban slums. Chances of spread of respiratory infections are maximum in dense population. Survival of young children in dense population is threatened with acute respiratory infections. Tuberculosis prevalence is much more in dense population.

The average density of population **per square km** in India was 382 in 2011 and 414 in 2021 and would be 433 in 2026. Delhi has the highest density of 11,297. Some of the areas have sparse population, and the terrains are difficult and access to population becomes difficult in such areas. Villages and hamlets are small and distances are too much to reach the services.

Definition: Economically dependent population is defined as sum of the population under 15 years of age plus population of 65 years of age and over, and

economically productive population is defined as the population in age group 15–64 years. The dependency ratio is average number of economically dependant population per 1000 economically productive population. It was 570 in 2011, 477 in 2021 and projected to 440 in 2026.

$$\text{Dependency ratio} = \frac{\text{Population under age 15 + Pop 65 years and above}}{\text{Population aged 15–64}}$$

INDIA'S DEMOGRAPHIC ACHIEVEMENTS

Despite all odds, India's demographic achievements have been significant. Over the last 70 years after formulating the National Family Welfare Programme, India has:

- Reduced its crude birth rate from 40.8 in 1951 to 19.5 in 2020.
- Halved the infant mortality rate (IMR) from 146 per thousand live births (1951) to 72 per 1000 live births (1998 SRS) and it has further gone down to 28 in 2020, a remarkable achievement indeed.
- Increased the couple protection rate five times from 10.4% in 1971 to 56.5 (modern methods) in 2019–21.
- Reduced crude death rate (CDR) from 23 (1951) to 6.0 (2019 SRS).
- Added 37 years of life expectancy from 32 years to 69.4 years.
- Reduced total fertility rate from 6.0 in 1951 to 2 in 2019–21.
- Steepest decline in decadal growth rate from 21.54 to 17.64% between 2001 and 2011 and 15.1 in 2021.

DEMOGRAPHIC PROFILE

India is following the demographic transition pattern of all developing countries from initial levels of "high birth rate – high death rate" to the current intermediate transition stage of "high birth rates – low death rates" which leads to high rates of population growth.

Competency addressed: The student should be able to:
CM 9.2: Define, calculate and interpret death rate, birth rate and fertility rates.

Objective: Learning objective of this skill is to learn impact indicators of National Family Planning Prog (RMNCH).

B. VITAL STATISTICS—BIRTH AND DEATH RATE

Interstate Differences in Fertility (Birth Rates)

India is country of striking demographic diversity. Substantial differences are visible between states in the achievement of basic demographic indices (Table 9.6).

Inequalities: Highest birth rates have been observed in the state of, Bihar, UP Rajasthan and Madhya Pradesh. This has led to significant disparity on current population size and potential to influence population increase in future.

Table 9.6: Crude birth and death rates and their inequality in major states of India—2020 (SRS 2021)

Major states	*Crude birth rate*	*Crude death rate*
Bihar	25.5	5.4
Uttar Pradesh	25.1	6.5
Madhya Pradesh	24.1	6.5
Rajasthan	23.5	5.6
Chhattisgarh	22	7.9
Jharkhand	22	5.2
Assam	20.8	6.2
Haryana	19.9	6.1
Gujarat	19.3	5.6
Odisha	17.7	7.3
Karnataka	16.5	6.2
Uttarakhand	16.6	6.3
Telengana	16.4	6.0
Andhra Pradesh	15.7	6.3
Maharashtra	15	5.5
J & K and Ladakh	14.6	4.6
NCT of Delhi	14.2	3.6
West Bengal	14.6	5.5
Tamil Nadu	13.8	6.1
Punjab	14.3	7.2
Kerala	13.2	7.0
India	**19.5**	**6.0**

These differences stem largely from poverty, illiteracy and inadequate access to health and family welfare services, which coexist and reinforce each others.

GROWTH RATE OF POPULATION (Fig. 9.5 and Table 9.6)

Positive Sign

India can smile at slowing of its population growth rates, which were indicated by census 1991. The growth rate of population has further declined in the year 2001 and 2011.

The decadal growth rate in the decade 2001–2011 was 17.64% lowest ever growth rate after independence. This is 3.90% points lower than the growth rate of 21.54% in the decade 1991–2001, it is in-fact lowest intercensus growth rate during the period 1951–2011. Maximum decadal growth rate of 24.8% was recorded in the decade 1961–1971 and this declined to 23.87 in the decade 1981–1991 and it further declined favourably to the mark of 21.54 in 1991–2001, which is a favourable declining trend indicating that we are marching ahead and entering in another phase of demographic transition of achieving replacement level of fertility by 2021. Decadal growth rate of 15.1% has been achieved in 2011–21 (Fig. 9.5).

The population growth rate has declined during 2011 as compared to 1991–2001 in practically all the major states. For the first time, there is a significant fall in the growth rate of population in the EAG states (UP, Bihar,

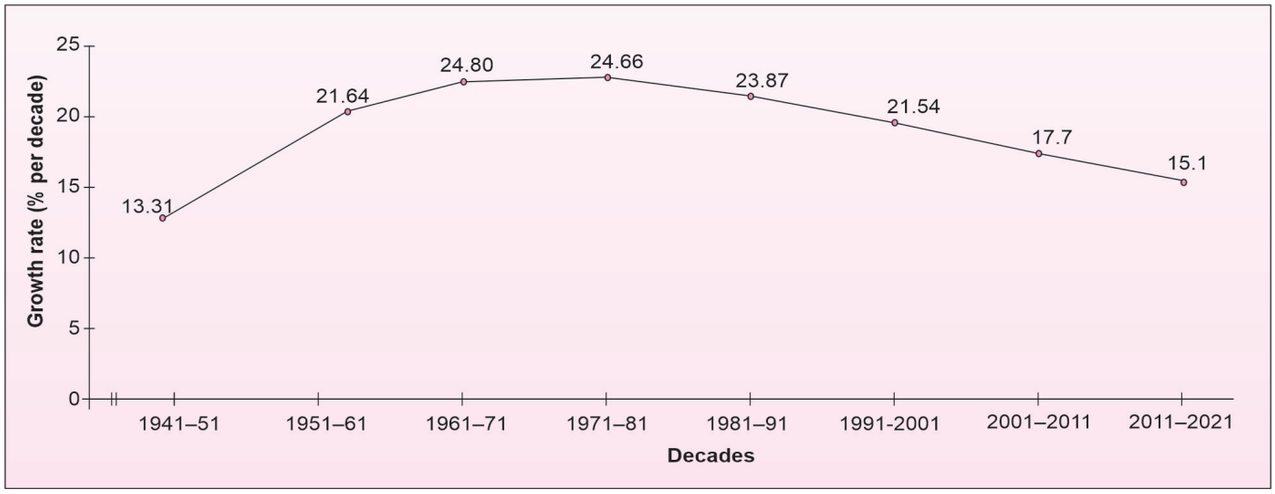


Fig. 9.5: Trends in decadal population growth rate in India, 1941–51 to 2011–2021

Rajasthan, Uttarakhand, Jharkhand, MP, Chhattisgarh and Odisha), after decades of stagnation.

Natural growth rate: It is the difference between the birth rate and death rate, was estimated at 13.5 per 1000 per annum in 2020 (Table 9.5) against a high of 17.1 in 2001. Between 2001 and 2011, we added whooping 182 million people.

LITERACY AND FERTILITY RATE

The results of census 2011 indicate significant increase in literacy rates and number of literate persons. The literacy has been defined as the ability to read and write with understanding in any language and it is determined for persons aged 7 years and above. Overall, literacy level of India was reported to be 74%, which is 9 points gain over literacy level of 2001 (65.38%). The female literacy level has increased to 65.46% from 54.16% in the year 2001, thus a gain of nearly 11 points. Kerala leads the way ahead of all the states with literacy of 93.9%. The male–female gap in literacy has declined to 16.68 percentage points, the lowest since the 1951 census. There is reduction in the gender gap in literacy levels in all the states and union territories. The biggest improvement in literacy has occurred in the state of Chhattisgarh, Rajasthan and MP.

Contraception acceptance or limiting the family size, spacing births at least three years apart is a function of literacy of parents and more so of women. If women are literate, their marriages will be at right age and their reproductive behaviour will change and they will have optimal total fertility rate and thereby the demography of a place would change as has happened in Kerala. Literacy is the best contraceptive to make positive impact on fertility.

EXPECTATION OF LIFE AT BIRTH (Table 9.7)

Expectation of life is used as an indicator of human development and countries are judged and graded on life expectancy. India has made considerable demographic gains over the years.

Table 9.7: Expectation of life at birth (India) by sex

Census years	*Total*	*Male*	*Female*
1901	23	23.63	23.96
1951	32	32.45	31.66
2003–07	65.0	63.7	66.5
2004–08	65.4	64	66.9
2005–09	65.7	64.3	67.2
2006–10	66.1	64.6	67.7
2007–11	66.5	64.9	68.2
2008–12	67.0	65.4	68.8
2009–13	67.5	65.8	69.3
2010–14	67.9	66.4	69.6
2011–15	68.3	66.9	70.0
2018	69.4	68.2	70.7
2021	67.2	65.8	68.9

Source: RGI and UNDP

The life expectancy over the years in India has improved significantly to 69.4 years. Life expectancy which was just 32 years in 1951 has risen to 70.7 years for females and 68.2 years for males in 2018. Since the life expectancy will rise further, India will face the problems of chronic and non-communicable diseases. Currently we in India are facing double disease burden, communicable diseases and emerging lifestyle diseases or non-communicable diseases. Covid pandemic has decreased the life expectancy by 2 years.

MORTALITY RATES IN INDIA

Crude Death Rate (Tables 9.6 and also *see* Table 7.4)

It is defined as total number of deaths per 1000 population per year. It is crude because death rates vary significantly

in infancy and old age groups. Hence, age specific death rates are more meaningful besides cause specific death rates for prevention of deaths.

$$\text{Calculation of crude death rate} = \frac{\text{Total deaths}}{\text{Mid-year population}} \times 1000$$

The crude death rates over the years have declined from 23 in the year 1951 to 6.0 in the year 2020. Similarly, infant mortality has declined to 28 and under five mortality has been reduced to 32, but these levels are unacceptably high. Maternal mortality, neonatal mortality and perinatal mortality continues to be unacceptably high. These have been discussed elsewhere for aggressive actions at the community level. It is expected that with increase in standards of living and quality of life, the mortality will come down to acceptable level.

The mortality is maximum or highest in the early childhood period, during infancy and children between 1 and 4 years of age. Mortality is least in age bracket 5–19 years, which is considered to be the healthiest period of life. Mortality tends to be higher in female in reproductive age group (15–49 years) and, thereafter, the mortality rates go on increasing as the age advances. Young children and old people are most vulnerable to death. Thus, the prime need of young infant is survival and development. The determinants of high mortality during infancy are high reproduction and prematurity due to repeated pregnancies. The other determinant is environment, which exposes the children to diarrhoea, respiratory infections and injuries. Lifestyle diseases and non-communicable diseases take heavy toll beyond the age of 50 but more young people die of coronary heart disease in India than in developed countries.

There are inequalities in birth and death rates between various states, rural and urban areas and socio-economic groups (Table 9.6).

Burden of Premature Deaths—Deaths below 70 Years

By 2030, India will witness 9.3 million premature deaths before age 70 to more than any other country, if its 2010 death rate continues.

Of these, 1.5 million will occur before age of five, 2.7 million at age five to 49 and 5.1 million at age 50 to 69.

The research stresses India needs rapid progress, not only to reduce child mortality but also tuberculosis, malaria and deaths from chronic diseases and non-communicable diseases which are made more common by tobacco use. With current rate of progress, deaths in India before age of 70 would fall only by 31% by 2030 short of suggested 40% target. Between 2000 and 2010 Indian death rate fell 30% before the age of five, 15% during ages 5–49, and 12% during ages 50–69. Overall death rates in India below age 70 fell by 17%.

FERTILITY RATES/INDICATORS (CM 9.2)

High fertility is a serious problem in India. The fertility can be measured by following indicators: (1) Age at effective marriage (AEM), (2) crude birth rate, (3) general fertility rate, (4) age specific fertility rate, (5) total fertility rate, (6) gross reproductive rate, (7) net reproduction rate, (8) parity, (9) birth interval, (10) child–woman ratio, and (11) eligible couples.

Mean Age at Effective Marriage (MAEM)

The mean age at effective marriage (female) is the age at consummation of marriage. It is very important demographic predictor as it relates to number of years a couple is exposed to pregnancy and the family size. At the national level, the mean age at effective marriage for female in the year 2017 was 22.1 years. The state level data show variation in MAEM. It was highest in J & K (25.1) followed by Delhi 23.7, Punjab 23.5, Himachal P 23.4, Kerala (23.2), and Tamil Nadu (23.0). West Bengal has the lowest MAEM (21.2). MAEM determines the number of children born by women. The MAEM in respect of more than 16.8% of female was below 18 years while 19.1% were married below 20 years of age.

Crude Birth Rate (CBR)

Crude birth rate is the most commonly used as simplest measure of fertility of a population and is a crucial determinant of population growth.

It is computed regularly by sample registration system (SRS) every year for rural and urban areas; for different states of India.

Crude birth rate has come down from 36.9 in 1971 to 19.5 in the year 2020.

Years	1971	1991	2011	2018	2020
CBR	36.9	30.9	21.8	20	19.5

Computation

CBR is the number of live births per 1000 population per year.

$$\text{CBR} = \frac{\text{Live births in one year}}{\text{Mid-year population in that year}} \times 1000$$

Inequalities

CBRs are higher in rural and urban slum areas. States like, Bihar, UP, and MP have higher crude birth rates: Above 24 per 1000 population, while Kerala had the lowest birth rate of 13.2.

Limitations

It is called crude because the whole population is used as denominator, but the fact remains that only females in

reproductive age group (15–49 years) are able to produce children. Generally, girls below 15 and women above 49 years of age are unable to produce children.

General Fertility Rate (GFR)

It is refined measure of fertility. Only women in reproductive age group of 15–49 years of age are able to produce children, is used as denominator in this rate. Accordingly, GFR is calculated by:

$$\text{GFR} = \frac{\text{Live births in the year}}{\text{Women in reproductive age group (15–49 years)}} \times 1000$$

Since women in reproductive age group are approximately 25.75% of the total population, therefore, the level of GFR in India is around 80, i.e. four times that of CBR.

Example:

$$\text{GFR} = \frac{\text{Live births in the year 2015 in India were 26 million}}{\text{Women in reproductive age group in that year 334 million}} \times 1000 = 80$$

At the level of sub-centre or PHC, GFR can be calculated by dividing the total number of live births in a year by total number of eligible couples (15–49 years married women). However, fertility rate varies with the age of women and age at marriage. Current GFR in India is 70.4 (SRS, 2018).

Age Specific Fertility Rate (ASFR) and Age Specific Marital Fertility Rate (ASMFR)[5]

It is used to measure the reproductive performance of women of a given age. The ASFR is defined as the number of children born to women in the specific age group per 1000 women in that age group and ASMFR is the number of children born to married women in the specific age group per 1000 women in the same age group.

$$\text{ASFR} = \frac{\text{Number of live births to women of specified age or age group in a year}}{\text{Mid-year population of the specified age or age group}} \times 1000$$

During the year 2018, the ASFR of women in age bracket 25–29 years was highest at 146 followed by age bracket 20–24, while in the age bracket 40–44 it was around 12.7. There is thus marked difference in fertility levels in different age brackets (Table 9.8). ASFR is, however, not a summary index of overall fertility level of the whole population.

Implications: Age group 20–29 years should be prime focus for spacing and limiting child births. Spacing methods need to be promoted and priority for contraception should be younger couples (20–29 years of age) with 2 or less children.

Table 9.8: ASFR (India) 2018—SRS

Age groups	*Urban*	*Rural*	*Total*
15–19	8.4	13.5	12.2
20–24	91.5	135.9	122.8
25–29	119.1	160.1	146.4
30–34	81.7	101.3	94.7
35–39	30.2	40.7	36.9
40–44	9.1	14.8	12.7
45–49	2.4	5.5	4.4

Total Fertility Rate (TFR)[6]

It is used as standardized index for the overall fertility level. It overcomes the limitations of the crude birth rate and general fertility rate.

The TFR means the average number of children that would be born per woman if she was to live to the end of her child bearing years (15–49 years) and bear children at each age in accordance with prevailing age specific fertility rates, or else TFR is average number of children born to woman during her lifetime.

TOTAL FERTILITY RATE (TFR)

India's TFR has declined overtime to 2 children per woman and is currently below the replacement level of fertility of 2.1 children per woman. 31 states/UTs have already reached below the replacement levels of fertility, and 5 states (Meghalya, Jhharkhand, Manipur, Rajasthan and Bihar) are approaching fast to replacement levels of fertility of 2.1 children per woman (the rate at which a population exactly replaces itself from one generation to the next). Notably these 5 states are among the laggards in term of per capita income and are high focus states (Table 9.9).

Table 9.9: Total fertility rate in 15–49 NFHS–5 (2019–21) India

Total fertility rate (TFR) level	*TFR in states and UTs*
• TFR less than 2 in 31 States and UTs **Non High focus states**	MP 1.99, Har 1.91, Mizo 1.87, Assam 1.87, GUJ 1.86, UK 1.85, Chhat 1.82, Odisha 1.82, Arunachal 1.80, Ladakh 1.31, J and K 1.41, Sikkim 1.05, Chandi 1.40, Kerala 1.79, TN 1.76, Telangana 1.75, Naga 1.72, Maha 1.71, Tripura 1.70, AP 1.68, Karnataka 1.67, HP 1.66, WB 1.64, PB 1.63, Delhi 1.62, Goa 1.30 Dadar Doman 1.84, Pudu 1.49, Laksha 1.42, Anda 1.28
• TFR between 2 and 2.9 5 States **High Focus States**	Meghalya 2.91, UP 2.35, Jhharkhand 2.26, Manipur 2.17, Rajasthan 2.01
• TFR 3 One-sate **Very High focus state**	Bihar 3

Since the pace of achievement of TFR varies from state to state. We have to ensure differential strategies in different areas to achieve the desired TFR. High Focus Approach has been adopted by Govt of India.

Impact of High Focus Approach of Govt of India: Government of India has categorized states as per the TFR level as **very high focus, high focus, and non-high focus**.

Computation

Total fertility rate is arrived at by sum of all age specific fertility rates for each year of age from 15 to 49 years. It is the average number of children that a synthetic cohort of women would have at the end of reproductive period, if there was no mortality among the women. Synthetic birth cohort is artificial birth cohort, composed of cross-sectional sample of the women in reproductive age group.

During the year 1951, the TFR in India was 6.0. The current level of TFR at national level is 2 (Table 9.10). India brought it down to the level of 2.0 by repositioning Family Planning Programme. This in other words means two child norm. Thirty-one States and UTs in India have already achieved below the replacement levels of 2.1 children per women. These states are Kerala, AP, TN, Punjab, Delhi, HP, West Bengal, Karnataka and Maharashtra. On the other hand, in states like, Bihar, has high TFR of **three**; which means differential strategies for contraception and regulating fertility are needed for these states to achieve the desired level of TFR. Focus now should shift to districts with high TFR.

Gross Reproductive Rate (GRR) in the Year 2018

The GRR means total number of female children born to a woman throughout the span of reproduction (15–49 years of age). Assumption here is that no female dies, and lives up to full span of reproduction and produces children at prevailing fertility rates. This rate is about half of TFR. Estimated GFR of India at present is 1.0. Pool of daughters born to women will determine the future pool of women in reproductive age group. Sex selective abortions and sex selective sterilizations have disturbed this rate.

Table 9.10: Trends in TFR in India (UNICEF and NFHS–5)

Year	*TFR*
1951	6.0
1970	5.6
1990	4.0
2005	2.9
2006	2.8
2007	2.7
2008	2.6
2009	2.6
2010	2.5
2012	2.4
2014	2.3
2015–2016 (NFHS–4)	2.2
2017	2.2
2019–2021 (NFHS–5)	2.0

Net Reproduction Rate (NRR)

While GRR assumes that no woman will die during her reproductive span, the NRR takes into consideration the mortality effects in women of reproductive age group. In essence, NRR is similar to GRR but it is adjusted for mortality in women. NRR is really replacement index. NRR 1 or unity means that a woman is replaced by another woman in her lifetime. NRR 1 is equivalent to TFR of 2.1. The National Health Mission has set the goal of achieving NRR 1 by 2025 or TFR of 2.1 by 2025 by different strategies, protecting effectively over 60% of eligible couples.

Parity (Live Births by Order of Birth) (2019)

Parity means number of live births/living children. High parity is a problem in India which reflects high level of fertility. High level of improvident maternity (parity three or more) prevails which speaks of high fertility rates. Similarly, urban slum areas have high improvident maternity rate (birth orders 3 and, or more).

Implication: High *improvident maternity* of over 21.7% was evident in India, which means high fertility. In Bihar, improvident maternity was over 39%. Different methods of contraception are required based on parity of couples. Sub-centre ANMs routinely generate these data and they can determine priority couples for contraception.

Birth Interval

This is the time interval between two consecutive births.

Birth interval is expressed as *closed* and *open* birth interval.

Closed birth interval: Interval between two successive births.

Open birth interval: Interval between the last birth and the date of study.

Spacing births at least three years apart by using spacing methods is good for health and survival of mothers and children. The risk of death for young children is increased to 50% if interval between births is less than 2 years.

Spacing between two childbirths is less than 3 years in 48% of births (SRS, 2016).

Child–Woman Ratio (CWR)

This is the ratio of 0–4 years children to women in reproductive age group (15–49). If this ratio is high it means fertility rate of the area is high. In the year 2021, the child women ratio in India was 8.3: 27.4 = 303 per 1000 women of 15–49 age group. Infant mortality and maternal mortality affects this ratio. This indicator is generally used if no other indicator is available.

0–4 years age group constitutes the base of population pyramid, if it is broad it signifies high fertility which is true for population pyramid of India. Of late (census 2011),

the base has begun to shrink which is positive sign and it speaks of success of Family Welfare Programme in India.

Eligible Couples (ECs)

Eligible couple means all married couples with age of wife between 15 and 49 years age group are listed as eligible couples by all the health workers and updated every year. Thus, the proportion of eligible couples stands worked out at the level of sub-centre. There will be on an average of 190 such couples per 1000 population. Over the years, the proportion of ECs should decline. If the proportion of ECs is high the fertility level is also high due to unmet needs of contraception. Large pool of ECs in India is responsible for high fertility rate and population growth to the extent of 60%. All eligible couples are being tracked for use of contraceptives by monthly follow-up visits.

Contraceptive Prevalence Rate (CPR)

Contraceptive prevalence rate is percentage of women between 15 and 49 years who are practicing or whose sexual partners are practicing, any form of contraception. During the year 2019–21 CPR was 56.5%.

Out of 205 million of ECs in the year 2011 only 44% were effectively protected (using contraception). ECs have to be disaggregated partywise and agewise to focus on young couples for spacing and limiting the size of the family by contraception. *Effective couple protection rate* of more than 60% is required to achieve NRR of 1 or TFR of 2.1. Protecting couples of high parity with sterilization or other means of contraception will have little demographic impact. In some states, paradox of high couple protection rate and high birth rate was observed due to over-reporting or inflation of reports to complete the targets. Sterilization of women who already have 3–4 children will have little demographic impact.

Couple Protection Rate (CPR)

It is defined as the percent of eligible couples effectively protected against child birth by one or the other approved method of family planning.

- *Number of couples protected effectively* can be arrived at by taking 100% for sterilization, and oral pills, 95% for IUD users and 50% for CC users.
- *Equivalent sterilization* can be calculated by adding the number of sterilizations, 1/3 the number of IUD insertions, 1/18 the number of equivalent CC users and 1/9 of equivalent oral pill users. Under the national programme, one beneficiary for oral pills is a woman who completes 13 cycles and for CC user one beneficiary is a person who uses 72 pieces of condoms.

According to NFHS–5 in India 56.5% of ECs were currently using modern contraceptives (female sterilization 37.9%, male sterilization 0.3%, condoms 9.5%, IUD 2.1%, pills 5.1%) and traditional methods were used by 9.6%. Therefore, to bring down birth rate significantly, it would be necessary to provide effective contraceptive coverage to about 75% of eligible couples. Spacing methods need to be promoted vigorously.

Expected outcome: Student prepares population and vital statistics profile of India (population pyramid) from census data/SRS, NFHS-5 data and determines sex ratio or calculates demographic indices from a given set of data and interprets in the context of national demographic goals.

Competency addressed: The student should be able to:
CM 9.5: Describe the methods of population control.

METHODS OF POPULATION CONTROL

Population control and its stabilization is a multisectoral endeavour cutting across party lines and religious affiliation.

i Adopt two child norms—by aggressive population education and behaviour change communication through multimedia approach for universal access to information and counselling services.

ii Ensure child survival and safe-motherhood by:
   a Reducing neonate, infant and child mortality and morbidity.
   b Safe motherhood—by ensuring:
   Safe pregnancy, safe abortion, safe delivery and safe puerperium and reducing maternal mortality rate as also improving health and nutritional status of women and children.

iii Limit family size and space child births 3 years apart by improved contraceptive services to reduce unmet needs. Increase men participation in contraception (sterilization).

iv Delay the marriage of girls, not earlier than 18 and preferably after 20 years of age. Strict implementation of Child Marriage Restraint Act of 1976.

v Free and compulsory education up to 14 years under Right to Education Act and vocational education especially for girls to delay marriages.

vi Aggressively implement PC and PNDT Act to improve child sex ratio and prevent sex determination and sex selective abortions.

vii Implement *Beti Bachao* and *Beti Padhao* Programme to improve declining child sex ratio.

viii Freeze the number of Lok Sabha seats on the basis of census 1971 till 2026 to motivate states to pursue fearlessly the agenda of population stabilization.

ix Promote *Pradhan Mantri Matru Vandana Yojna*. It is conditional maternity benefit scheme under ICDS. Eligible pregnant and lactating mothers receive cash incentive of ₹ 5000 in three installments of ₹ 1000 for early registration of pregnancy, ₹ 2000 on antenatal check up and ₹ 2000 on registration of child birth and completion of immunizations up to 42 days.

x One time incentive of ₹ 21000 to eligible girls getting married after 18 years (*Apni Beti Hamari Beti*).
xi Implementation of MTP Act.

Competency addressed: The student should be able to:
CM 9.6: Describe National Population Policy.

NATIONAL POPULATION POLICY (NPP), 2000

POLICY

Policy means statement of intentions and time frame to achieve the set goals.

Major goal: To improve quality of life and stabilize population.[7]

Objectives of National Population Policy (NPP)

- The immediate objective of NPP, 2000, is to address the "unmet needs" of contraception, healthcare infrastructure, and healthcare personnel and to provide integrated service delivery for basic reproductive and child healthcare.
- The medium-term objective is to bring total fertility rate (TFR) to 2.1 (replacement level).
- Long-term objective is to achieve a stable population by 2045 at a level consistent with the needs of sustainable economic growth social development and environmental protection.[1]

NATIONAL SOCIODEMOGRAPHIC GOALS

1 Address the unmet needs for basic reproductive and child health services, supplies and infrastructure.
2 Make school education up to age 14 free and compulsory, and reduce dropouts at primary and secondary school levels to below 20% for both boys and girls.
3 Reduce infant mortality rate to below 30 per 1000 live births.
4 Reduce maternal mortality ratio to below 100 per 100,000 live births.
5 Achieve universal immunization of children against all vaccine preventable diseases.
6 Promote delayed marriage for girls, not earlier than age 18 and preferably after 20 years of age.
7 Achieve 80% institutional deliveries and 100% deliveries by trained persons.
8 Achieve universal access to information/counselling, and services for fertility regulation and contraception with a wide basket of choices.
9 Achieve 100% registration of births, deaths, marriages and pregnancies.
10 Contain the spread of acquired immunodeficiency syndrome (AIDS), and promote greater integration between the management of reproductive tract infection (RTI) and sexually transmitted infections (STIs) and the national AIDS control organization.
11 Prevent and control communicable diseases.
12 Integrate Indian Systems of Medicine (ISM) in the provision of reproductive and child health services, and in reaching out to households.
13 Promote vigorously the small family norm to achieve replacement level of TFR.
14 Bring about convergence in implementation of related social sector programs so that family welfare becomes a people-centred programme.

STRATEGIC THEMES

- Decentralized planning and programme implementation: 73rd and 74th Constitutional Amendment Act, 1992 made *health*, *family welfare* and *education* a responsibility of village *Panchayats* and Nagarpalikas respectively. The Panchayati Raj Institutions (PRIs) are important means of decentralized planning and programme implementation in the context of NPP, 2000. Delegate administrative and financial powers to PRIs.
- Convergence of service delivery at village level.
- Empowering women for improved health and nutrition.
- Child health and survival.
- Meeting the unmet needs for family welfare services.
- Underserved population groups—(a) urban slums, (b) tribal communities, hill area population and migrant population, (c) adolescents, (d) increased participation of men in planned parenthood.
- Diverse healthcare providers.
- Collaboration with and commitments from Non-Governmental Organizations (NGOs) and the private sector.
- Mainstreaming Indian System of Medicine and Homeopathy.
- Contraceptive technology and research on reproductive and child health.
- Providing for the older population.
- Information, education and communication.

LEGISLATION

As a motivational measure, in order to enable state governments to fearlessly and effectively pursue the agenda for population stabilization contained in the NPP, 2000, one legislation is considered necessary. It is recommended that 42nd Constitutional Amendment that freezes till 2001, the number of seats to the Lok Sabha and Rajya Sabha based on 1971 census be extended up to 2026.

Public Support

Enlisting support for small family norm by political, community, business, professional and religious leaders,

media and film stars, sports personalities and opinion makers will enhance its acceptance.

NEW STRUCTURES

Population problem is multisectoral endeavour. This requires multisectoral coordination of planning and implementation between health and family welfare on the one hand, along with schemes for education, nutrition, women and child development, safe drinking water, sanitation, rural roads, communications, transportation, housing, forestry development, environmental protection and urban development. The following structures were recommended:

- National Population Commission established in 2000 and reconstituted in 2005.
- State/UT Commissions on population
- Coordination Cell in Planning Commission.
- Technology Mission in the Department of Family Welfare.

FUNDING

In order to implement immediately the action plan, it would be necessary to double the annual plan budget of the Department of Family Welfare to enable government to address the shortfall in unmet needs of healthcare infrastructure, services and supplies. The annual budget of Family Welfare for the year 1999–2000 was 2920 crores, half of this gets spent on non-plan activities (recurring expenditures for maintenance of healthcare infrastructure in the states and UTs, and towards salaries). Only 50% is available for genuine plan activities including procurement of supplies and equipment.

PROMOTIONAL AND MOTIVATIONAL MEASURES FOR ADOPTION OF SMALL FAMILY NORMS

The following promotional and motivational measures will be undertaken:

1. Rewarding Panchayat and Zila Parishad for exemplary performance.
2. The ***"Balika Samridhi Yojna"*** run by department of Women and Child Development to promote survival and care of girl child, will continue. A cash incentive of ₹ 500 is awarded at birth of the girl child of birth order 1 or 2.
3. ***Maternity benefit scheme:*** Cash incentive of ₹ 500 to mothers who have their first child after 19 years of age for birth of first and second child only.
4. Family welfare health linked insurance plan for couples below poverty line.
5. Setting-up of revolving fund for income generating activities by village self-help groups.
6. Opening-up of crèches and child-care centres.
7. Enlarging the basket of contraceptives.
8. Facilities for safe abortion will be strengthened and expanded.
9. Strict Enforcement of Child Marriage Restraint Act, 1976.
10. Strict Enforcement of Prenatal Diagnostic Technique Act, 1994.
11. Soft loan to ensure mobility of ANMs.
12. Social marketing schemes for contraceptives.
13. Ambulance services to transport referral high-risk women to encourage village level organization by providing soft loans.

The vast number of people in India can be its greatest asset if they are provided with means to lead healthy and economically productive lives. In the new millennium, nations are judged by the well-being of their people, by level of health, nutrition and education, by civil and political liberties. Success will be achieved if the action plan contained in the NPP, 2000 is pursued as a national movement.

NATIONAL POPULATION POLICY 2000 ACTION PLAN

Decentralization Planning and Programme Implementation and Convergence of Services at Village Level

Since 33% of Elected Panchayat seats are reserved for woman, representative committees of *Panchayats* (headed by elected woman member) should be formed to promote gender sensitive, multisectoral agenda for population stabilization, that will "think plan and act locally, and support nationally".

1. By utilizing self-help groups to organize and provide basic services for reproductive and child health (RCH) with ongoing integrated child development scheme (ICDS).

   Once a fortnight these *self-help acceptor groups* meet and provide at one place 6 different services for (i) registration of births, deaths, marriages and pregnancy; (ii) weighing of children under five years and recording the weight on standard growth chart; (iii) counselling and advocacy for contraception, plus free supply of contraceptives; (iv) preventive care with availability of basic medicines for common ailments: Antipyretics for fevers, ORT/ORS for childhood diarrhoea together with standardised indigenous medicines; (v) nutrition supplements; and (vi) advocacy and encouragement for the continued enrolment of children in school up to age 14. One health staff appointed by Panchayat will be suitably trained to provide guidance.
2. Meaningful decentralization will result only if the convergence of the national family welfare programme with the ICDS programme is strengthened. At village level, the *Anganwadi* centre may become the focal point for basic care activities, contraceptive counselling and supply, nutrition education and supplementation

as well as preschool activities. The *Anganwadi* centre can also function as depot for ORS/basic medicines and contraceptive.

3 Establishment of maternity hut in each village for safe delivery. Panchayat may appoint competent and mature midwife.

4 Trained birth attendants as well as vast pool of traditional dais should be made familiar with emergency and referral procedures. This will greatly assist the ANMs.

5 Provide a wider basket of choices of contraception.

Empowering Women for Improved Health and Nutrition

- Cluster services for women and children at the same place.
- Open more child-care centres in rural areas and urban slums, i.e. establish *Anganwadis* or crèches where woman can leave her children in safe hands for care and development. This will encourage women to participate in development process.
- To empower women to pursue programme of social afforestation to facilitate easy access to firewood, fodder. Increased access to potable water. This will reduce long absence from home and need for large number of children to perform such tasks.
- Promote energy saving devices, such as solar cookers, provision of sanitary latrines, or extension of telephone lines; this will empower woman and households.
- Strengthen the referral network between SC, PHC, CHC and district hospital in management of obstetric and neonatal complications to reduce maternal and infant mortality.
- Establish mechanism of maternal and perinatal death audit from village level upwards.
- Ensure adequate transportation from village level upwards of mothers having obstetrical complications.
- Improve the accessibility and quality of maternal and child health services—through deployment of community midwives and additional health providers at village level, training, improved supervision and provision of standard equipment and medicines and physical facilities.
- Monitoring of maternal and child health services at each level. ANM should be responsible for registering every pregnancy and childbirth in her area.
- Providing universal antenatal and postnatal services.
- Improve technical skills of maternal and child healthcare providers by on the job training to all category of workers and birth attendants.
- Improve information education and communication at community level.
- Universalization of ICDS and convergence of maternal and child health services.
- Include STD/RTI and HIV/AIDS prevention, screening, and management in maternal and child health services.
- Develop health package for adolescents.
- Expand the availability of safe-abortion services at PHC level and CHC level. District civil surgeon should be the authority to register abortion clinics. Provide MTP training to medical officers and include MTP in the curriculum of all categories of workers and doctors.
- Establishing first referral unit at subdistrict level and community health centre and make them functional.
- Ensure the efficient functioning of first referral units, i.e. 30 bedded hospital at block levels (CHC) to bring down maternal mortality and IMR. Augment availability of specialists in these units by increasing seats in medical institutions and acquiring postgraduate qualifications through National Board of examination and open universities like IGNOU. As an incentive, seats will be reserved for those in-service medical graduates who are willing to abide by a bond to serve for 5 years at FRU after completion of PG course. State would sanction the posts of specialists at FRUs.
- Create national network of public–private and NGO centres identified by a common logo for delivering RCH services free to any client. The provider will be compensated for the service provided. The end user can choose the provider of service.

CHILD HEALTH AND SURVIVAL

- Essential neonatal care at community level and at PHC, CHC and hospitals.
- Set-up national technical committee on neonatal care to align programme and project interventions with newly emerging technologies in neonatal and perinatal care.
- Train health personnel for integrated management of childhood illnesses (IMCI).
- Pursue rigorously the pulse polio-campaign to eradicate polio.
- Ensure 100% coverage of routine immunizations in particular tetanus and measles.
- Promote delayed marriage of girls not earlier than 18 years and preferably after 20 years of age by compulsory education of girls and vocational training for girls.
- Reduction of maternal malnutrition, morbidity and mortality by ensuring availability of supplies equipment at village level and sub-centre.
- Expand the ICDS to include children between 6 and 9 years of age to promote 100% of school enrolment particularly for girls.

MEETING THE UNMET NEEDS FOR FAMILY WELFARE SERVICES

- Unmet need for contraceptive is estimated at 9.4% in 2019–21.

- Establishing adequate number of sub-centres, PHCs, CHCs as per norms to complete their deficiency, provide manpower, equipment, medicines and supplies (contraceptives, laparoscopes, tubal ring, vaccines and RCH drugs).
- Formulate and implement social marketing schemes.
- Improve facilities for referral transportation at Panchayat, Zila Parishad and PHCs. Increase mobility of ANMs to increase coverage.
- Encourage local level organization and NGO to start ambulance services for transportation of women needing emergency care.
- Opening up of chemist shops at village level through loan facility.

UNDERSERVED POPULATION GROUPS

Urban Slums

Finalize comprehensive *urban health* strategy. Facilitate service delivery centres in *urban slums* to provide comprehensive basic health, reproductive and child health services by NGOs and private sector including corporate sector.

- Promote network of retired government doctors, paramedicals and nonmedical personnel who may function as healthcare providers on remunerative terms.
- Initiate specially targeted information education and communication activities in urban slums.
- Promote intersectoral coordination in urban slums to enhance services.
- Streamline the referral systems and linkages between primary, secondary and tertiary levels of healthcare in urban areas.

Tribal Communities, Hill Area Population and Displaced and Migrant Populations

NGO sector may be encouraged to organize system of preventive and curative healthcare in these areas. Promote indigenous system of medicine. Sensitization of providers to the needs of tribal areas.

Adolescents

Ensure for adolescent's access to information, counselling and services including reproductive health services. Strengthen PHCs and sub-centres to provide counselling to adolescents on spacing and right age of marriage.

- Provide for adolescents the package of nutrition services available under ICDS programme.
- Enforce the Child Marriage Restraint Act, 1976 to reduce incidence of teenage marriages.
- Provide integrated intervention in pockets with unmet needs in the urban slums, remote rural areas, tribal area and border districts.

Increase Participation of Men in Planned Parenthood

- Currently 99% sterilizations are tubectomies. Repopularize vasectomies in particular no-scalpel vasectomy.
- Focus attention on men in the information and education campaign to promote small family norms.
- Continuing education and training at all levels to promote use of no-scalpel vasectomy. Include this in the syllabi.

DIVERSE HEALTHCARE PROVIDERS

Public–Private Partnership

Involve private practitioners and assign satellite population of 5000 to provide RCH services and compensate them adequately for providing these services. One year contract at a time be given.

- Revival of licentiate of medical practitioners.
- Include RCH strategies into the curriculum of under- / postgraduates, nursing and paramedical professional courses, syllabi and curriculum.

Collaboration with and Commitment from Non-Governmental Sector

Collaboration with voluntary sector and NGO in clinical services, for motivation of village level self-help groups and social marketing will be encouraged.

Collaboration with and Commitment from Industry

Collaboration with industrial sector for strengthening of the management information system in seven most deficient states at PHCs and sub-centre level by electronic data entry machines, to reduce the load on ANMs, in social marketing of RCH services, transportation, providing RCH services to their own employees, managing primary schools for children and outreach of basic reproductive and child-care services.

Mainstreaming of Indian Systems of Medicine and Homeopathy

Providing orientation and training in respect of RCH programme for qualified doctors in Indian system of medicine and utilize their services, institutions and their time tested practices and medicines.

Contraceptive Technology and Research on RCH

Promote RCH research in consultation with Indian Council of Medical Research and the network of academic and research institutions. The International Institute of Population Sciences and the Population Research Centres will continue to review the programme and monitor the indicators of RCH services to provide feedback to the programme. Research areas would include contraceptive technology, CNAA approach, new models of neonatal care, convergence of services, public–private partnership, and newer technologies in vaccines.

Providing for Older Population

Sensitize, train and equip rural and urban health centres and hospitals towards providing geriatric healthcare. Encourage NGOs and voluntary organizations to make the elderly economically self-reliant. Tax benefits could be explored as an encouragement for children to look after their aged parents.

Information Education and Communication

Converge IEC efforts across the social sectors. Achieve coordination between family welfare and education sector to promote cause of literacy.

Involve all other departments like rural development, social welfare, transport, cooperative and education with special reference to schools to improve clarity and focus on the IEC efforts. Coverage and outreach of IEC activities can be extended by using elected leaders, opinion makers and religious leaders. Utilize radio and television as also indigenous media on the issues of small family norms. National communication strategies in RCH have been evolved and presented elsewhere.

Jansankhya Sthirata Kosh (JSK)

JSK is also known as population stabilization fund. The objective of JSK is to facilitate the attainment of the goals of National Population Policy, 2000 and support projects, schemes, initiatives and innovative ideas designed to help **population stabilization** both in the government and voluntary sector. It can generate resources through government and voluntary sectors contributions (from individuals, industry, trade organizations and other legal entities) in furtherance of the national cause of population stabilization.

JSK has Undertaken a Number of Initiatives for Population Stabilization

- **PRERNA strategy:** Aim is to delay the age of marriage of girls and space the births 3 years apart. Girls married after 19 years of age and giving birth to first child after at least 2 years of marriage are given incentive of ₹ 10,000 to ₹ 12,000. The scheme is meant for BPL families. It is a responsible parenthood strategy in seven focus states, namely Bihar, UP, MP, Chhattisgarh, Jharkhand, Odisha and Rajasthan.
- **SANTUSHTI strategy:** Accredited private nursing home/hospital can sign a tripartite (state health society as first party, accredited private health facility as second party and JSK as third party) memorandum of understanding. Such hospitals and nursing homes are entitled for incentives for performing tubectomy and vasectomy operations.
- **JSK** has also set up National Helpline in India to provide reliable information on reproductive, and sexual health, contraception, pregnancy and child health issues.

Competency addressed: The student should be able to:
CM 9.7: Enumerate sources of vital statistics including: SRS, NFHS, NSSO, civil registration system and census.

SOURCES OF VITAL STATISTICS[5]

Vital statistics means data on births, deaths and causes of deaths, marriages, migration. The major sources of vital statistics are:

1. Civil registration system of births and deaths on voluntary basis, under Births and Deaths Registration Act, 1969.
2. Sample Registration System (SRS) of Registrar General of India.
3. Large scale demographic and health surveys such as NFHS, annual health and district level household surveys.
4. Routine reports of service statistics in healthcare delivery system.
5. Special studies on causes of death statistics such as Million Death Study, verbal autopsy on causes of maternal and child deaths and other deaths.
6. Medical certification of cause of death—from hospital statistics and private practitioners.

SAMPLE REGISTRATION SYSTEM (SRS)

Since civil registration system is incomplete and not reliable, SRS is an alternative but not substitute to civil registration system (CRS).

The sample registration system (SRS) is a large-scale demographic survey for providing reliable annual estimates of infant mortality rate, birth rate, death rate and other fertility and mortality indicators at the national and sub-national levels. Initiated on a pilot basis by the office of the Registrar General India in a few selected states in 1964–1965, it became fully operational during 1969–1970 with about 3700 sample units. The field investigation consists of continuous enumeration of births and deaths in selected sample units by resident part time enumeratos, generally *Anganwadi* workers and teachers, and an independent survey every six months by SRS supervisors. The data obtained by these two independent functionaries are matched. The unmatched and partially matched events are re-verified in the field and thereafter an unduplicated count of births and deaths is obtained. The sample unit in rural areas is a village or a segment of it (if the village population is 2000 or more). In urban areas, the sampling unit is a census enumeration block with population ranging from 750 to 1000. The SRS sample is replaced every ten years based on the latest census frame. The current sample is based on the 2011

census frame. At present, SRS is operational in 8850 sample units (4,961 rural and 3,889 urban) covering about 7.9 million population, spread across all states and union territories.

Summary

The SRS provides reliable estimates of birth rate, death rate, natural population growth rate and infant mortality rate (IMR) for India and its States/UTs.

NATIONAL FAMILY HEALTH SURVEYS (NFHS)[6]

NFHSs are large scale demographic and health surveys being conducted nationwide since 1992–1993. NFHS-5, the fifth in NFHS series conducted in 2019–21, provides information on indicators on, health, nutrition and population for India and each state/Union Territory and district. NFHS-4 was conducted in 2015–16 and for the first time, it provides district level estimates for many health indicators. These surveys provide information on key health indicators and trends for India.

The 131 key indicators generated by these surveys are grouped broadly as: Population and household profile focusing on social determinants of health, marriage and fertility, Infant and child mortality rate, current use of family planning methods, unmet need for family planning, quality of family planning services, maternal and child health (maternal care, delivery care, child immunization, treatment of childhood diseases, child feeding practices and nutritional status of children), nutritional status (BMI) of adults, anaemia among children and adults, blood sugar level among adults, hypertension among adults, knowledge on HIV/AIDS among adults, women empowerment and gender based violence, tobacco use and alcohol consumption among adults. The findings of NFHS-4 and 5 are reflected in relevant chapters. NFHS-5 has expanded to cover Pre-school education, disability, access to toilet, death registration and reasons for abortion. Key indicators of NFHS–5 are displayed at Table 9.11.

Uses of NFHS or Objectives

i It evaluates the effectiveness of ongoing national health programmes like RMNCH+A, family planning, maternal and child health, national immunization programme, nutritional interventions and programme of non-communicable and communicable diseases.

ii It helps in planning and improving national programmes interventions.

iii It provides benchmark data and trends.

Other Uses

We can learn the subject of epidemiology, biostatistics, management and community medicine from live data of NFHS, available at national, state and district level. Students can be given learning exercises for presentation of these data by diagrams, tables and analysis and interpretation of data for actions at various levels. Live epidemiological exercises can be developed from these data by teachers. NFHS uses cut off levels for various indicators, which can be used as reference standards and for case definitions. Problem-based learning and self-directed learning and real time learning from NFHS data can enrich medical education especially the learning of community medicine.

At the level of village, sub-centres and *Anganwadis* **Household Survey Data** is available for tracking the beneficiaries for providing services and planning of health services at local level. These data can be rich resource material for learning community medicine.

National Sample Survey Office (NSSO)

National sample surveys (NSS) are large scale nationwide surveys to generate information on health (morbidity data) since 1953. Full scale survey on morbidity was conducted in 1973–1974. Since then NSSO has not conducted any separate morbidity survey. Morbidity data are now being collected as part of the decennial surveys on social consumption. The last survey on social consumption: Health was carried out during NSS 75th round (July 2017—June 2018).

Aim

Aim of NSS 75th Round was to generate quantitative information in the health sector.

What information on health?

The NSSO is primary source of basic information in the health sector such as—morbidity, hospitalization, extent of receipt of prenatal and postnatal care by women, expenditure incurred on treatment received from public and private sector, use and cost of AYUSH treatment, etc. Key indicators generated, in 75th round of NSSO.

i Proportion of ailing persons.
ii Spells of ailments and its treatment.
iii Rate of hospitalization.
iv Cost of treatment—hospitalization.
v Cost of treatment—non-hospitalized treatment.
vi Incidence of child birth, and place of child birth and expenditure on institutional child birth and maternity care.
vii Quantile classes of—usual monthly per capita consumer expenditure (UMPCE).

Proportion of Ailing Persons (PAPs)

1 The number of living persons self-reporting of ailments during a 15-day period per 1000 (living) persons, was 68 in rural and 91 in urban areas. Overall percentage of ailing persons at point in time was 7.5%. This was the self- reported morbidity data. The level of morbidity increased with level of living—economic status.

Table 9.11: India-Key Indicators 2019–21—NFHS-5

Indicators	*NFHS-5 2019–21*	*NFHS-4 2015–16*
• **Sex ratio (females per 1000 males)**	1020	991
• Sex ratio at birth (females per 1000 males)	929	919
• Households using iodized salt (%)	94.3	93.1
• Total fertility rate (children per woman)	2.0	2.2
• **Current use of family planning methods (women 15–49 years)**		
a. Any method (%)	66.7	53.5
b. Any modern method (%)	56.5	47.8
• Children age 12–23 months, fully vaccinated based on information from either vaccination card or mother's recall (%)	76.4	62.0
• Children fully vaccinated based on vaccination card only	83.6	77.9
• **Child-feeding practices and nutritional status**		
a. Children under age 3 years, breastfed within one hour of birth	41.8	41.6
b. Children under 6 months of age, exclusively breastfed (%)	63.7	54.9
c. Children under 5 years who are stunted (%) height for age	35.5	38.4
d. Children under 5 years who are wasted (weight for height) (%)	19.3	21.0
e. Children under 5 years who are severely wasted (%)	7.7	7.5
f. Children under 5 years who are underweight (weight for age) (%)	32.1	35.8
g. Children under 5 years who are overweight (weight for height) (%)	3.4	2.1
• **Nutritional status of adults (age 15–49 years)**		
a. Women whose BMI is less than 18.5 kg/m^2	18.7	22.9
b. Men whose BMI is less than 18.5 kg/m^2	16.2	20.2
c. Women who are overweight or obese, BMI more than 25 kg/m^2	24.0	20.6
d. Men who are overweight or obese, BMI more than 25 kg/m^2	22.9	18.9
• **Anaemia among children and adults**		
a. Children 6–59 months with Hb less than 11 g/dl (%)	67.1	58.6
b. Non-pregnant women who are anaemic, Hb less than 12 g/dl	57.2	53.2
c. Pregnant women, age 15–49 years who are anaemic, Hb less than 11 g/dl	52.2	50.4
d. All women, age 15–49 years who are anaemic (%)	59.1	54.1
• **Blood sugar level among adults (age 15 years and above)**		
a. Women with blood sugar level high or very high more than 140 mg/dl or taking medicine to control blood sugar level (%)	13.5	NA
b. Men with blood sugar level high or very high more than 140 mg/dl or taking medicine to control blood sugar level (%)	15.6	NA
• **Hypertension among adults (age 15 years and above)**		
a. Women with elevated blood pressure (systolic ≥140 mmHg) and/or diastolic ≥90 mmHg) or taking medicine to control BP (%)	21.3	NA
b. Men with elevated blood pressure (systolic ≥140 mmHg) and/or diastolic ≥90 mmHg) or taking medicine to control BP (%)	24.0	NA
• **Screening for cancer among adults (age 30–49 years)**		
a. Women ever undergone a screening test for cervical cancer (%)	1.9	NA
b. Women ever undergone a screening test for breast and oral cancer (%)	0.9	NA
c. Men ever undergone an oral cavity examination for oral cancer (%)	1.2	NA

2 **Treatment** of ailments—for over 95.4% of spells of sickness treatment was sought from allopathy system and only 4.4% sought treatment from AYUSH system.
3 Private doctors were most important single source of treatment in rural as well as in urban areas. In fact 67.5% in rural and 74% in the urban areas spells of ailments were treated in **private sector**. Overall 70% of ailments were treated in private sector.
4 Cost of treatment per hospitalization in private sector was ₹ 38,822 in urban and 27,347 in rural against ₹ 4837 and ₹ 4290 in public hospital.
5 Overall hospitalization cases (in 365 days) per 100 persons were 29 in 2017–18. Of all hospitalization, 42% were treated in government hospitals while 58% were treated in private/NGO hospitals.

Nature of Ailments Experienced

Ailments were clubbed into 11 broad categories, namely, infections 31.4, injuries 11.2, gastrointestinal 9.9, cardiovascular 9.1, genitourinary 5.9, psychiatric/neurological 5.7, musculoskeletal 4.4, respiratory 4.2, eye 3.6, obstetric and neonatal 3.5 and others 11.1%, respectively.

Usefulness

These are used for evaluation of health programmes interventions, besides planning, policy formulation, decision support as inputs for further analytical studies.

Census

Census is the count of total population of the country. Census in India started in 1851. Census data is collected once every 10 years. Census collects population by age and sex, determines sex ratio, population density, decadal growth rate, average annual exponential growth rate, percentage of urban and rural population statewise, literacy rates, occupation, housing and amenities like safe drinking water and toilet connectivity within the house, type of drainage, distribution of slum population, common disabilities/impairments in population statewise and data on socio-economic and caste census.

Uses of Census in Health

- Helps in planning of health services in population.
- Useful in evaluation of health interventions such as family welfare programmes.
- It provides baseline data and data on quality of life and determinants of health (literacy, occupation, income, etc.)
- **Civil registration system** (*see* pages 505, 526).

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MEDICAL GENETICS

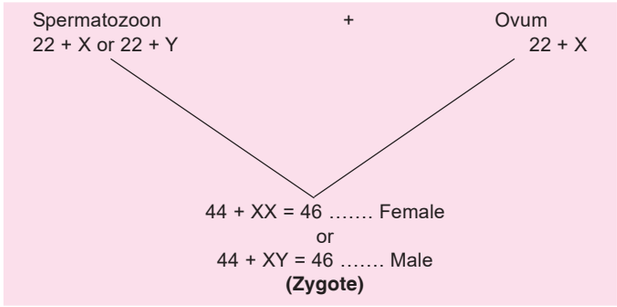
INTRODUCTION

The major application of medical genetics is control of hereditary diseases in population. Research on human DNA is being coordinated internationally. The main medical application of DNA technology at present is in the diagnosis of genetic disorders, genetic counselling, screening and prevention of hereditary diseases.[1]

Nucleic acids are of two kinds: Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). The DNA is the basis of life. DNA is found within the nucleus and mitochondria and RNA is found in cytoplasm. DNA is responsible for synthesis of RNA, duplication, and genetic copying and mutation. RNA synthesizes proteins.

Most human DNA is contained in 23 pairs of chromosomes in the cell nucleus. Each chromosome consists of a single DNA molecule associated with proteins. DNA is not confined to the nucleus, however, mitochondria also has an independent and characteristic DNA complement, inherited only through the mother.

Human beings have 46 (23 pairs) chromosomes of which 44 are autosomes and the rest two are sex chromosomes. In male, these sex chromosomes are XY and in female XX. The male and female chromosomal pattern can be depicted as 44 + XY = 46 and 44 + XX = 46 respectively. Due to reduction cell division (meiosis), in male and female gamete (spermatozoon and ovum) a



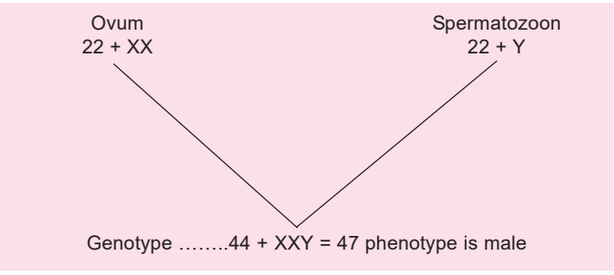
gamete will contain 22 autosomes + 1 sex chromosome. In case of spermatozoon, it is 22 + X or 22 + Y and in case of ovum it is always 22 + X.

Thus, the spermatozoon (not the ovum) is the sex determinant factor. Hence, females should never be blamed for sex of a child at birth.

Chromosomal Abnormalities

Two full chromosome sets are required for balanced gene expression leading to normal embryonic development and functioning. However, errors of cell division leading to aneuploidy (one or more chromosomes present in the many or too few copies) are common during gamete formation.

Normally, the unfertilized ovum should contain after reduction division 22 + X number of chromosomes, however, if the reduction of sex chromosome fails to occur, it will be 22 + XX. If such an ovum fertilizes spermatozoon of 22 + Y, it can lead to:



This is called Klinefelter's syndrome (XXY)

The person is genetically female because of presence of two X chromosomes. Phenotype of this individual is male (outward appearance)—the penis, testis, vas, seminal vesicles are small with no spermatogenesis (sterility). Sometimes, they have gynaecomastia and may be mentally retarded.

Turner's Syndrome (XO)

Genetically such a person is sexless. No ovary, no testis and no gonadal sex. Appearancewise, this person is a female (have vulva, vagina and small uterus) but breasts do not develop owing to absence of estrogen, no menstruation and such person is sterile. They are short statured and often have other congenital abnormalities.

Effects

Aneuploidy usually causes failure of fertilization or of early embryonic development or miscarriage. Only a few foetuses with abnormalities such as additional chromosome 21 (Down syndrome), 18 (Edward syndrome) or 13 (Patau syndrome) or an additional, or missing sex chromosome, survive to birth.[2]

The frequency of chromosomal aneuploidy and hence of spontaneous abortions and of chromosomally abnormal infants, increases with maternal age.

Chromosomal rearrangements, in which two chromosomes exchange unequal proportion of their DNA, can also occur during gamete formation, and hence, is another important cause of genetic disease.

Demographic factors influence the incidence of chromosomal disorders because of their relationship with advanced maternal age. Where women continue having children up to the end of reproductive life, the birth incidence of chromosomal disorders may reach 6/1000 and of children with **Down syndrome** about 1/1000. Family planning and bearing children at appropriate age reduces the incidence of Down syndrome by 30–60%.

Mutation of Gene

In normal individual, several variations are seen in the genomic DNA sequence which are called polymorphisms. In individuals with genetic disorders, variations in the form of substitutions, deletions, or insertions are seen in crucial positions in the disease gene, which ultimately affect the final expression of the gene and are called mutations.

The haemoglobinopathies constitute one of the most common autosomal disorders in India. Besides cancer, hemophilia and glucose-6-phosphate dehydrogenase (G6PD) deficiency also pose significant public health problems in our country. Characterization of mutations is one of the important aspects in the study of these hematological disorders. Several powerful and sensitive molecular techniques are available to diagnose these disorders.

A mutation is a spontaneous change in the sequence or the complement of DNA. There are two broad groups of mutations, namely chromosomal abnormalities which are changes in chromosome number or arrangement and point mutation; which are changes in the sequence of DNA bases. Mutation is an intrinsic property of DNA and is the basis of evolution and of individual variation, it can also give rise to genetic diseases and disorders.

Point mutations arise in only one of pair of genes. When a single altered gene is sufficient to cause evident change, the mutation is termed dominant; if the presence of remaining unmutated gene prevents such change, the mutation is recessive. Mutation confers selective advantage on carriers (e.g. carriers of haemoglobin disorders and glucose-6-phosphate dehydrogenase (G6PD) deficiency are protected against falciparum malaria).

Mutagens

The natural mutation rate is increased by exposure to mutagens such as ultraviolet light, radiations or chemical carcinogens (drugs) and use of tobacco.

The frequency of mutation rises with parental age.

Genetic Diagnosis

- By taking family history in detail—as genetic disorders are inherited from parents to offsprings.

- By biochemical methods to detect marker or presence or absence of a particular protein.
- By molecular genetic and changes in DNA.

Single Gene Disorders

Single gene disorders are important causes of fatal or chronically disabling disease especially in childhood and have led to the development of the modern biochemical and DNA methods for investigating the genetic component in more common and complex disease categories.

Example: Huntington disease, haemophilia, phenylketonuria (PKU) follow clear-cut inheritance pattern that directly reflect the transmission of the abnormal gene.

The number of single gene disorders is very large more than 6000 are now known. When the gene involved is known, it may be possible to offer definitive carrier tests (biochemical or DNA) to determine which relatives are, and which are not carriers of mutated gene. Carrier then may choose different options to avoid passing of disorder to their offspring.

Multifactorial Disorders

These disorders are due to genetic causes or due to environmental causes alone or due to both genetic and environmental factors. A baby with jaundice may have one or more of the following genetic or environmental problems—prematurity, infection, G6PD deficiency, rhesus incompatibility, congenital hypothyroidism or an inherited disorder of bilirubin metabolism. The genetic predisposition is being understood in other multifactorial disorders including congenital malformation, coronary heart disease, diabetes mellitus, asthma and cancer.

Dominant Inheritance

Everyone inheriting a gene for dominant disorder is likely to be affected. Severe early onset dominant disorders (e.g. osteogenesis imperfecta or brittle bone disease) are caused by new mutations, arise without previous family history and are not passed onto descendants because they are fatal in early life. Parents of the affected child have a very low risk of the disorder recurring in subsequent pregnancies. Dominant conditions transmitted in families are usually of late onset, after reproductive age is reached (e.g. Huntington disease, adult polycystic disease of the kidney, family cancer syndromes, tuberous sclerosis, neurofibromatosis). Carriers of dominant genes have a very high reproductive risk, each of their children has 50% chance of inheriting the gene and suffering from the same disorder.

Recessive Inheritance

Recessive inherited disorders include haemoglobin disorder, cystic fibrosis, phenylketonuria and Werdnig-Hoffmann disease. Carriers are healthy themselves but have a reproductive risk. When partner carry the same mutated gene there is 1 in 4 chances in each pregnancy, that the child will suffer from the disorder. Most people carry one or two lethal recessive mutations, but these are usually transmitted through many generations without causing disease. Most children with a recessively inherited disease do not have a family history. About 50% of their first degree relatives will be carriers, but only a tiny fraction of the carriers present in the population can be identified by testing family members. Therefore, when a condition is common and carrier screening is feasible and useful, it is appropriate to offer it at the population level.

X-linked Inheritance

Most mutations on the X chromosome are transmitted through unaffected carrier females (with the X chromosomes) and affect mainly, but not exclusively males. Examples include hemophilia, Duchenne muscular dystrophy, fragile X mental retardation and glucose-6-phosphate dehydrogenase deficiency. In principle, about 60% of carriers of X-linked disorders might be detected by family studies, but a family history may be absent if the disorder has been transmitted in the female line for several generations or is the result of a new mutation. Female carriers are at high genetic risk, in each pregnancy there is a 25% risk of an affected son and 25% risk of a carrier daughter.

EPIDEMIOLOGY OF GENETIC DISORDERS AND SERVICES

Congenital Abnormalities and Genetic Disorders

Many environmental agents are known to cause congenital disorders "An agent which causes congenital abnormalities is called *teratogen*". Common teratogens include maternal infection with rubella, radiation during pregnancy, tobacco use and treatment with drugs during pregnancy.

The incidence and burden of congenital abnormalities is increasing. Out of every 100 babies born in India annually, 6 to 7 have a birth defect. In Indian context, this would translate to 1.7 million birth defects annually out of 27 million births. This would account for 9.6% of all newborn deaths. Around 2 lakh babies are born with congenital rubella syndrome every year. Appropriate prevention and treatment strategies need to be developed (Table 9.10). *Rashtriya Bal Swasthya Karyakram* has been launched in India for screening and early intervention services under NHM in 2013. The new initiative aims at screening 0–18 years children for defects at birth, diseases, deficiency and development delays for follow-up and early intervention at district early intervention centre (DEIC).

Birth Defects Surveillance System (BDSS)

Birth defects account for 9% of all newborn deaths and 4% of child mortality. BDSS intends to identify burdens and trends of birth defects. It is a collaborative effort between MOHFW, WHO and CDC. It is envisaged to establish at least one surveillance centre per state

preferably in medical colleges. Currently 55 medical colleges are part of birth defects surveillance system.

Haemoglobinopathies

Haemoglobin disorders and G6PD deficiency are commonest single gene disorders. The carriers are protected against *Plasmodium falciparum* malaria. Both types of genetic disorders are endemic in tropics and subtropics and migration has distributed them widely. Haemoglobin disorders are often the first genetic condition to be recognized as public health problem in developing countries. In India, thalassaemia carrier rate is 4%.

Comprehensive guidelines on prevention and control haemoglobinopathies (thalassaemia, sickle cell anaemia, etc.) have been prepared by MOH and FW.

Consanguineous Marriages (Marriage between Cousins)

It is favoured by at least 20% of the world's population and probably more. This social *custom/practice* increases the risk of congenital malformation, stillbirth and childhood death. It increases the birth incidence of children with recessively inherited disorders.

Management of congenital disorders is by advanced surgical intervention, and it can treat about 40% of children and other diseases require social support and rehabilitation.

Prevention

It includes: Adopting contraception to limit the size of family (family planning), optimal maternal nutrition, prevention of rubella by immunization, genetic diagnosis and family counselling, early diagnosis and treatment when possible (e.g. for congenital malformations, phenylketonuria (PKU), congenital hypothyroidism, sickle cell disease) and prenatal diagnosis. It is estimated that use of all these approaches could prevent more than 75% of congenital abnormalities.

ROLE OF GENETIC PREDISPOSITION IN COMMON DISORDERS

Research related to human genome project will eventually lead to the identification of every gene that contributes to susceptibility or resistance to disease.

Recent progress in molecular genetics has shown that inherited predisposition is important in a number of common diseases which normally manifest in later life such as atherosclerosis, coronary heart disease, hypertension, diabetes mellitus and some rheumatic, oncological and mental illnesses, which appear at an early age and develop into severe disabilities in predisposed people.

Coronary Heart Disease

More recently risk factors identified include high levels of fibrinogen and possibly also homocystine (both of which are genetically influenced), high level of lipoprotein [Lp(a)] and apolipoprotein E4 (ApoE4) and polymorphism of apolipoprotein E. Non-apolipoprotein "candidate" genes (e.g. angiotensinogen converting enzyme-1) have also been identified. Similarly, genetic predisposition may be involved in as many as 10–25% of cases of cancer of colon and breast. At least one relatively common gene probably on chromosome 17, is known to predispose to breast cancer. A careful family history is a must in these cancers. Screening of relatives of breast and colon cancer for early detection and prompt treatment may be helpful.

Asthma

Asthma and allergy have a strong familial tendency and a specific gene that affects plasma level of IgE may contribute to susceptibility.

Diabetes Mellitus

Evidence for genetic element in IDDM comes from studies that show a higher concordance in identical twins (25–30%) than in non-identical twins (5–10%). Similarly, prevalence of IDDM is 3–6% among first degree relatives of people with disease, compared with 0.2–0.5% among the general population. Genes on the short arm of chromosomes, either within or close to the major histocompatibility (HLA) region are primarily responsible for genetic predisposition. Diabetes thus has strong familial tendency. Gene therapy and transplantation of pancreatic tissue may be future biological treatment.

Mental Disorders

Some mental disorders occur preferentially in people with inherited predisposition. Research continues for detection of responsible gene.

Alzheimer's Disease

A strong association has been found between the ApoE4 polymorphism on chromosome 19 and late onset Alzheimer's disease. The ApoE4 protein may participate in the disease process and homozygotes are at very high-risk of developing Alzheimer's disease by the age of 80.[1,3]

Approaches for Prevention

The various approaches for prevention of congenital and genetic disorders are given below.

Basic Public Health Measures

1 ***Rh group:*** Screening of women for rhesus blood groups (Rh group) allows appropriate management of at risk programmes by giving Rh negative women anti-D antibody after childbirth, miscarriage or termination of pregnancy. Perinatal mortality and chronic problems of rhesus hemolytic disease have significantly decreased in most developed countries by appropriate management (Table 9.12).

Table 9.12: Established genetic population screening services[3]

Types of service	*Conditions*	*Preventive or screening action*
Primary prevention	• Rhesus haemolytic disease	• Postpartum use of anti-D globulin
	• Congenital rubella	• Immunization of girls (MMR vaccine)
	• Congenital malformation	• Addition of folic acid to the maternal diet (may prevent neural tube defect)
		• Control of maternal diabetes. Avoidance of mutagens and teratogens such as alcohol, certain drugs and possibly tobacco
Antenatal screening	• Congenital malformations	• Ultrasound fetal anomaly scan, maternal serum alpha-fetoprotein (AFP) estimation and amniocentesis
	• Chromosomal abnormalities	• Noting maternal age and maternal serum factor levels
	• Inherited disease	• Checking family history, carrier screening for haemoglobinopathies, Tay-Sachs disease
Neonatal screening	• Congenital malformations	• Examination of the newborn for early treatment (e.g. of congenital dislocation of the hip) by ultrasonography
	• Phenylketonuria, congenital hypothyroidism, sickle cell disease	• Biochemical tests for early detection

2 ***Congenital rubella:*** It can be prevented by immunizing children and non-pregnant women and routine testing of pregnant women for antibody; abortion is usually offered to women infected in early pregnancy. The incidence of congenital rubella has declined in Europe from 3.5 to 0.41% per 1,00,000 (Table 9.12).

3 ***Congenital toxoplasmosis:*** It can be prevented by advising pregnant women to eat only well-cooked meat and avoid contact with cat faeces. In some areas, vulnerable women are identified by antibody screening followed by surveillance (TORCH test explained elsewhere). Pregnant women and newborn infants with evidence of infection are treated with antibiotics to prevent damage to eye or brain from primary and later reactivated infection.

4 ***Risk of neural tube defects:*** Use of folic acid is promoted in planned pregnancies during the periconception phase (three months before and three months after conception) which can prevent neural tube defects and other congenital anomalies. National programme for prevention and control of anaemia in India helps to prevent these defects as all pregnant women are provided with iron and folic acid prophylaxis.

5 Pregnant woman with insulin dependent diabetes has an increased risk of bearing severely malformed child but this can be greatly reduced by meticulous control of blood sugar. A similar risk is associated with certain anti-epileptic drugs. Mothers with either risk are candidates for expert scanning for foetal abnormalities during second trimester.

6 ***G6PD deficiency:*** The incidence of newborn jaundice and exchange transfusion can be greatly reduced by screening of neonates, exposure of babies to light and education of population not to feed broad beans (which provokes a clinical reaction in G6PD deficiency) to children.

The stillbirths and neonatal deaths should be examined for an evidence of genetic problem to prevent further deaths. Measures like healthy diet and lifestyle may be rewarding.

Detection of Genetic Risks by Population Screening

Sporadic Disorders

It includes most congenital malformations and chromosomal disorders, the vast majority of affected children are born to parents with no known risk factor and the risk of recurrence is low.

It is essential to identify people at risk of developing disorder themselves and/or of passing a disorder onto their children. Population screening is helpful and reliable. There is usually a moderately increased risk for people with an affected relative, 1–6% in most multifactorial disorders, 1–2% for chromosomal disorders and women with IDDM.

Various screening programmes focus on preconception, antenatal, neonatal and for general population. Screening can be helpful in reducing the risk to foetus and identification of risk couples and affected foetus and for early detection and treatment.

Inherited disorders: These affect a limited number of families and are usually transmitted by healthy carriers who have a high-risk of passing the disorder to their children. Genetic counselling can be offered following diagnosis of either genetic disease or the carrier states in a family member.

Population-based screening enhances the significance at the public health level and can be high cost-effective as compared to family-based approach (Table 9.13).

Genetic Family Studies

Genetic diagnosis has implications for whole family as well as for individual. While a correct diagnosis benefits individual patient, who can be given guidance on the

Table 9.13: Options open to carriers of an inherited disease

Time at which the risk is discovered	*Possible action*	*Frequency*
Before choosing partner (uncommon)	• Remain single	• Uncommon
	• Avoid selecting another carrier as partner[a]	• Very uncommon
	• Select a partner in the usual way	• Most uncommon
Before pregnancy (more common)	• Remain childless	• Common only for severe disease, when prenatal diagnosis is impossible
	• "Take a chance"	• Common for less severe diseases
	• Use prenatal diagnosis	• Very common
	• Use artificial insemination by donor or other form of assisted reproduction	• Very common
	• Separate and find another partner	• Very uncommon indeed
After birth of an affected child (most common)[b]	• Accept infant and treatment	• Usual
	• Accept infant, but reject treatment	• Occasional
	• Reject infant	• Occasional

[a] Relates only to recessively inherited disorders.
[b] The options that apply before first pregnancy also apply to pregnancies following the birth of an affected child.

management, natural history or prognosis, and put in touch with support group. It is also of value to other family members who can be offered genetic counselling.

Genetic Population Screening

A genetic population screening programme means to identify and counsel as many people at genetic risk as possible. A simple "primary screening test" is usually offered to the whole population to identify those groups at increased risk, who are then offered further tests for definite diagnosis. A screening programme is public health policy and it should meet epidemiological criteria: Condition being serious, clear diagnosis available and sound knowledge of natural history of disease and effective method of treatment available with affordable cost.

Genetic Counselling

Genetic counselling is a coping mechanism. It recognizes the autonomy of the individual couple, each couple has the right to complete information and highest standard of confidentiality must be maintained. Genetic counselling takes time and most clinical geneticists work with number of trained associates. Genetic counselling involves serious decisions on the part of client. The decision such as to marry or not to marry, to produce a child or not to produce a child, what are the chances of child being abnormal with genetic defect, etc. are critical decisions. The main components of genetic counselling are:

- A correct diagnosis.
- Estimation of genetic risk; this often requires a pedigree and may call for investigations involving other family members.
- Provision of information on existence of risk and on any options for avoiding it. The options will depend upon:
  - The nature of disorder involved.
  - The prognosis and the availability of treatment or palliative care.
  - The chances that other family members may be at risk and in particular, of passing the risk onto children.
  - The possibility of avoiding risks to individuals own health.
  - Possibility of avoiding transmission of the risk to children.

Genetic counselling requires long-term contact and support. Every one who suspects a personal genetic risk or a risk of having offspring with a serious disease or malformation should have access to genetic counselling.

It is generally agreed that the genetic counselling should be "non-directive", this does not mean, however, simply giving information or facts and leaving them to make their own mind, rather, it implies that they should be actively helped to reach the decision that is right for them in their personal circumstances and according to their own moral code, not that of health worker (Table 9.13).

Molecular Genetics

DNA has many advantages for genetic diagnosis. It is easy to obtain since every cell of an individual or foetus contains the full DNA complement of that individual. Genes can be studied whether they are actively producing their product or not. A definitive diagnosis can usually be made, and essentially similar laboratory approaches can be used for the diagnosis of all genetic conditions. One important limitation of DNA diagnosis, however, is that many different mutations may underlie the same clinical disorder and it can be difficult to identify them all, particularly rare ones.

DNA Technology

DNA technology is advancing rapidly and it has been used in many ways for diagnosis, therapy and to identify carriers and the mechanism of evolution:

- The synthesis of DNA probes with specific sequences which allows genetic diagnosis.

- DNA sequencing methods for rapid analysis of unknown DNA and identification of mutations.
- New diagnostic techniques such as polymerase chain reaction (PCR) for amplifying known DNA sequencing. This allows a simple and rapid diagnosis using extremely small tissue samples.
- Techniques for synthesis of DNA that allows the production of known sequences of increasing length. Coding sequences produced in this way can be used for the production of therapeutic agents such as insulin, erythropoietin and factor VIII. They may also be used in the creation of transgenic animals and gene therapy.
- Positional cloning strategies using genetic markers, which are now defined along the entire human genome.
- *In vitro* methods for examining the proteins product of gene sequences with unknown functions.
- New cytogenetic techniques such as fluorescence *in situ* hybridization (FISH), which permits direct visualization of the relationship of the genes to one another in the nucleus of the living cell.
- Comparison between the DNA sequences of different genes and species. This helps elucidate the mechanisms of evolution.
- Insertion of coding DNA sequences into animal embryos to create transgenic animals: Valuable for studying the roles of specific genes in multifactorial diseases.
- ***Gene therapy:*** Insertion of missing DNA sequences into individuals with genetically determined disorders.

The most recent revolution in biology has been the development of the recombinant DNA technology which has been used in synthesis of substances like insulin, growth hormone, interferon, factor VIII, factor IX, somatostatin and vaccines.

THE HUMAN GENOME PROJECT[1,3]

The sum total of genetic information of an individual which is encoded in structure of deoxyribonucleic acid (DNA) is called genome. The study of genome is called "genomics".

It is now believed that the information generated by genomics will, in the long-term, have major benefits for the prevention, diagnosis and management of many diseases which hitherto have been difficult or impossible to control. These include communicable and genetic diseases, together with other common killers or cause chronic ill-health, including cardiovascular diseases, cancer, diabetes, the major psychoses, dementia, rheumatic diseases and asthma.[3]

The human genome project is an attempt to systemize the research on mapping and isolating human genes that is already in progress in many countries, in order to create a single linear map of the human genome, with each coding gene defined and sequenced. Essentially, it is mapping and sequencing of gene in population.

Aim

The primary aim of human genome project is to advance knowledge and increase understanding of the way in which genes interact with each other and with the environment to generate normal structure and function; findings will also cover the individual variation that incidentally contribute to susceptibility to common diseases.

The DNA data obtained by mapping and sequencing will need to be correlated systemically with clinical and scientific data, which may be more difficult to obtain once relevant genes and their interactions, with each other and the environment have been defined. Scientific, clinical, epidemiological and psychological research will be required to determine gene function and to identify possibilities for prevention or treatment of particular disorders. "International collaboration is essential to ensure that clinically relevant information can be applied worldwide, and to permit international and inter-regional comparisons, quality control, technological simplifications and free exchange of reagents and clinical data. The burden of congenital and genetic disorders is frequently greatest in developing countries, where the emerging problems have a genetic component. It is important to encourage genetic studies in populations with specific problems such as thalassaemias and sickle cell anaemia and to ensure that technology and resources are generally available and to maintain international collaboration".

It is an important function of Human Genome Organization (HUGO) to ensure that data from the project are available to all, in an integrated and usable form.

THE HUMAN GENOME DIVERSITY PROJECT

As a part of the work of HUGO, the Human Genome Diversity Project (HGDP) is aimed at increasing understanding of human evolution. The major objective is to define the genetic relationships between human populations and interpret them in terms of natural selection, genetic drift, migration, etc. For example, the frequency and distribution of single gene disorders are related to history of human migration. The HGDP is not primarily concerned with health, but certain aspects of human genetic diversity related to health and disease are relevant to the project. For instance, difference between populations in the incidence of common disorders such as hypertension, atherosclerosis, diabetes and some forms of cancer and in the proportion of fit elderly people, suggest that the study of "genes for health" could be considered as part of HUGO strategy.

GENE THERAPY

Gene therapy means the introduction of gene sequence into cell with the aim of modifying the cell behaviour in a clinically relevant fashion. It can be used in many ways, e.g. to correct genetic mutation (as for cystic fibrosis), or to kill a cell (as for cancer) or to modify susceptibility (as for coronary artery disease). The gene may be introduced

using a virus (usually a retrovirus or adenovirus) or by means of a lipid or receptor targeting. New system for gene delivery will be developed in due course of time.

EUGENICS

Galton propagated the idea of hereditary improvement of men and animals by such methods as selective breeding. Thus *eugenics* can be defined as improvement of human species or race by selective breeding. But we cannot advocate drastic eugenic policies as our knowledge in human genetics is still inadequate. It is not simple to propagate or transfer a particular character or desirable character (intelligence, height or colour or physique) to offsprings through genes as many environmental factors modify the behaviour of genes.

Positive Eugenics

It is being applied to animals in a prolific way. Improving cattle breeding by artificial insemination to have increase yield of milk and to have better quality of animals for other purposes. Improving yield of grains (wheat and rice) has been in practice for many years now, is another example of genetic manipulation for human welfare and survival. Positive eugenics in those persons who carry harmful hereditary factors of the risks of having affected children can be by limitation of family size or accepting other reproductive choices.

EUTHENICS

It means providing appropriate environments/suitable environments for genotype to express themselves fully. The environmental manipulations for development of genotypes is called euthenics.

GENETIC SERVICES

Genetic services are very rudimentary in our country. Greater attention needs to be paid to develop genetic services at the level of tertiary, secondary and primary healthcare. Community genetic services are relatively inexpensive and set against the great social and financial burden of chronic disease, highly cost-effective. One of the main problems in delivering genetic services appears to be difficulty of informing both the health professions and the community of the real significance of genetic problem.

PC-PNDT Act, 1974 and Medical Termination of Pregnancy Act, 1971 lays down the legislative framework of application of science of genetics in the country.[4]

Sex selective abortions need to be eliminated by implementation of PC-PNDT Act.[4] This is positive eugenics to have a balanced sex ratio and to avoid demographic catastrophy.

Antenatal clinics provide the opportunity to educate individual and family on genetics.

Screening of antenatal mothers for Rh grouping, avoidance of teratogenic drugs and radiation and promoting immunization against rubella before pregnancy is preventive genetics. Contraception for limiting the size of family and bearing children at right age is another example of positive and preventive genetics. Improving nutritional status and consumption of iron and folic acid tablets during pregnancy prevents anaemia as also neural tube defects. Use of ultrasonography to detect defective children is essentially a good screening activity. Early childhood development services in ICDS programme by providing environmental stimuli is an attempt to realize full potential of genetic endowment of young children. Malnourished children and children with mild mental retardation have progressively improved, and developed their IQ to desired level by early childhood education through environmental stimuli.

Competency addressed: The student should be able to:
CM 20.4: Demonstrate awareness about laws pertaining to practice of medicine.

THE PRECONCEPTION AND PRENATAL DIAGNOSTIC TECHNIQUES (PC-PNDT) (PROHIBITION OF SEX SELECTION) ACT, 1994 AND AMENDED RULES, 2003

Problem

The Prenatal Diagnostic Techniques (Regulation and Prevention of Misuse) Act, 1994 has since been amended to make it more comprehensive. The amended Act and Rules came into force with effect from Feb 2003 and the PC-PNDT Act has been renamed "Preconception and Prenatal Diagnostic Technique (prohibition of sex selection) Act, 1994 to make it more comprehensive.

There is unfavourable female child sex ratio or Juvenile sex ratio due to female foeticide and sex selective abortions. To achieve balanced sex ratio, the Government of India made PC-PNDT Act.

The Act provides for the prohibition of sex selection before and after conception and for the regulation of prenatal diagnostic techniques for the purpose of detecting genetic abnormalities, or metabolic disorders or chromosomal abnormalities or certain congenital malformations or sex-linked disorders and for prevention of their misuse for sex determination leading to female foeticide and for matters connected therewith.

Regulation of Prenatal Diagnostic Technique

No place including a registered genetic counselling centre or genetic laboratory or genetic clinic shall be used or caused to be used by any person for conducting prenatal diagnostic techniques except for the purpose specified below:

1. Chromosomal abnormalities
2. Genetic metabolic disorders
3. Haemoglobinopathies
4. Sex-linked genetic diseases
5. Congenital abnormalities
6. Other abnormalities as may be specified by the central supervisory board.

Following conditions must be fulfilled:

i Age of the pregnant women is above 35 years.
ii The pregnant women have undergone two or more spontaneous abortions or foetal loss.
iii The pregnant women had been exposed to potentially teratogenic agents such as drugs, radiation, infection or chemicals.
iv The pregnant women or her spouse has a family history of mental retardation or physical deformities such as spasticity or any other genetic disease.
v Any other condition as may be specified by the board.
vi Person conducting ultrasonography on pregnant women shall keep complete records as prescribed under the Act.
vii No person including a relative or husband of the pregnant woman shall seek or encourage the conduct of any prenatal diagnostic techniques on her except for purposes specified above.

Prenatal diagnostic procedures cannot be conducted unless:

- All side and after effects of such procedures have been explained to the concerned pregnant women.
- Her written consent to undergo such procedures has been obtained in the language she understands.
- A copy of her written consent has been given to the concerned woman. Communication of sex of the foetus by words, signs or in any other manner to the concerned pregnant women or her relations or any other person is prohibited.

Determination of sex is prohibited in genetic counselling centre, genetic laboratory or genetic clinic and no person shall whatever means cause or allow to be caused selection of sex before or after conception.

Before conducting pre-implantation genetic diagnosis or any prenatal technique/test/procedure such as amniocentesis, chorionic villi biopsy, foetoscopy, foetal skin or organ biopsy or cordocentesis, a written consent in a language the person undergoing such procedure understands, shall be obtained.

Any person conducting ultrasonography/image scanning on a pregnant woman shall give declaration on each report on ultrasonography/image scanning that he/she has neither declared nor disclosed the sex of foetus of the pregnant women to anybody. The pregnant woman should before undergoing ultrasonography/image scanning declare that she does not want to know the sex of her foetus.

Who Can do the Procedures?

Gynaecologist having experience of performing at least 20 procedures in chorionic villi aspiration per vagina, per abdomen, chorionic villi, biopsy, amniocentesis, cordocentesis, foetoscopy, foetal skin or organ biopsy or foetal blow sampling, etc. under supervision of an experienced gynaecologist or a sonologist, imaging specialist, radiologist, or registered medical practitioner having post-graduate degree or diploma or 6 months training or one year experience in sonography or image screening or a medical geneticist, may set up a genetic clinic/ultrasound clinic/imaging centre.

APPROPRIATE AUTHORITY

Under the Act, the appropriate authority has been decentralized at the district level. Civil surgeon/chief medical officer (CMO) has been designated authority under the Act to recognize and register an ultrasonography/genetic centre.

Registration of Genetic Counselling Centres, Genetic Laboratories or Genetic Clinics

Genetic counselling centre, laboratory or genetic clinic, including clinic, laboratory or centre having ultrasound or imaging machine or scanner or any other technology capable of undertaking determination of sex of foetus and sex selection can be opened unless it is duly registered under the Act. District civil surgeon/chief medical officer is appropriate authority to issue certificate of registration of place and machine.

Offence

Any medical geneticist, gynaecologist, registered medical practitioners or any other person who owns a genetic counselling centre, a genetic laboratory or a genetic clinic or is employed therein and renders his or her professional technical services there, whether on honorary basis or otherwise and who contravenes provisions of the Act or rules made under that and advertising relating to pre-conception and prenatal determination of sex or sex selection is punishable; with imprisonment up to 3 years and fine up to 10 thousand rupees and on any subsequent conviction, with imprisonment which may extend to 5 years and with fine which may extend to 50 thousand rupees. If any person who seeks the aid of any centre/doctor or any person for sex selection or for conducting prenatal diagnostic techniques on any pregnant women, he shall be punishable with imprisonment up to 3 years and fine up to 50 thousand rupees for the first offence and for any subsequent offence with imprisonment up to 5 years and with fine up to 1,00,000 rupees.

THE MEDICAL TERMINATION OF PREGNANCY ACT, 1971 (AMENDED ACT, 2002 AND AMENDED ACT, 2021)

This Act is known as Medical Termination of Pregnancy Act, 1971 (Relates to AETCOM 4.2)

Pregnancies which can be terminated by a registered medical practitioners under the Act:[5]

a Where the length of pregnancy does not exceed 20 weeks if such medical practitioner is or
b Where the length of pregnancy exceeds 20 weeks but does not exceed 24 weeks in case of such category of woman as may be prescribed by rules under this Act, if not less than two medical practitioners are of the opinion formed in good faith that:
   i Continuation of pregnancy would involve a risk to the life of pregnant woman or of grave injury to her physical or mental health, or
   ii There is substantial risk that if the child was born, it would suffer from such physical or mental abnormalities to be seriously handicapped.
   iii If a pregnancy is alleged by the pregnant women to have been caused by rape the anguish caused by such pregnancy shall be presumed to constitute a grave injury to the mental health of pregnant women.
   iv When pregnancy occurs as a result of failure of a contraception used by married women or her husband.

No pregnancy of a woman, who has not attained the age of 18 years or who having attained the age of 18 years, is mentally ill person shall be terminated without the consent in writing of her guardian.

Most MTPs are done in private sector. Safe abortion services are denied to women in government facilities, hence women are compelled to seek services from unsafe providers and risk their lives.

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