NUCLEAR HAZARDS AND HUMAN HEALTH RISKS

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Introduction

- According to International Atomic Energy Agency (IAEA), a nuclear and radiation accidents/ hazards is an event that has led to significant consequences to people, the environment or the facility.
- Nuclear hazards. Risk or danger to human health or the environment exposed by the **radiation** emanating from the atomic nuclei is called as nuclear hazard. Nuclear hazard is an actual or potential release of radioactive material at a commercial nuclear power plant or a transportation accident

- Nuclear power plant accidents:
  - The SL-1 accident(1961)
  - The Three Mile Island Accident(1979)
  - Chernobyl Disaster (1986)
  - Fukushima Daiichi nuclear disaster(2011)

Radiation Pollution

The process by which an atom changes from an unstable state to a more state by emitting radiation is called radioactive decay or radioactivity.

The most common source of radiation is nuclear power plants.

Other sources include

- Spent-fuel reprocessing plants
- By products of mining operations
- Experimental research laboratories

RADIATIONS THAT CAUSE POLLUTION

1. Electromagnetic radiations:
   - UV rays
   - X-rays
   - Gamma rays
   - Infrared rays
   - Radio waves

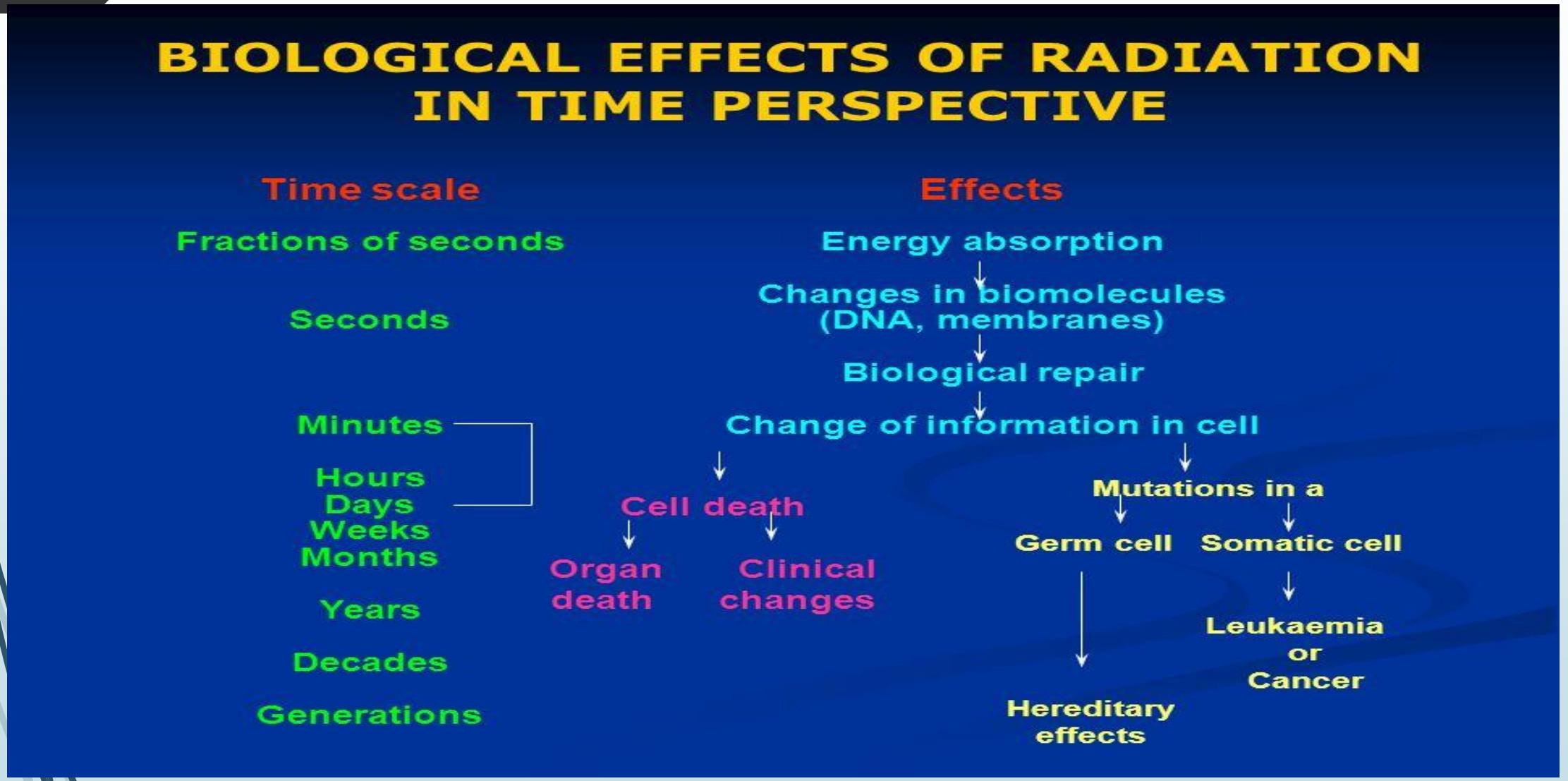
2. Particulate radiations
   - Beta, alpha particles etc

Impacts of Nuclear Radiation

- **SHORT TERM RECOVERABLE EFFECTS**
  - Short term affect on skin, hair loss, lungs and on reproductive organs
- **LONG TERM IRRECOVERABLE EFFECTS**
  - **Radiation sickness**
    A person's risk of getting sick depends on how much radiation the body absorbs. Radiation sickness is often fatal and can produce such symptoms as bleeding and shedding of the lining on the gastrointestinal tract.
  - **Bone marrow death** is caused by a dose of radiation between 2 and 10 Gray and is characterized by the part of the bone marrow that makes the blood being broken down. Therefore, production of red and white blood cells and platelets is stopped due to loss of the blood-making stem cells
  - **Cataract induction**
  - **Cancer induction**
  - **Infectious diseases resulting from nuclear attack such as dysentery, tuberculosis, cholera, pneumonia etc.**
- **GENETIC**
  - The effect is suffered by the offspring of the individual exposed. Mutations of these reproductive cells are passed to the offspring of the individual exposed.

How Does Nuclear Radiation Harm the human body?

- Radioactive iodine and cesium are being released into the environment from the malfunctioning nuclear reactors in Japan.
- As radioactive material decays, or breaks down, the energy released into the environment has two ways of harming a body that is exposed to it,
- It can directly kill cells, or it can cause mutations to DNA. If those mutations are not repaired, the cell may turn cancerous.
- Children are most at risk for thyroid cancer, since their thyroid glands are 10 times smaller than those of adults as the radioactive iodine would be more concentrated in them. The Chernobyl accident released a plume of radioactive materials into the atmosphere in a fraction of a second. In the following years, the incidence of thyroid cancer among those exposed as children increased in Ukraine and nearby countries.


BIOLOGICAL EFFECTS OF RADIATION IN TIME PERSPECTIVE
Time scale
Fractions of seconds
Seconds
Minutes
Hours
Days
Weeks
Months
Years
Decades
Generations
Effects
Energy absorption
Changes in biomolecules (DNA, membranes)
Biological repair
Change of information in cell
Cell death
Organ death
Clinical changes
Mutations in a
Germ cell
Somatic cell
Leukaemia or Cancer
Hereditary effects

Nuclear Disasters:

Chernobyl, Ukraine (former Soviet Union), April 26, 1986

- Chernobyl is considered the world's worst nuclear disaster to date. It occurred on April 26, 1986, when a sudden surge in power during a reactor systems test resulted in an explosion and fire that destroyed Unit 4. Massive amounts of radiation escaped and spread across the western Soviet Union and Europe. As a result of the disaster, approximately 220,000 people had to be relocated from their homes.

How did it happen?

Unit 4 was to be shut down for routine maintenance. A test was conducted to determine the plant equipment's ability to provide sufficient electrical power to operate the reactor core cooling system and emergency equipment during the transition period between a loss of main station electrical power supply and the start-up of the emergency power supply. Workers did not implement adequate safety precautions or alert operators to the electrical test's risks. This lack of awareness led the operators to engage in actions that diverged from safety procedures. Consequently, a sudden power surge resulted in explosions and nearly complete destruction of the reactor. The fires that broke out in the building contributed to the extensive radioactive releases.

Fukushima, Japan, March 2011

- The earthquake and tsunami that struck eastern Japan on March 11, 2011, caused a serious accident at the Fukushima Dai-ichi nuclear power plant on the northeastern coast of Japan.

How did it happen?

The earthquake cut off external power to the reactors. tsunami, which reached levels more than twice as high as the plant was designed to withstand, disabled backup diesel generators, crippling the reactor cooling systems. Battery power was quickly exhausted, and overheating fuel in the plant's operating reactor cores led to hydrogen explosions that severely damaged three of the reactor buildings. Fuel in three of the reactor cores melted, and radiation releases from the damaged reactors contaminated a wide area surrounding the plant and forced the evacuation of nearly half a million residents.

Nuclear power accidents in India

Date	Location	Cost (in millions 2006 US$)
10 Sep 1989	Tarapur, Maharashtra, **India**	78
13 May 1992	Tarapur, Maharashtra, **India**	2
31 Mar 1993	Bulandshahr, Uttar Pradesh, **India**	220
2 Feb 1995	Kota, Rajasthan, **India**	280

India's Worst Radiation Accident

- Kalpakkam, 70 km from Chennai, is home to a host of Department of Atomic Energy –run installations like Madras Atomic Power station (MAPS) with two Pressurized Heavy Water Reactors and reprocessing plants like Kalpakkam Reprocessing Plant(KARP)
- Reprocessing plants use chemical processes to extract Uranium and Plutonium from spent fuel that has been irradiated in nuclear reactors
- On January 21, 2003, due to valve failure, high level waste entered a tank designed for low-level wastes. This resulted in six workers receiving high doses of radiation.

Nuclear holocaust

- The word holocaust in Greek refers to extensive destruction and loss of lives
- Nuclear weapons are weapons of mass destruction and thus nuclear warfare can devastate in a much shorter time and can impart effects that can last for decades and centuries.
- Hiroshima and Nagasaki Incident which occurred in 1945 during world war II, killed thousands of people , injured many thousands and caused long-lasting effects.
- The United States dropped atom bombs over these two Japanese towns viz. Hiroshima and Nagasaki.

Minimizing Nuclear Hazards

1. Seek out and act on new information about hazards.

2. Improve nuclear plant systems, resources, and training to enable effective ad hoc responses to severe accidents.

3. Strengthen capabilities for assessing risks from beyond-design-basis events.

4. Further incorporate modern risk concepts into nuclear safety regulations.

5. Examine offsite emergency response capabilities and make necessary improvements.

6. Improve the nuclear safety culture.

7. Monitoring radioactivity around disposal sites

- The mitigation measures are to be applied in any nuclear power plants or nuclear facility in all stages:
  - the mining of uranium or other substance,
  - in transportation of nuclear materials,
  - processing of nuclear fuels, using them and
  - storage of the raw materials as well as storage of nuclear wastes.
- During Mining:

  Serious health risks exist during mining stage. There is also a lot of (rejected/ unutilized) waste heat that goes in to environment.
- Decommissioning a reactor:

  When the life of a nuclear reactor/power plant is over, the plant is decommissioned. The cost of that operation is high. Both the reactor and the uranium enrichment facility in the plant are to be decommissioned so that the radiation levels are very low. Cutting, dismantling reactors, dismantling, packing and disposing off the parts of reactors is expensive, time taking. Not only that it is a health threat to the people doing those jobsThus disaster mitigation is important in decommissioning as there are threats to the environment.

- Radioactive waste management:

It seems about ten thousand metric tonnes of spent high level nuclear fuel waste is produced each year in the whole world. The radio active wastes have long half life times like thousands of years and more; technetium-99, iodine-129, neptunium-237 and plutonium-239 are such examples. These need careful and elaborate management strategy that includes storage, and disposal or treatment to convert them into non-toxic form. One of the ways is to bury them deep inside Earth.

- Limits to mitigation measures:

Nuclear reactor designs should be upgraded with newer safety standards. Many types of expected failures can be taken care of in the design, implementation and operation. However, there are some multiple failures which are unexpected (with very less probability).

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THE END

Human population growth: Impacts on environment, human health, and welfare

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Rise in human population

- The fundamental cause of the acceleration of growth rate for humans in the past 200 years has been the reduced death rate due to changes in public health and sanitation.
- Clean drinking water and proper disposal sewage has drastically improved health in developed nations. Also, medical innovations such as the use of antibiotics and vaccines have decreased the ability of infectious disease to limit human population growth.

CHARACTERISTICS FEATURES OF HUMAN POPULATION

- Population density:

It is defined as the size of a population per unit area at a given time. Density is expressed as the total number of individuals present per unit area.

- Natality

Refers to the production of offsprings or increase in the number of individuals in a population under given environmental conditions is termed natality or birth.When the number of offsprings produced is expressed as per unit time, it is called natality rate/birth rate.

- Mortality

Mortality rate/death rate indicates the number of dead individuals in a year per thousand individuals.

- Age Distribution

A population comprises of individuals of various ages ranging from 0 to 100 or more years. The age of an individual determines the productive status of a population.

- Sex ratio

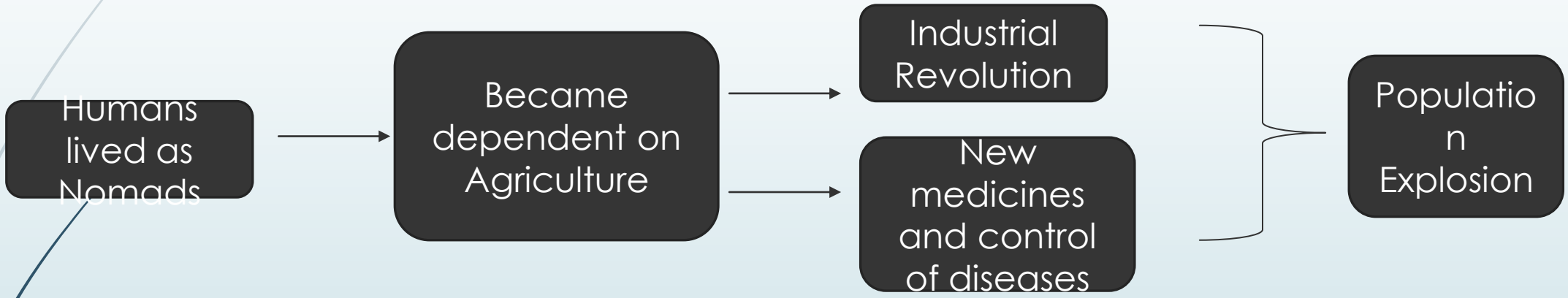
Defined as the no. of females per thousand males.

State/ Union Territory	Sex Ratio (2011)	Sex Ratio (2001)
Kerala	1084	1,058
Puducherry	1037	1,001
Tamil Nadu	996	987
Chhattisgarh	991	989
Meghalaya	989	972
Sikkim	890	875
Haryana	879	861
Delhi	868	821
Chandigarh	818	777
Dadra and Nagar Haveli	774	812
Daman and Diu	618	710
Total Average(India)	**943**	**933**

Population growth

Increase or growth of the population is determined by the difference in the number of births and number of deaths in a particular year.
Population growth is calculated as the per cent increase in population.

- Chronology of Human Population growth



Important points

- India ranks second in the size of population
- India has only 2.4% of the geographical area of the world and **17.7%** of the total world population
- Approximately 95% of the population growth is taking place in the developing countries
- One-third of the world's population is under the age of 15.
- The world population is most likely to nearly double to 10 billion in 2050 and reach 20.7 billion a century later

Impact of overpopulation

- The large population of a country puts a heavy on the resources of the country.

1. Demand for food: limited supply of food causes undernourishment, malnutrition and starvation.
2. Pressure on land: overpopulation places great demand on agricultural land for food and for many developmental activities
3. Decrease in forest cover
4. Need for civic services: more population means more space, more electricity, more water and more sewage disposal.
5. Depletion of water: drawing more water and polluting the water bodies.
6. Unhygienic conditions: aggravates the insanitary and unhygienic conditions.
7. Energy crisis
8. Eco-degradation: overpopulation leads to eco-degradation by increasing air, water, soil and noise pollution.

Impact of Population growth on environment

Impacts of Population Growth on the Physical Environment

- **Air and water pollution**
- **Deforestation**
- **Depletion of ozone layer**
- **Extinction of species**
- **Land/soil degradation**
- **Global warming and climate change**
- For details please go through the following link
- https://www.researchgate.net/publication/237771340_IMPACT_OF_POPULATION_EXPLOSION_ON_ENVIRONMENT/link/0046351bbe678846e2000000/download

- Population control
- Family planning: is not confined only birth control or contraception but it also takes care of
  - Improvement of family's economic condition
  - Health and nutrition of the mother and child
  - Importance of spacing births

Impact of overpopulation on health (in India)

- The current population of **India** is **1,377,418,724** as of Thursday, April 23, 2020, based on Worldometer elaboration of the latest United Nations data.
- India population is equivalent to **17.7%** of the total world population.
- The population density in India is 464 per Km^2 (1,202 people per mi^2
- Many people are already aware of the social and environmental problems caused due to overpopulation, but only a few are aware of its adverse effects on health.
- Human health is at risk as the denser the population; the easier airborne diseases can spread. The increase in population has led to issues like urban crowding and environmental changes that have resulted in the emergence of many infectious diseases. Increase in antimicrobial resistance proves to be an unexpected problem for diseases such as:
- **Tuberculosis**
- **Malaria**
- **Cholera**
- **Dengue fever**
- Water borne diseases: Overpopulation results in polluted water supplies. People die each year because of contaminated water-related disease. The viruses spread faster in a denser population which enables deadly mutations to continue, making the water unsafe for utilization.

- With the increasing number of people travelling by their vehicle, there is a growing concern about the health impacts caused due to the traffic on the road. The toxic content in the air impacts the kids more than the adults. Today, the decrease in the quality of air has resulted in the majority of people suffering from respiratory problems such as:
- Asthma,
- Lung cancer
- **Chest pain**
- Congestion
- **Throat inflammation**
- Cardiovascular disease
- Respiratory diseases

- Increased pollution has also led to a depletion of ozone layer. The ozone layer of the atmosphere no longer protects us from the harmful ultraviolet (UV) rays of the sun causing skin problems such as **skin cancers** and premature aging of the skin. UV rays also result in a host of eye-related problems such as **cataract** and **blindness**.
- Most of all, it weakens the human immune system.
- **Various other illnesses:**The number of people migrating to the cities for jobs and prosperity increases daily. Concentrated energy use leads to greater air pollution with significant impact on human health, and automobile exhaust produces elevated lead levels in the urban air. Large volumes of uncollected waste create multiple health hazards like cancer, neurological disease, congenital malformation etc.
- Over population is the root of all other major problems. Population growth adds to the inability of governments to scale up health care systems and facilities. Hence, the need of the hour is to deal with the issue and come up with solutions to resolve the problem. The problem of overpopulation can only be solved by spreading awareness about family planning and education about overpopulation, enacting birth control measures and regulations, and providing universal access to birth control devices. Some of these measures can prove useful in ending the vicious circle of population growth and rising health threats.

HUMAN WELFARE

- The practice of public health has been dynamic in India, and has witnessed many hurdles in its attempt to affect the lives of the people of this country. Since independence, major public health problems like malaria, tuberculosis, leprosy, high maternal and child mortality and lately, human immunodeficiency virus (HIV) have been addressed through a concerted action of the government.

CHALLENGES CONFRONTING PUBLIC HEALTH

- The new agenda for Public Health in India includes the epidemiological transition (rising burden of chronic non-communicable diseases), demographic transition (increasing elderly population) and environmental changes. The unfinished agenda of maternal and child mortality, HIV/AIDS pandemic and other communicable diseases still exerts immense strain on the overstretched health systems.
- Health systems are grappling with the effects of existing communicable and non-communicable diseases and also with the increasing burden of emerging and re-emerging diseases (drug-resistant TB, malaria, SARS, avian flu H1N1 and currently COVID-19 pandemic).
- Health inequalities lie in the social, economic and political mechanisms that lead to social stratification according to income, education, occupation, gender and race or ethnicity

ROLE OF GOVERNMENT WITHIN THE HEALTH SECTOR

- The National Rural Health Mission (NRHM) launched by the Government of India is a leap forward in establishing effective integration and convergence of health services and affecting architectural correction in the health care delivery system in India.
- Health information system: The Integrated Disease Surveillance Project was set up to establish a dedicated highway of information relating to disease occurrence required for prevention and containment at the community level, but the slow pace of implementation is due to poor efforts in involving critical actors outside the public sector.
- Health research system: There is a need for strengthening research infrastructure in the departments of community medicine in various institutes and to foster their partnerships with state health services.
- Human resource development and capacity building
- Health promotion
- Public health policy: In India, we need a road map to "better health for all" that can be used by states, communities, professional organizations and all sectors. It will also facilitate changes in resource allocation for public health interventions and a platform for concerted intersectoral action, thereby enabling policy coherence.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3114612/