Epidemiology and Health

What is "Health"?

According to WHO, Health is defined as ***a state of complete physical, mental, and social wellbeing and not only in absence of disease or infirmity***

Thus Health means (a) No obvious evidence of disease and that the person is functioning normally (b) Several organs of the body are functioning adequately as well as in relation to one another (Equilibrium or Homeostasis). Health is a common theme in most cultures. All communities have their concepts of health, as part of their culture. Health is evolved over the centuries as a concept from individual concern to world wide social goal and encompasses the whole quality of life. According to WHO, health has three parameters

- ***Physical health***- Physical health of a person is defined as "A good complexion, a clean skin, bright eyes, lustrous hair with a body well clothed with firm flesh, regular activity of bowels and bladder and smooth, easy, coordinated bodily movements. All the organs of the body are of adequate size and function normally".
- ***Mental health***-The mental health of a person is defined as "self-satisfaction, self-confidence, no conflict within himself, happy, calm, and cheerful personality, well-adjusted with others, understanding, having self-control".
- ***Social health***-Social concept means those having abilities making friendship with others that are satisfying and lasting, living effectively with others, and showing socially considerate behaviour.

Health is a state of an individual living in complete harmony with its environment.

- It is not fighting unusual circumstances to maintain a physiological normal state of being
- Simply put, it is functioning as it would normally function
- It is "normal"

What is normal?

- Normal here is defined as measures of health that fall within predictable routine ranges
- It is where your temp, HR, breathing, etc. would fall on average for that species under regular circumstances

For example, a normal temperature for humans is 98.6° F

- However, some people fall out of the "normal" range where most people lie.
- Their "normal" is abnormal; so long as their vitals are within their normal range, they are healthy.

Changing Concepts of Health

• ***Biomedical Concept*** (Health has been viewed as an "absence of disease", and if one was free from disease the person was considered healthy)

• ***Ecological Concept*** (Health implies the relative absence of pain and discomfort and a continuous adaptation and adjustment to the environment to ensure optimal function)

• ***Psychosocial Concept (***Health is both a biological and social phenomenon)

• ***Holistic Concept*** (A sound mind in a sound body, in a sound family, in a sound environment; All sectors of society like agriculture, animal husbandry, food, industry, education, housing, public works, communication & other sectors have an effect on health).

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Dimensions of Health

Health is multidimensional, WHO definition envisages three (3) specific dimensions, however there are many more dimensions:

1. ***Physical*** (Perfect functioning of the body)

Evaluation of Physical Health:

i) Self-assessment of overall health
ii) Inquiry into symptoms of ill health and risk factors
iii) Inquiry into medications
iv) Inquiry into level of activity
v) Inquiry into use of medical services
vi) Standardized questionnaires for cardiovascular diseases
vii) Standardized questionnaires for respiratory diseases
viii) Clinical examination
ix) Nutrition and dietary assessment and
x) Biochemical and laboratory investigations

2. Mental (Mental Health has been defined as " a state of balance between the individual and the surrounding world, a state of harmony between oneself and others, a coexistence between the realities of the self and that of other people and that of the environment".)

Psychological factors can induce all kinds of illness not simply mental ones which may include: Essential Hypertension; Peptic Ulcer and Bronchial Asthma. Some major Psychiatric Illnesses like Depression and Schizophrenia have biological component.

3. Social (Social wellbeing implies " Quality and quantity of an individual's interpersonal ties and the extent of involvement with the community".

Social health takes into account that every individual is a part of a family and a wider community and focuses on social and economic conditions and well being of the "Whole Person" in the context of his social network. Social Health is rooted in "Positive material environment" (focusing on financial and residential matters) and "Positive human environment" which is concerned with social network of the individual.

4. ***Spiritual (***Spiritual health in this context, refers to that part of the individual that reaches out and strives for meaning and purpose in life) This dimension seems to defy concrete definition. It includes:

i) Integrity
ii) Principles of Ethics
iii) Purpose in life
iv) Commitment to some higher being
v) Belief in concepts that are not subject to "state of the art" explanation

5. Emotional (Initially mental and emotional dimensions were seen one in the same thing but as more research becomes available a definite difference is emerging. Mental health can be seen as "Knowing" or "Cognition", while Emotional health refers to "Feeling").

6. Vocational (Importance of this dimension is exposed when individuals suddenly loose their jobs or are faced with mandatory retirement. For some this dimension may merely be a source of income but for others it may be source of self-worth and life success. Goal achievement and self-realization in work are source of satisfaction and enhanced self-esteem)

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7. Other Dimensions include Philosophical, Cultural, Socioeconomic, environmental, educational, nutritional, curative and preventive.

Positive Health: The state of positive health implies the notion of "perfect functioning of the body and mind".• It includes all the three aspects which are in a perfect state and include i) Biological ii) Psychological and Social. Positive health is however a mirage, because everything in our life is subject to change.

Concept of Well Being

WHO definition of health introduces the concept of "wellbeing". It has both subjective and objective components.

• ***Standard of Living*** (Spiritual , educational, recreational and other services may be used individually as measures of socioeconomic status and collectively as an index of the standard of living". The standard of living depends on the per capita GNP)

• ***Level of Living*** (It consists of nine components: health, food consumption, education, occupation and working conditions, housing, social security, clothing, recreation and leisure and human rights. These objective characteristics are believed to influence human well being)

• ***Quality of Life*** (It is a subjective component and is defined by WHO as " The condition of life resulting from the combination of the effects of the complete range of factors such as those determining health, happiness (including comfort in the physical environment and a satisfying occupation), education, social and intellectual attainments, freedom of action, justice and freedom of expression.")

Indicators of health

- Health indicators only give an indication about the health status of a community .An indicator is only the reflection of a give situation. According to WHO, they are variables which help to measure the changes.
- They are used when changes cannot be measured directly. For example. health and nutritional status.

- It indicates the direction and speed of changes and serve to compare different areas or groups of people at the same moment in time. These indicators are useful in measuring health status of a community, to compare health status of two places or countries, for assessment of heath care needs, for evaluating health services, activities and programmes.
- Indicators of health are required not only to measure the health status of a community, but also to compare the health status of one country with that of another ., for assessment of health care needs., for monitoring and evaluation of health services, activities and programmes.
- **Mortality indicators** such as (Crude Death rateCrude death rate-it is defined as the number of death per 100 population per year in a community .It indicates the rate at which people are dying) Life Expectancy, Infant mortality rate, Child mortality rate, Under five mortality rate, Maternal mortality ratio, Disease specific mortality, proportional mortality rate etc), **morbidity indicators such as (** Incidence and prevalence rate, disease notification rate, OPD attendance rate, Admission, readmission and discharge rate, duration of stay in hospital and spells of sickness or absence from work or school), **disability rates, nutritional status indicators, health care delivery indicators, utilization rates** etc

What is "Disease"?

Disease is a condition in the individual animal that overtly shows physiological, anatomical, or chemical changes that are outside the normal range for that species. Webster defines disease as "a condition in which body health is impaired, a departure from a state of health, an alteration of the human body interrupting the performance of vital functions". The disease is any deviation from the normal state of complete physical, mental, or social well-being.

The term' disease means without ease or uneasiness.

The changes that mark the disease are known as symptoms.

- Symptoms are not disease, just an indication that a disease is occurring.
- For example, a cold does not cause a stuffy nose; your body stuffs up your nose because of the cold.
- A stuffy nose is not a cold, just a symptom

Disease can be broken down into two categories:

- ***<u>Noninfectious Disease</u>***: results from injury, improper nutrition, genetic abnormality, unfavorable environmental conditions (heat, cold), or exposure to toxic materials. For example, vitamin/mineral deficiency; obesity; poisonings and toxicities; hypothermia; cancer
- ***<u>Infectious Disease</u>***: a disease caused by microorganisms that gain entrance into the body in sufficient numbers and with sufficient virulence that changes occur to what would otherwise be normal physiological stats. For example, brucellosis; swine erysipelas; rabies; bovine viral diarrhea; ringworm All infectious diseases are caused by a <u>pathogen</u>.

Pathogen: Disease causing agent and most commonly refers to infectious organisms such as bacteria, viruses and fungi

Virulence: ability to overcome the resistance of the host metabolism and defenses

- **Infectious vs. Contagious:** Infectious diseases are <u>contagious</u> if they are transmitted by being passed from animal to animal. For example, tetanus is infectious but not contagious; it is not spread from animal to animal but acquired from soil-borne organisms in the ground and on rusty nails. Ringworm, on the other hand (no pun intended), is contagious because it is spread from animal to animal contact.

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Natural history of disease: Natural history of a disease consists of two phases namely prepathogenesis phase and pathogenesis phase.

- Prepathogenesis phase is the period prior to the onset of a disease in which the causative agent has not entered in the human body but favourable factors for the disease agent to interact with the human host already exist in the environment. In this phase the man is exposed to the risk of disease.
- Agent, host and environment are the important causative factors in the production of a disease. Agent means the disease agent is a substance living or non-living or a force tangible or intangible, the excessive presence or relative lack of which is the immediate cause of a particular disease. Agents include biologic agents including bacteria, viruses, fungi, protozoa etc. Physical agents include heat, cold, humidity, electricity, Pressure etc. Exposure to excessive heat, cold, humidity, pressure, radiation, electricity, sound, etc. may result in illness. Nutrient agents are proteins, fats, carbohydrate, vitamins, minerals, and water. Any excess or deficiency of the intake of nutritive elements may result in nutritional disorders. Chemical agents-Endogenous: some of the chemicals may be produced in the body as a result of derangement of function, eg., urea (uremia),serum bilirubin (jaundice),ketones (ketosis), uric acid (gout),calcium carbonate (kidney stones) etc. Exogenous: Agents arising outside of human host. Eg., allergens, metals, fumes, dust, gases, insecticides etc. These may be acquired by inhalation, ingestion or inoculation. Mechanical agents: Exposure to chronic friction and other mechanical forces may result in crushing, tearing, sprains, dislocations and even death.
- Pathogenesis Phase starts with the entry of the disease agent into the human host. The time interval from the entry of agent in the host to the appearance of disease is termed as incubation period. During this period the disease agent multiplies and induces tissues and physiological changes.
- The incubation period is followed by the pathological changes in the form of early and late pathogenesis. Finally a disease leads to recovery, chronicity, disability or death.

Disease Transmission

- Microbes gain entrance into the body in many ways. Many types enter through breaks in the skin or direct openings into the body including mucus membranes such as the nose, eyes, teats, and vaginal area. Contaminated feed and water are possible sources.
- Vectors can also spread disease
    - A vector is an organism that introduces the pathogen that causes a disease
    - For example, mosquitoes are vectors for malaria; ticks are vectors for Lyme disease

Most pathogens have a preferred tissue in which they are most effective given their genetic adaptations

- For example, the rabies organism prefers and is most effective in nervous tissue
- Salmonella has the most virulence in the digestive tract

Concept of prevention

The goal of medicine is to promote health, to preserve health, to restore health when it is impaired, and to minimize suffering and distress. Successful prevention depends on knowledge of causation, dynamics of transmission, identification of risk factors and risk groups, availability of prophylactic or early detection, and treatment measures etc.

Disease control: The term disease control refers ongoing operation aimed at reducing:

- The incidence of disease.
- The duration of disease and the consequently the risk of transmission.

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- The effect of infection including physical and psychological complication.
- The financial burden to the community.

Elimination: Reduction of case transmission to a predetermined very low level or interruption in transmission. E.g. measles, polio, leprosy from the large geographic region or area.

Eradication: Termination of all transmission of infection by extermination of the infectious agent through surveillance and containment. The disease is no longer occur in a population. E.g. Small pox.

Monitoring: Defined as "the performance and analysis of routine measurement aimed at detecting changes in the environment or health status of population." E.g. growth monitoring of child, Monitoring of air pollution, monitoring of water quality etc.

Surveillance: Defined as "the continuous scrutiny of the factors that determine the occurrence and distribution of disease and other conditions of ill health." E.g. Poliomyelitis surveillance programme of WHO.

Preventative Strategies

Natural selection has provided livestock and other animals with strategies to prevent, reduce, or minimize the transmission of disease.

- Skin, hair, and feathers provide a first line of defense
- Mucous membranes provide protection by "trapping" airborne microbes
- Lysozymes in saliva, gastric acid, and bile also help to break down harmful bacteria
- Mucus excreted in the respiratory tract and hair-like cilia help to trap and expel microbes

Immunity

- Immunity refers to a lack of susceptibility to an infectious agent. The animal does not get sick when exposed to the microbe in question
- Immunity can be natural or acquired
- Natural immunity - acquired due to infection
- Artificial or Acquired immunity – acquired due to vaccination
- Resistance refers to a situation where an animal is immune to a particular disease

Antigen vs. Antibody

- An antibody is a serum blood protein (or globulin) that is produced by the body in response to a pathogenic microbe.
- Antibodies can serve different functions depending on their type; these functions can include detection, breakdown, elimination, and recovery
- An antigen is short for "Antibody Generator".
- An antigen is the microbe that caused the formation of an antibody.
- Common antigens are microbes, venom, toxins, and cellular proteins.

Active vs. Passive Immunity

- Active immunity is acquired by the animal as a result of an infection (or vaccination) followed by full recovery. Active immunity is long lasting but takes a period of time to develop.
    - The animal's body "remembers" the pathogen

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- Passive immunity is transferred from another animal that has active immunity. Passive immunity is rapidly acquired but only short term – 20-30 days.
    - The transfer may be caused by ingestion of colostrum (antibody-rich milk produced immediately after calving), transfusion of blood, through the shell of an egg to a newly hatched bird, or through the placenta to the unborn offspring

Sanitation

- Many microbes live and even multiply outside of the host. This reproduction of microbes in the environment can cause infestation of buildings, lots, and pens.
- The animals that inhabit these areas have bodies that must continuously fight infection
- Sanitation can reduce the impact of 2 of the 3 elements of the disease triangle, the environment and the pathogen. Sanitation also reduces the impact of the environment by reducing the ability of the pathogenic microbe to reproduce and transmit
- The first step of sanitation is a thorough cleaning and removal of organic material and waste
- Organic matter furnishes nutrients for some microbes and protest them from destruction caused by desiccation (drying out), temperature fluctuation, and lysolizing disinfectants.
- Antiseptics are substances that kill or prevent the growth of microorganisms
- The term antiseptic refers to preparations that may be applied to the living tissues of animals
- Antiseptic comes from "anti-sepsis". Sepsis means "decay"; antiseptics were meant to prevent the decay of tissue
- While general cleanliness can prevent disease transmission, antiseptics are necessary whenever invasive procedures are needed, such as surgery.

(Disinfectants are products that prevent the reproduction and spread of microbes on inanimate or non-organic surfaces (i.e. not the tissue of the animal). A sanitizer is a kind of disinfectant that is capable of reducing the numbers of microbes to within a public health standard. Sterilization refers to the complete destruction of all forms of life, particularly microbes).

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Principles of Epidemiology and Epidemiological Methods

Epidemiology is the study of the distribution and determinants of health states or events in specified populations, and the application of this study to control health problems. Health states or events usually refer to infection, illness, disability, or death but may equally be used to refer to a positive outcome (e.g. survival). Epidemiological studies describe the distribution of these health outcomes in terms of frequency and pattern. The frequency is the number of occurrences of an outcome within a given time period, and the pattern refers to the occurrence of the outcome by time, place and personal or population characteristics. Determinants influence the frequency and pattern of health outcomes and are known as risk factors or protective factors, depending on whether they result in a negative or positive health outcome respectively.

Epidemiological research also involves the testing of preventive interventions (e.g. vaccines, improved hygiene) and therapeutic interventions (e.g. medicines, surgery) to improve health and survival. An intervention may be evaluated either under ideal (research-controlled) conditions to assess its efficacy or through a routine delivery system to assess its effectiveness. After collecting epidemiological evidence, its application to improve health is a natural progression. Identification of risk factors and protective interventions, and quantification of their effects are key to informing action. Knowledge of the distribution and time-trends of outcomes, risk factors, and intervention coverage may be used for advocacy, for health promotion, and to inform public health policy and practice.

The study of epidemiology

The two main approaches to epidemiological study are descriptive and analytical. Descriptive epidemiology may provide information on the distribution of health outcomes by age, population type, geography or over time. Sources of descriptive data include routine monitoring such as registers of births and deaths, notification systems of specific diseases or adverse treatment reactions, and hospital or clinic records. Population censuses may also provide data on births, deaths, and a variety of risk factors (e.g. age, gender), and there is an overlap with demography (i.e. research on changes in the size, structure and distribution of human populations). Population health surveys evolved from censuses and provide information on the use of health services, coverage of interventions and the frequency of specific outcomes.

Cause and effect

Analytical epidemiology aims to investigate which factors may be responsible for increasing or decreasing the probability ('risk') of an outcome. Identifying the cause of an outcome is not always simple, and can be described in terms of ***sufficient cause*** and ***component causes***. Sufficient cause refers to a factor or set of factors that inevitably produces the outcome. The factors that form a sufficient cause are called component causes. Some component causes are essential for the outcome to occur:

tuberculosis cannot occur without *Mycobacterium tuberculosis*, and this is known as a necessary cause. However, some people may be infected with M. tuberculosis without developing tuberculosis, because other components such as immune status and concurrent infections (e.g. HIV) will determine their susceptibility to the disease.

A single necessary cause is rarely sufficient to cause the outcome. While this may make epidemiological investigation of causality more difficult to untangle, it works to our advantage in public health, as it means that there are often several points at which we can intervene to reduce the likelihood of an outcome. Necessary causes may be:

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1 infectious agents such as viruses, bacteria or parasites;

2 environmental agents such as sun-rays or allergens (e.g. pollen, dust-mites);

3 industrial agents such as chemicals (e.g. nicotine) or radiation (e.g. mobile phones);

4 genetic factors such as chromosomal abnormalities;

5 physical factors such as violence or car accidents;

6 psychological factors such as stress or abuse.

Component causes may influence an individual's contact or response to a necessary cause. Environmental factors tend to affect contact and may be physical (e.g. climate, altitude), biological (e.g. vectors that transmit an agent) or structural (e.g. crowding, sanitation). Human factors affect both contact and response, and include age, sex, ethnicity, behaviour, genetics, and nutritional and immunological status. These environmental and human factors also interact, making the whole process even more complex. For example, people living in conditions of poor sanitation will have greater contact with the polio virus because transmission is mainly via faecal contamination. Children will be at greater risk of infection than adults because of their poorer sanitary practices and also because of their lack of natural immunity or incomplete immunization. Depending on the perspective we take, a cause can also be considered as an outcome for the purpose of epidemiological investigation. For example, human immunodeficiency virus (HIV) is a necessary cause of acquired immunodeficiency syndrome (AIDS). However, we might then want to consider HIV infection as an outcome, and identify the necessary cause as unprotected sex with an infected individual, or contact with contaminated needles. This leads us to consider other risk factors that might increase the likelihood of HIV infection: multiple sexual partners, sharing of intravenous drug needles or poor safety practices in health facilities. However, while these risk factors can be component causes, they are not necessarily causal. A person may become infected through only one sexual contact, while another person with multiple sexual partners may not become infected at all. Relating a causative agent or risk factor – from here on termed exposure – to an outcome of interest is known as inferring causality. For an association to be causal, the exposure must occur before the outcome. Other factors that support a causal relationship include a dose–response relationship, the strength of the association seen, a plausible biological mechanism of action, and reproducibility of the result.

Measurements

Aim –

1 To describe the distribution and magnitude of health and disease problem in human population.

2 To identify risk factors in pathogenesis of disease.

3 To provide data needed for planning, implementation and evaluation of services for prevention, control and treatment of diseases and to set priority among the services.

Survey or ways to approach:

1. Questionnaire survey

2. Field data collection based on observation and their information.

Measurements: Measurement of

1 mortality (number of deaths)

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2 morbidity (the condition of suffering from a disease or medical condition or the rate of disease in a population)

3 disability (have a physical or mental impairment, and. the impairment has a substantial and long-term adverse effect on the person's ability to carry out normal day-to-day activities)

4 natality (birth rate or the ratio of the number of births to the size of the population)

5 demographic variables

6 presence, absence, or distribution of characteristics of disease

7 medical needs, health facilities, and other health-related events.

Factors of measurement –

1 frequency... Number of occurrence

2 duration... Time of occurrence

3 severity... Extent of occurrence

1. Measuring Morbidity

Morbidity:

It is defined as 'any departure or deviation, from a state of physiological well - being'. Morbidity may be a sickness, illness or disability.

Or Morbidity refers to the diseases and illness, injuries, and disabilities in a population. Morbidity is also measured in terms of rates and ratios. The two important measurements of disease frequency (i.e the rate at which disease occurs) are incidence and prevalence.

Frequently used measures of morbidity

- Incidence Rate
- Point Prevalence
- Period Prevalence
- Attack Rate
- Secondary Attack Rate

A. Incidence rate

Incidence measures the number of new cases of a disease (or other health -related phenomenon) that occur during a specified period of time in a population at risk

$$\text{Incidence rate} = \frac{\text{new cases ocurring during a given time period}}{\text{population at risk during the same time period}} \times 10^{n}$$

- The **numerator** of an incidence rate should reflect **new** cases of disease which occurred or were diagnosed during the specified period.
- The numerator should **not** include cases which occurred or were diagnosed earlier.

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Incidence rate refers

1. Only the new cases.

2. during a particular period (usually one year)

3. a specified population (population at risk).

Uses of incidence rate:

1. to control the disease

2. for research in etiology, pathogenesis and distribution of diseases.

The population at risk.

This means that persons who are included in the **denominator** should be able to develop the disease that is being described during the time period covered.

Factors affecting incidence

- **New risk factor**
  - Oral contraceptives and increase in thromboembolism;
  - Food additives and cancer
  - New virus (HIV and AIDS)
- **Changing habits**
  - Increased smoking and lung cancer
  - Fluoridated water and decrease in dental caries
- **Changing virulence of causative organisms**
  - Drug-resistant bacteria and deaths from infection (TB)
  - Influenza virus mutation Increase influenza
  - Drug resistance to malaria prophylaxis and increase in malaria
- **Changing of intervention programmes**
  - vaccination against measles ↓ measles
  - Polio eradication campaigns ↓ polio
- **Selective migration** of susceptible persons to an endemic area ↑ incidence
- **Population pattern**
  - Aging ↑ Degenerative diseases
- **Reporting**
  - Increase reporting ↑ incidence
- **Screening**
  - Early detection of cases ↑ incidence
- **New diagnostic tools**
  - New diagnostic tools ↑ detection of cases

B. Prevalence

Prevalence measures the number of cases (new and old) of the disease (or other health-related phenomenon) at a point or period in time.

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$$Prevalence = \frac{all\ new\ and\ pre\text{-}existing\ cases\ during\ a\ given\ time\ period}{population\ during\ the\ same\ time\ period} \times 10^n$$

- The numerator for prevalence includes:

All persons ill from a specified cause during a specified interval (or at a specified point in time) regardless of when the illness began

The term disease prevalence refers to all current cases (old and new) in a given population at a particular point of time or over a period of time. The term incidence refers only to new cases, but prevalence refers to both new and old cases.

Prevalence is classified into two types:

1. ***Point prevalence***: It refers to the number of all current cases (old and new) at a particular point of time (e.g. particular day or particular week.)
2. ***Period prevalence***: It refers to the number of all current cases (old and new) during a particular period of time (e.g. period of one year)

Factors affecting Prevalence:

- Changes in incidence
    - Prevalence= Incidence x duration.

    Example:

    Incidence (new cases) = 20 cases per year per 1000 population

    Duration of the disease = 5 years

    Prevalence = 20* 5 = 100 per 1000 population

Changes in disease duration and chronicity

- Chronic diseases are accumulating so increase the prevalence
- Acute diseases of a high recovery rate or high case fatality rate decrease prevalence

Intervention programs

- If management programs lead to cure decrease prevalence
- If only increase survival without cure increase prevalence

Selective attrition

- selective migration of cases, or susceptible or immune persons

Changing classifications:

- the data coding according to various disease categories often changes, and variations in prevalence may be reported due to misclassification).

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C. Attack Rate

- An attack rate is a variant of an incidence rate, applied to a narrowly defined population observed for a limited time, such as during an epidemic.
- The attack rate is usually expressed as a percent.

$$\text{Attack rate} = \frac{\text{Number of new cases among the population during the period}}{\text{Population at risk at the beginning of the period}} \times 100$$

Example

Of 75 persons who attended a picnic, 46 subsequently developed gastroenteritis.

Calculate the attack rate of gastroenteritis

Attendees = 76

ILL = 46

Attack rate = (46 ÷ 76) X 100

= 61%

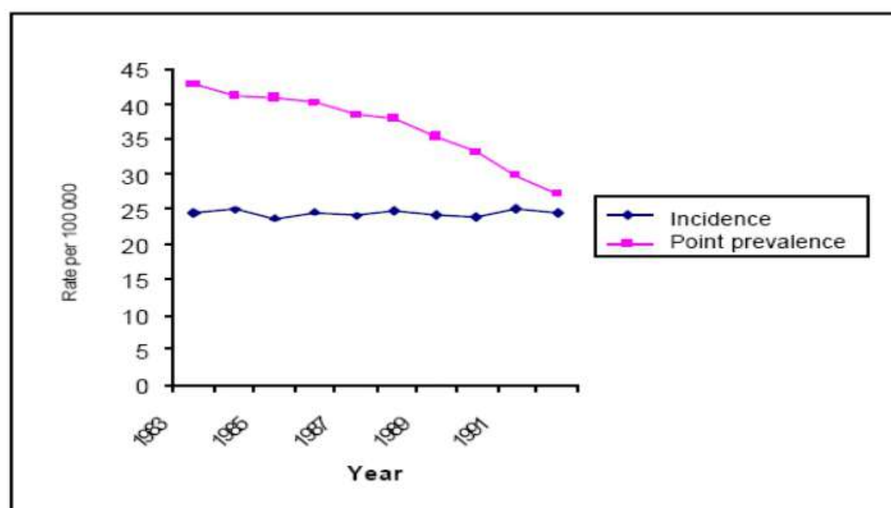
Secondary Attack Rate

- A secondary attack rate is a measure of the frequency of new cases of a disease among the contacts of known cases.

$$\text{Secondary attack rate} = \frac{\text{Number of cases among contacts of primary cases during the period}}{\text{total number of contacts}} \times 10^n$$

Divergence between incidence and prevalence:

Disease in which incidence is **stable** and prevalence is decreasing



Measuring disease frequency

The most common measures of disease frequency (i.e. prevalence, risk, odds, incidence rate) vary according to how cases and time-period are considered. We can explain the measures of frequency as follows:

1 ***Prevalence**:* is the number of existing cases in a defined population at a defined point in time divided by the total number of people in that population at the same point in time:

$$\text{Prevalence} = \frac{\text{Number of cases at one time point}}{\text{Total number of individuals in the defined population at same time point}}$$

Prevalence is a proportion and can never be greater than one. It is dimensionless, meaning that it has no units, so the term 'prevalence rate' is incorrect. Prevalence is usually presented as a percentage by multiplying the proportion by 100. Prevalence is sometimes referred to as point prevalence to distinguish it from period prevalence. Period prevalence refers to the number of existing cases identified during a specified, usually short, period divided by the total number of people in that population during the same period.

2. ***Incidence rate:*** Incidence is the frequency of new ('incident') cases in a defined population during a specified time-period. Incidence may be measured in ecological or cohort studies. There are three different ways of considering incidence: risk, odds and incidence rate.

$$\text{Incidence rate} = \frac{\text{Number of new cases in a specified time-period}}{\text{Total person – time at risk during that time-period}}$$

3 ***Risk:*** Risk is also known as cumulative incidence because it refers to the total number of new cases in a defined 'population at risk' over a specified period of time:

$$\text{Risk} = \frac{\text{Number of new cases in a specified time-period}}{\text{Total number of individuals at risk in the population at the start of that time-period}}$$

This measure can be interpreted as the likelihood ('risk') that an individual will develop an outcome during the specified time-period, and the 'population at risk' excludes existing ('prevalent') cases. Risk is also a dimensionless proportion, so can never be greater than one and has no units. However, its value can increase with the duration of the time-period under consideration, making it essential to specify the period at risk. For example, if a group of 100 people were studied for a year, and 75 had caught at least one cold during that year, we could say that the risk of catching a cold was 75 ÷ 100 = 0.75 or 75% in that year in that group. However, the result would be interpreted differently if 100 people had been studied for six months and 75 had caught at least one cold during this six-month period; it would have to be specified as a 75% risk over 6 months.

A specific form of risk used in disease outbreak settings is called the **secondary attack rate**. This is a misnomer, as it is a proportion and not a rate, but the term is commonly accepted. The secondary attack rate is calculated as the number of new cases among contacts of a primary case in a specified period of time:

$$\text{Secondary attack rate} = \frac{\text{Number of new cases among contacts in a specified time-period}}{\text{Total number of contacts of a primary case in that time-period}}$$

This can be interpreted as the 'risk' that a contact of a case will develop the outcome during the specified time-period. The total number of contacts is often estimated from the household members of primary cases, but may also include school or workplace contacts. For example, if eight children developed varicella (chicken pox) in an outbreak at a school, and five out of a total of 15 siblings developed varicella in the subsequent two

weeks, we could estimate the secondary attack rate, or risk of developing varicella among household contacts, as 5 ÷ 15 = 0.33 or 33% in this two-week time-period.

4 Odds: Odds is a different way of representing risk, and is calculated as the number of new cases divided by the number of individuals still at risk after a specified time- period:

$$\text{Odds} = \frac{\text{Number of new cases in a specified time-period}}{\text{Number who did not become a case during that time-period}}$$

The odds is actually a ratio of two proportions and can be greater than one. It is the ratio of the 'risk' that an individual develops the outcome during a specified time period, to the 'risk' that the individual does not develop the outcome during that same time-period. Below you can see how this simplifies mathematically to the equation given above, as the denominator (total number at risk) is the same for both outcomes, and cancels-out:

$$\text{Odds} = \frac{\text{Cases}}{\text{Total}} \div \frac{\text{Non-cases}}{\text{Total}} = \frac{\text{Cases}}{\text{Total}} \times \frac{\text{Total}}{\text{Non-cases}} = \frac{\text{Cases}}{\text{Non-cases}}$$

2. Mortality

Mortality is death. The frequency of death and the number of people who die is a measure of health of a community. Death is a unique and universal event, and as a final event, clearly defined. Age at death and cause provide an instant depiction of health status. As survival improves with modernization and populations age, mortality measures do not give an adequate picture of a population's health status. Indicators of morbidity such as the prevalence of chronic diseases and disabilities become more important.

Measures of mortality

- Crude Death Rates
- Age-Specific Death Rates
- Life Table Estimates

–Life expectancy

–Survivorship (by age)

- Cause-Specific Death Rates
- Special Indicators

–Infant and maternal mortality rates

A. Crude Death Rate (CDR)

Number of deaths in a given year per 1000 mid-year population.

Crude death rate = Number of deaths during the year/Mid - year population*1000

B. Age-Specific Death Rates

Number of deaths per year in a specific age (group) per 1000 persons in the age group

ASDR= **Da/ Pa * 1000**

Where Da= Number of deaths in age group a

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Pa= Midyear population in age group a

Why Age Specific Death Rates?

- Can compare mortality at different ages
- Can compare mortality in the same age groups over time and/or between countries and areas
- Can be used to calculate life tables to create an age-independent measure of mortality (life-expectancy)

Potential (minimum) Mortality	Realized (actual) Mortality
Number of deaths which would occur under ideal conditions due to oldage, malnutrition, etc.	Actual death rate is observed under existing conditions
No variation	Varies with physical factors and decreases with population size and density

Vital Index (VI): VI of a population is the percentage ratio of natality over mortality.

VI= (Natality rate/ Mortality rate) x 100

3. Life Table

A powerful demographic tool used to simulate the lifetime mortality experience of a population, by taking that population's age-specific death rates and applying them to a hypothetical population of 100,000 people born at the same time

----Life Expectancy

Estimate of the average number of additional years a person could expect to live if the age-specific death rates for a given year prevailed for rest of his or her life

Cause Specific Death Rates

Number of deaths attributable to a particular cause *c* divided by population at risk, usually expressed in deaths per 100,000

CSDR = Dc/ P ×100000

Special Indicators

4. Infant Mortality Rate (IMR):

Number of deaths of infants under age 1 per year per 1000 live births in the same year

IMR = Death of infants in a given year/total live births in that given year *1000

Why Infant Mortality Rates?

- The IMR is a good indicator of the overall health status of a population
- It is a major determinant of life expectancy at birth
- The IMR is sensitive to levels and changes in socio-economic conditions of a population.

5. Maternal Mortality

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'Maternal death'is death of a woman

- while pregnant ,or
- within 42 days of termination of pregnancy

Irrespective of the duration or site of the pregnancy

From any cause related to, or aggravated by the pregnancy or its management

Not from accidental causes

Maternal Mortality Ratio

Number of women who die as a result of complications of pregnancy or childbearing in a given year per 100,000 *live births* in that year.

Maternal Mortality Rate

Number of women who die as a result of complications of pregnancy or childbearing in a given year per 100,000 *women of childbearing age* in the population.

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