# Epidemiology notes 1

health records and information technology (Kenya Medical Training College)

# EPIDEMIOLOGY
# Concept of Epidemiology

**Definition of epidemiology and its origin**

The word epidemiology comes from the Greek words epi, meaning “on or upon,” demos, meaning “people,” and logos, meaning “the study of.” Many definitions have been proposed, but the following definition captures the underlying principles and the public health spirit of epidemiology:

- Epidemiology- Greek
    - *Epi*: ‘on, upon, at, by, near, over, on top of, against, among’;
    - *demos*: ‘people/populations’
    - *logos/ology*: ‘study of’
- Epidemiology is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the prevention and control of health problems. ***(Last, 1995)***
- The study of the patterns, causes, and control of disease in groups of people
- Study of how disease is distributed in populations and the factors that influence this distribution

Why a study?

- Epidemiology relies on scientific methods to apply a systematic approach to the collection, analysis and interpretation of data.
- The main basis of epidemiology is using an observation and comparison group to determine if whether what is observed (distribution and determinants) differs from what is expected.
- Epidemiology also depends on methods from other fields such as economics, social and behavioural sciences, biology, biostatistiscs, informatics etc.

Why distribution?

In distribution we consider:

- **Frequency**: This includes not only # of health-related states or events but also their relation to the whole population.
- **Pattern**: This includes disease occurrence in time, place or person:
- **Time**: daily, weekly, monthly etc
- **Place**: geography (rural, urban), work, school
- **Person**: personal characteristics: age, sex, socio-economic status, etc

**Why determinants**?

- The underlying assumption of Epidemiology is that human disease does not occur in a vacuum.
- Human disease occurs when a host (you and I), the agent (e.g. bacteria etc) and the environment (e.g. polluted air) interact to cause disease.

**Why health related states or events?**

- Health related events may be defined as anything that may threaten or affect the general health of a population.
- Originally, epidemiology focused on outbreaks of communicable diseases however, with time, epidemiology now also focuses on non-communicable diseases, injuries, maternal and child health, environmental and occupational health and recently genetics and molecular health studies

**Why specified Populations?**

- Epidemiology focuses on the health of communities or populations. This is unlike healthcare professionals who focus on the health of an individual. Epidemiology is about ggroups of people not individuals. It answers population questions

✓ aetiology of disease

✓ prevention of disease

✓ Extent/distribution of disease (allocation of effort & resources in health facilities and communities)

- How is epidemiology different from clinical medicine?

**Epidemiology Clinical Medicine**

Studies/Assessments Diagnosis

Prevention Treatment

Evaluation Cure

Planning Care

**Why application?**

- The knowledge gained from epidemiology and epidemiological studies is used to inform best practice to improve community and population health

**Core Functions of an Epidemiologist**

- ❑ Public health surveillance
- ❑ Data analysis
- ❑ Investigation
- ❑ Prevention and control measures
- ❑ Evaluation
- ❑ Communication
- ❑ Management and teamwork

## Types of Epidemiology

**Descriptive epidemiology**

This is characterization of the distribution of health-related states or events is one broad aspect of epidemiology called **descriptive epidemiology**. Descriptive epidemiology provides the ***What, Who, When, and Where of health-related events*.**

**Analytic epidemiology**

Epidemiology is also used to search for **causes and other factors that influence** the occurrence of health-related events. Analytic epidemiology attempts to provide the ***Why and How*** of such events by comparing groups with different rates of disease occurrence and with differences in demographic characteristics, genetic or immunologic make-up, behaviors, environmental exposures, and other so-called potential risk factors. Under ideal circumstances, epidemiologic findings provide sufficient evidence to direct swift and effective public health control and prevention measures.

**Applied Epidemiology**

The term ***applied epidemiology*** is used to describe the application or practice of epidemiology to address public health issues.

Examples of applied epidemiology include the following:

•*the monitoring of reports of communicable diseases in the community*

•*the study of whether a particular dietary component influences your risk of developing cancer*

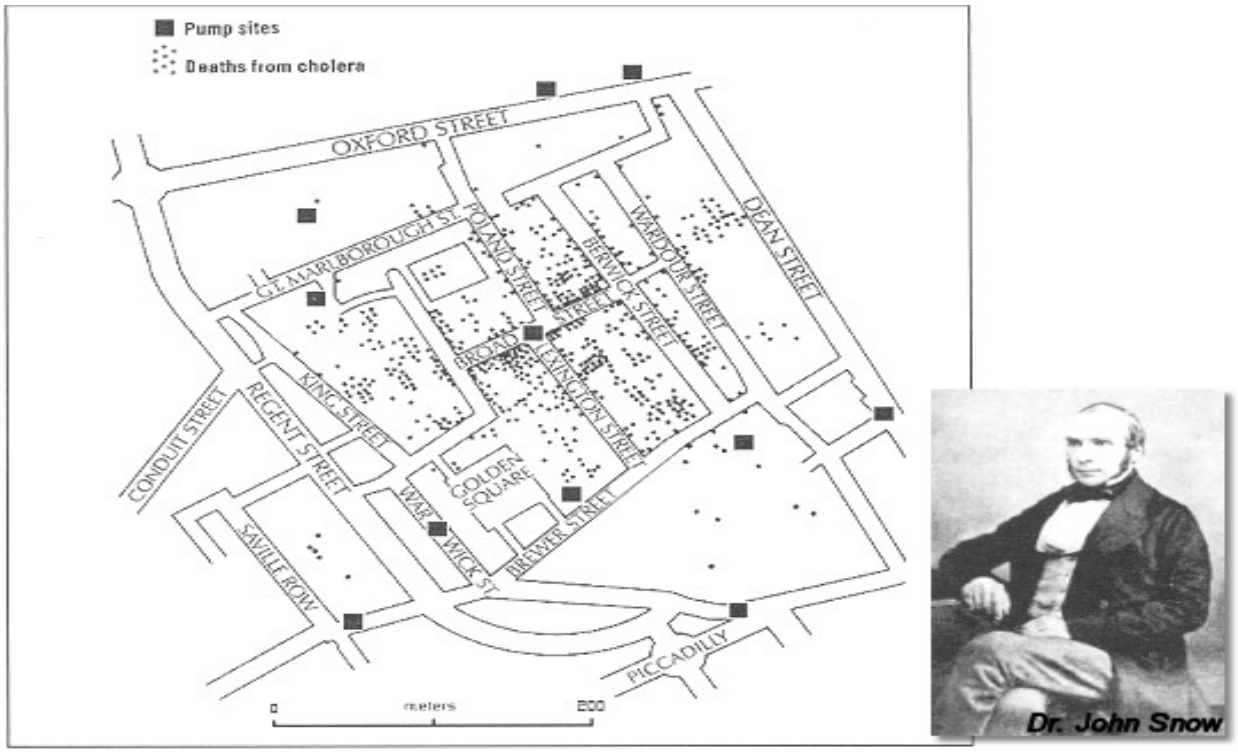
•*evaluation of the effectiveness and impact of a cholesterol awareness program*

•*analysis of historical trends and current data to project future public health resource needs*

**Historical Evolution of Epidemiology**

- **Circa 400 B.C**.-Hippocrates attempts to explain there is a rational cause for disease rather than supernatural forces. He suggests that the environment and host factors may influence disease occurrence
- **1662 -John Graunt,** a Londoner haberdasher and councilman published his analysis of mortality data in 1662. His data noted difference in mortality patterns in males, females and infants.
- **1854-** An anesthesiologist named John Snow was conducting a series of investigations in London that later earned him the title "the father of field epidemiology." Twenty years before the development of the microscope, Snow conducted studies of cholera outbreaks both to discover the cause of disease and to prevent its recurrence. Because his work classically illustrates the sequence from descriptive epidemiology to hypothesis generation to hypothesis testing (analytic epidemiology) to application, we will consider two of his efforts in detail. Snow conducted his classic study in 1854 when an epidemic of cholera developed in the Golden Square of London. He began his investigation by determining where in this area persons with cholera lived and worked. He then used this information to map the distribution of cases on what epidemiologists call a spot map as

shown.




- ***1890*-William Farr**, built on Graunt'swork by systematically analyzing Britain's mortality statistics. He developed the basic practices used in collecting, analysing and reporting vital statistics.
- **19thand 20thCentury:**

Epidemiological methods have been used to investigate infectious diseases, chronic diseases (Doll & Hill; Framingham), injuries/violence, molecular and genetic epidemiology.

With the advent of bioterrorism, epidemiologists have to consider not only natural transmission but also biological warfare in epidemiology of infectious diseases

## Terms used in epidemiology,

**Epidemiology** is the study of factors affecting the health and illness of populations, and serves as the foundation and logic of interventions made in the interest of public health and preventive medicine. It is considered a cornerstone methodology of public health research, and is highly regarded in evidence-based medicine for identifying risk factors for disease and determining optimal treatment approaches to clinical practice.
**Health** is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

**Illness** (sometimes referred to as **ill-health** or **ail**) can be defined as a state of poor health.

**Logic** is the study of the principles of valid inference and demonstration. The word derives from Greek *λογική*(*logike*), fem. of *λογικός*(*logikos*), "possessed of reason, intellectual, dialectical, argumentative", from *λόγος*logos, "word, thought, idea, argument, account, reason, or principle".

**Public health** is the study and practice of managing threats to the health of a community. The field pays special attention to the *social context* of disease and health, and focuses on improving health through society-wide measures like vaccinations, the fluoridation of drinking water, or through policies like seatbelt and non-smoking laws. The public-health approach can be applied to a population of just a handful of people or to the whole human population. Public health is typically divided into epidemiology, biostatistics and health services. Environmental, social, behavioral, and health are also important subfields.

Generally speaking, **preventive medicine** is the part of medicine engaged with preventing disease rather than curing it. It can be contrasted not only with curative medicine, but also with public health methods (which work at the level of population health rather than individual health).

Professionals involved in the public health aspect of this practice may be involved in entomology, pest control, and public health inspections. Public health inspections can include recreational waters, pools, beaches, food preparation and serving, and industrial hygiene inspections and surveys.

**Evidence-based medicine** (EBM) aims to apply evidence gained from the scientific method to certain parts of medical practice. It seeks to assess the quality of evidence relevant to the risks and benefits of treatments (including lack of treatment

**Disease Causation (determinants of disease)**

When you have completed this session you will be able to:

♦ Explain the difference between the various models of causation

♦ State the relationship between association and causation

♦ Explain the different types of causal inference

♦ List the Hill causal criteria.

**Causal Inference: Introduction**

♦ Why be concerned with cause?

– so that can intervene and prevent disease

♦ **Basic definition of "cause":** – exposure that leads to new cases of disease –remove exposure and some cases do not occur (disease rate drops)

♦ do not need to understand all casual factors to prevent disease

**What is the cause?**

♦ Certain conditions or events bring about other conditions or events

♦ Survival trait – Crying baby – Happy baby

♦ Based on observations initially – Light switch –Computer monitor

**What causes an MI?**

–Cigarette smoking

–Cholesterol

–Elevated blood pressure

–Stress –Family history

–Obesity

♦ Which contributes the most risk?

♦ What are the relationships among risk factors?

## Models of causation

♦ Issue is not as simple as first appears

♦ Need a framework of causation

– Necessary and Sufficient

– Multicausality

**Necessary and Sufficient**

♦ ***Sufficient Cause***

- ✓ Precedes the disease
- ✓ If the cause is **present**, the disease **always occurs**

♦ ***Necessary Cause***

- ✓ Precedes the disease
- ✓ If the cause is **absent**, the disease **cannot occur**

**The 4 Models of Causal Relationships**

1. Necessary and Sufficient
2. Necessary but not Sufficient
3. Sufficient but not Necessary
4. Neither Sufficient nor Necessary

**Association vs. Causation**

♦Does exposure **A**cause disease **B**?

- ✓ First, find out if variables associated
- ✓ Then use causal inference methods to assist

♦ Association is simply an identifiable relationship between an exposure an exposure and disease e.*g. Coronavirus is isolated more frequently from individuals with diarrhoea than those without*

♦ Implies that exposure might cause disease

♦ Exposures associated with a difference in disease risk are often called "risk factors

Causation implies that there is a true mechanism that leads from exposure to disease – *e.g., long-term heavy smoking causes myocardial infarction*

Finding an association does not make it causal – e.g., *hospital stays are associated with an increased mortality rate, but this does not mean they cause death*

**Bradford Hill's Criteria for Causal Inference**

♦ Strength of association

♦ Consistency of findings

♦ Biological gradient (dose-response)

♦ Temporal sequence

♦ Biological plausibility

♦ Coherence with established facts

♦ Specificity of association

♦ Analogy

♦ Experimental evidence

**Strength of Association**

♦ Strong associations are less likely to be caused by chance or by bias

– A strong association is one in which the relative risk is

- ✓ A very high (>>1), or
- ✓ Very low (<<1)

Strong associations are more likely to be causal than weak ones.

♦ Smoking > 20 cigarettes/d = laryngeal cancer (RR 20)

- ✓ Not all strong associations are causal eg*Downs syndrome and birth rank (confounder)*
- ✓ Weak associations do not rule out causality eg*passive smoking and lung cancer (RR 1.4)*

# Epidemiology and Disease Transmission

## Dynamics of Disease Transmission

## Occurrences of diseases

Human disease does not occur in a vacuum and occurs from the interaction between **host, agent and environment.** (Epidemiological Triad)

Specifically transmission occurs when an agent leaves its reservoir or host through a portal of exit, by a mode of transmission and through the portal of entry into infect a susceptible host. (chain of infection)

**Factors that may be associated with increased risk of disease**

**Host characteristics**

- Age and Sex
- Race and Religion
- Occupation and Genetics
- Marital status
- Previous diseases

**Environmental Factors**

- Physical: Trauma, radiation
- Climate
- Housing
- Water
- Sanitation
- Pollution

**Types of Agents**

- **Biological**: bacteria, viruses
- **Chemical**: Poison, alcohol

**Modes of disease transmission**

- Direct:
    - ✓ Direct contact
    - ✓ Person –person
- Indirect:
    - ✓ Airborne

- ✓ Vector bone
- ✓ Vehicle borne ( food, water, biological products, fomites-inanimate objects)

**Natural history of disease,**

Natural History and Spectrum of Disease Natural history of disease refers to the progress of a disease process in an individual over time, in the absence of intervention. The process begins with exposure to or accumulation of factors capable of causing disease. Without medical intervention, the process ends with recovery, disability, or death.

Most diseases have a characteristic natural history (which is poorly understood for many diseases), although the time frame and specific manifestations of disease may vary from individual to individual. With a particular individual, the usual course of a disease may be halted at any point in the progression by preventive and therapeutic measures, host factors, and other influences.

**Stages of Natural history of disease**

1) Exposure
2) Pathologic changes
3) Onset of symptoms
4) Usual time of diagnosis
5) Stage of susceptibility
6) Stage of subclinical disease
7) Stage of clinical disease
8) Stage of recovery, disability or death

The natural history begins with the appropriate exposure to or accumulation of **factors sufficient** to begin the disease process in a **susceptible host**. For infectious disease, the exposure usually is **a microorganism.** For cancers, the critical factors may require both cancer initiators, such as asbestos fibers or components in tobacco smoke (for lung cancer), and cancer promoters, such as estrogens (for endometrial cancer). Usually, a period of subclinical or in apparent pathologic changes follows exposure, ending with the onset of symptoms. For infectious diseases, this period is usually called the **incubation period**; for chronic diseases, this period is usually called the **latency period**. This period may be as brief as seconds for hypersensitivity and toxic reactions to as long as decades for certain chronic diseases. Even for a single disease, the characteristic incubation period has a range. For example, for hepatitis A, this range is about 2 to 6 weeks.

Although disease is in apparent during the incubation period, some pathologic changes may be detectable with laboratory, radiographic, or other screening methods. Most screening programs attempt to identify the disease process during this phase of its natural history, since early intervention may be more effective than treatment at a later stage of disease progression. The onset of symptoms marks the transition from subclinical to clinical disease. Most diagnoses are made during the stage of clinical disease. In some people, however, the disease process may

never progress to clinically apparent illness. In others, the disease process may result in a wide spectrum of clinical illness, ranging from mild to severe or fatal. Three terms are used to describe an infectious disease according to the various outcomes that may occur after exposure to its causative agent.

**Infectivity** refers to the proportion of exposed persons who become infected.

**Pathogenicity** refers to the proportion of infected persons who develop clinical disease.

**Virulence** refers to the proportion of persons with clinical disease who become severely ill or die.

For example, hepatitis A virus in children has low pathogenicity and low virulence, since many infected children remain asymptomatic and few develop severe illness. In persons with good nutrition and health, measles virus has high pathogenicity but low virulence, since almost all infected persons develop the characteristic rash illness but few develop the life-threatening presentations of measles, pneumonia, or encephalitis. In persons with poorer nutrition and health, measles is a more virulent disease, with mortality as high as 5-10%. Finally, rabies virus is both highly pathogenic and virulent, since virtually 100% of all infected persons (who do not receive treatment) progress to clinical disease and death.

The natural history and spectrum of disease presents challenges to the clinician and to the public health worker. Because of the clinical spectrum, cases of illness diagnosed by clinicians in the community often represent only the "tip of the iceberg." Many additional cases may be too early to diagnose or may remain asymptomatic. For the public health worker, the challenge is that persons with in apparent or undiagnosed infections may nonetheless be able to transmit them to others. Such persons who are infectious but have subclinical disease are called **carriers.** Frequently, carriers are persons with incubating disease or in apparent infection. Persons with measles, hepatitis A, and several other diseases become infectious a few days before the onset of symptoms. On the other hand, carriers may also be persons who appear to have recovered from their clinical illness, such as chronic carriers of hepatitis B virus.

**General disease processes**

- Signs and symptoms of disease, the test values and findings of disease, and the therapeutic treatment of disease.
    - Clinical and subclinical disease
    - Preclinical, subclinical, chronic, latent, carrier
    - Infectious and NCDs
    - Signs and symptoms

- Tests
- Treatment

**Infectious/communicable disease**

- Infectious: **transmissible** diseases results from the transmission and presence of pathogenic biological agents.
- Infectious pathogens include some *viruses*, *bacteria*, *fungi*, *protozoa*, *multicellular parasites*, and aberrant proteins known as *prions*
- NCD- Non-contagious/non-infectious
- Causes- Hereditary, deficiency, physiological/lifestyle

**Clinical and subclinical disease**

- Disease progression
- Infectious: Exposure- incubation- prodrome- acme- decline/worsening- recovery/death
- NCD: Risk factor-subclinical-signs/symptoms-recovery/disability/death
- Exposure: routes of transmission
  - Direct
  - indirect

**Disease process**

- **Subclinical**: carrying a disease causing agent without signs and symptoms; no recognizable clinical disease
- **Incubation**: between exposure and dev't of symptoms
  - Varies with disease eg flu 2-3 days; measles 1-2 weeks; leprosy 3-6 yrs
  - Determined by no. of organisms, host resistance etc

**Prodromal**: mild signs/symptoms; general symptoms eg fever, general aches, fatigue

- **Acme**: climax of the disease; specific signs and symptoms; complications- depends on disease, host
- **Decline/Convalescence/Recovery**- signs and symptoms subside, duration varies with disease, body systems return to normal

**Worsening/Death**

**Signs and symptoms**

- Depends on disease
- Different systems
- General s/s: Constitutional- related to the systemic effects of a disease (e.g., fever, malaise, anorexia, weight loss). Affect the entire body rather than a specific organ or location.
- Specific s/s
- **Symptom**: Subjective evidence of disease; only the patient can perceive it may be chronic, relapsing or remitting
- **Sign:** Objective evidence of disease; can be detected by other people
- **Types of signs:**
  - **Prognostic signs-** *indicate the outcome of the current bodily state of the patient; point to the future eg in cancer, mets- advanced stage-poor prognosis*
  - **Anamnestic signs -***indicate the past existence of a certain disease or condition; point to the past eg certain gait- stroke, polio*
  - **Diagnostic signs-** *lead to the recognition and identification of a disease i.e., they indicate the name of the disease eg neck stiffness*
  - **Pathognomonic signs -** *signs whose presence means, beyond any doubt, that a particular disease is present; represent a marked intensification of a diagnostic sign egKoplik's spots, hydrophobia*

**Ecological approach to disease causation**

**Chain of Infection**

The traditional model (epi triad) illustrates that infectious diseases result from the interaction of agent, host, and environment. More specifically, transmission occurs when the agent leaves its reservoir or host through a portal of exit, and is conveyed by some mode of transmission, and enters through an appropriate portal of entry to infect a susceptible host. This is sometimes called the chain of infection consisting of the following;

1. Reservoir
2. Agent

3. Portals or entry
4. Mode of transmission

    Direct-

        - Direct contact,
        - Droplet

    Indirect

    - Airborne
    - Vehicleborne
    - Vectorborne -

5 Susceptible host

## Reservoir:

**The reservoir** of an agent is the habitat in which an infectious agent normally lives, grows, and multiplies. Reservoirs include ***humans, animals, and the environment***. The reservoir may or may not be the source from which an agent is transferred to a host. For example, the reservoir of Clostridium botulinum is soil, but the source of most botulism infections is improperly canned food containing C. botulinum spores.

**Human reservoirs.** Many of the common infectious diseases have human reservoirs. Diseases which are transmitted from person to person without intermediaries include the sexually transmitted diseases, measles, mumps, streptococcal infection, most respiratory pathogens, and many others. Smallpox was eradicated after the last human case was identified and isolated because humans were the only reservoir for the smallpox virus. Two types of human reservoir exist:

- persons with symptomatic illness
- carriers

**A carrier is** a person without apparent disease who is nonetheless capable of transmitting the agent to others. Carriers may be ***asymptomatic carriers***, who never show symptoms during the time they are infected, or may be ***incubatory or convalescent carriers***, who are capable of transmission before or after they are clinically ill. A ***chronic carrier*** is one who continues to harbor an agent (such as hepatitis B virus or Salmonella typhi—the agent of typhoid fever) for an extended time (months or years) following the initial infection. Carriers commonly transmit disease because they do not recognize they are infected and consequently take no special precautions to prevent transmission.

**Symptomatic persons**, on the other hand, are usually less likely to transmit infection widely because their symptoms increase their likelihood of being diagnosed and treated, thereby reducing their opportunity for contact with others.

**Animal reservoirs.** Infectious diseases that are transmissible under normal conditions from animals to humans are called zoonoses. In general, these diseases are transmitted from animal to animal, with humans as incidental hosts. Such diseases include brucellosis (cows and pigs), anthrax (sheep), plague (rodents), trichinosis (swine), and rabies (bats, raccoons, dogs, and other mammals). Another group of diseases with animal reservoirs are those caused by viruses transmitted by insects and caused by parasites that have complex life cycles, with different reservoirs at different stages of development. Such diseases include St. Louis encephalitis and malaria (both requiring mosquitos) and schistosomiasis (requiring fresh water snails).

**Environmental reservoirs.** Plants, soil, and water in the environment are also reservoirs for some infectious agents. Many fungal agents, such as those causing histoplasmosis, live and multiply in the soil.

## Portal of exit

Portal of exit is the path by which an agent leaves the source host. The portal of exit usually corresponds to the site at which the agent is localized eg tubercle bacilli and influenza viruses exit the respiratory tract, schistosomes through urine, cholera vibrios in feces, Some blood borne agents can exit by crossing the placenta (rubella, syphilis, toxoplasmosis), while others exit by way of the skin (percutaneously) through cuts or needles (hepatitis B) or blood-sucking arthropods (malaria).

## Modes of transmission

After an agent exits its natural reservoir, it may be transmitted to a susceptible host in numerous ways. These modes of transmission are classified as:

**Direct**

- ✓ Direct contact
- ✓ Droplet spread

**Indirect**

- ✓ Airborne
- ✓ Vehicleborne
- ✓ Vectorborne -
    - ➢ Mechanical

- Biologic

In ***direct transmission***, there is essentially immediate transfer of the agent from a reservoir to a susceptible host by direct contact or droplet spread. ***Direct contact*** occurs through kissing, skin-to-skin contact, and sexual intercourse. Direct contact refers also to contact with soil or vegetation harboring infectious organisms. Thus gonorrhoea is spread from person-to-person by direct contact. Hookworm is spread by direct contact with contaminated soil. ***Droplet spread*** refers to spray with relatively large, short-range aerosols produced by sneezing, coughing, or even talking. Droplet spread is classified as direct because transmission is by direct spray over a few feet, before the droplets fall to the ground.

In ***indirect transmission***, an agent is carried from a reservoir to a susceptible host by *suspended* air particles or by ***animate (vector)*** or ***inanimate (vehicle) i***ntermediaries. Most vectors are arthropods such as mosquitoes, fleas, and ticks. These may carry the agent through purely mechanical means. For example, flies carry Shigella on appendages; fleas carry Yersinia pestis (agent that causes plague) in the gut and deposit the agent on the skin of a new host. In ***mechanical transmission***, the agent does not multiply or undergo physiologic changes in the vector. This is in contrast to instances in which an agent undergoes part of its life cycle inside a vector before being transmitted to a new host. *When the agent undergoes changes within the vector, the vector is serving as both an* ***intermediate host and a mode of transmission***. This type of indirect transmission is a ***biologic transmission***. Guinea worm disease and many other vectorborne diseases have complex life cycles which require an intermediate host.

**Vehicles** that may indirectly transmit an agent include *food, water, biologic products (blood*), and fomites (inanimate objects such as handkerchiefs, bedding, or surgical scalpels). As with vectors, vehicles may passively carry an agent—as food or water may carry hepatitis A virus

**Airborne transmission** is by particles that are suspended in air. There are two types of these particles: *dust and droplet nuclei*. **Airborne dust** includes infectious particles blown from the soil by the wind as well as material that has settled on surfaces and become resuspended by air currents. **Droplet nuclei** are the residue of dried droplets. The nuclei are less than 5 μ (microns) in size and may remain suspended in the air for long periods, may be blown over great distances, and are easily inhaled into the lungs and exhaled. This makes them an important means of transmission for some diseases. Tuberculosis, for example, is believed to be transmitted more often indirectly, through droplet nuclei, than directly, through droplet spread. Legionnaires' disease and histoplasmosis are also spread through airborne transmission.

## Portal of entry

An agent enters a susceptible host through a portal of entry. The portal of entry must provide access to tissues in which the agent can multiply or a toxin can act. Often, organisms use the same portal to enter a new host that they use to exit the source host. For example, influenza virus must exit the respiratory tract of the source host and enter the respiratory tract of the new host.

Other portals of entry include the skin (hookworm), mucous membranes (syphilis, trachoma), and blood (hepatitis B).

## Host

The *final link* in the chain of infection is **a susceptible host**. Susceptibility of a host depends on genetic factors, specified acquired immunity, and other general factors which alter an individual's ability to resist infection or to limit pathogenicity. An individual's **genetic makeup** may either **increase or decrease susceptibility**.

General factors which defend against infection include the skin, mucous membranes, gastric acidity, cilia in the respiratory tract, the cough reflex, and nonspecific immune response. General factors that may increase susceptibility are malnutrition, alcoholism, and disease or therapy which impairs the nonspecific immune response.

Specific acquired immunity refers to protective antibodies that are directed against a specific agent. Individuals gain protective antibodies in two ways:

1. They develop antibodies in response to infection, vaccine, or toxoid; immunity developed in these ways is called **active immunity**.
2. They acquire their mothers' antibodies before birth through the placenta or they receive injections of antitoxins or immune globulin; immunity that is acquired in these ways is called **passive immunity.**

Note that the chain of infection may be interrupted when an agent does not find a susceptible host. This may occur if a high proportion of individuals in a population is resistant to an agent. These persons limit spread to the relatively few who are susceptible by reducing the probability of contact between infected and susceptible persons. This concept is called **herd immunity**. The degree of herd immunity necessary to prevent or abort an outbreak varies by disease. In theory, herd immunity means that not everyone in a community needs to be resistant (immune) to prevent disease spread and occurrence of an outbreak. In practice, herd immunity has not prevented outbreaks of measles and rubella in populations with immunity levels as high as 85 to 90%. One problem is that, in highly immunized populations, the relatively few susceptible persons are often clustered in population subgroups, usually defined by socioeconomic or cultural factors. If the agent is introduced into one of these subgroups, an outbreak may occur.

## Implications for public health.

By knowing how an agent exits and enters a host, and what its modes of transmission are, we can determine appropriate control measures.

In general, we should direct control measures against the link in the infection chain that is most susceptible to interference, unless practical issues dictate otherwise. For some diseases, the most

appropriate intervention may *be directed at controlling or eliminating the agent at its source*. In the hospital setting, patients may be treated and/or isolated, with appropriate "enteric precautions," "respiratory precautions," "universal precautions," and the like for different exit pathways. In the community, soil may be decontaminated or covered to prevent escape of the agent.

Sometimes, we *direct interventions at the mode of transmission*. For direct transmission, we may provide treatment to the source host or educate the source host to avoid the specific type of contact associated with transmission. In the hospital setting, since most infections are transmitted by direct contact, hand washing is the single most important way to prevent diseases from spreading. For vehicle-borne transmission, we may decontaminate or eliminate the vehicle. For fecal-oral transmission, we may also try to reduce the risk of contamination in the future by rearranging the environment and educating the persons involved in better personal hygiene. For airborne transmission, we may modify ventilation or air pressure, and filter or treat the air. For vector-borne transmission, we usually attempt to control (i.e., reduce or eradicate) the vector population.

Finally, we may apply measures *that protect portals of entry of a susceptible potential host or reduce the susceptibility of the potential host*. For example, a dentist's mask and gloves are intended to protect the dentist from a patient's blood, secretions, and droplets, as well to protect the patient from the dentist. Prophylactic antibiotics and vaccination are strategies to improve a potential host's defences.

## Epidemic Disease Occurrence

### Level of disease

The amount of a particular disease that is usually present in a community is the baseline level of the disease. This level is not necessarily the preferred level, which should in fact be zero; rather it is the observed level. Theoretically, if no intervention occurred and if the level is low enough not to deplete the pool of susceptible persons, the disease occurrence should continue at the baseline level indefinitely. Thus, the baseline level is often considered the expected level of the disease.

Different diseases, in different communities, show different patterns of expected occurrence:

1) a persistent level of occurrence with a low to moderate disease level is referred to as **an endemic level;**
2) a persistently high level of occurrence is called a **hyperendemic level;**
3) an irregular pattern of occurrence, with occasional cases occurring at irregular intervals is called **sporadic.**

Occasionally, the level of disease rises above the expected level. When the occurrence of a disease within an area is clearly in excess of the expected level for a given time period, it is called **an epidemic**. Public health officials often use the term **outbreak,** which means the same thing, because it is less provocative to the public. When an epidemic spreads over several countries or continents, affecting a large number of people, it is called a **pandemic**. Epidemics occur when *an agent and susceptible hosts are present in adequate numbers,* and the agent can effectively be conveyed from a source to the susceptible hosts. More specifically, an epidemic may result from the following:

- a recent increase in amount or virulence of the agent
- the recent introduction of the agent into a setting where it has not been before
- an enhanced mode of transmission so that more susceptibles are exposed
- some change in the susceptibility of the host response to the agent
- factors that increase host exposure or involve introduction through new portals of entry

**Epidemic patterns**

We sometimes classify epidemics by how they spread through a population, as shown below:

•Common source

- ✓ Point
- ✓ Intermittent
- ✓ Continuous

•Propagated

•Mixed

•Other

A ***common source outbreak*** is one in which a group of persons is exposed to a common noxious influence, such as an infectious agent or a toxin. If the group is exposed over a relatively brief period, so that everyone who becomes ill develops disease at the end of one incubation period, then the common source outbreak is further classified as ***a point source outbreak***. When the number of cases in a point source epidemic is plotted over time, the resulting epidemic curve classically has a steep upslope and a more gradual downslope (a so-called “log-normal distribution”).

In some common source outbreaks, cases may be exposed over a period of days, weeks, or longer, with the exposure being ***either intermittent or continuous***. When we plot the cases of a

continuous common source outbreak over time, the range of exposures and range of incubation periods tend to dampen and widen the peaks of the epidemic curve. Similarly, when we plot an intermittent common source outbreak we often find an irregular pattern that reflects the intermittent nature of the exposure.

An outbreak that does not have a common source, but instead spreads gradually from ***person to person—***usually growing as it spreads—is called ***a propagated outbreak***. Usually transmission is by *direct person-to-person* contact, as with syphilis.

Transmission may also be vehicle-borne, as the transmission of hepatitis B or HIV by sharing needles, or vector-borne, as the transmission of yellow fever by mosquitoes. In a propagated epidemic, cases occur over more than one incubation period. In theory, the epidemic curve of a propagated epidemic would have a successive series of peaks reflecting increasing numbers of cases in each generation. The epidemic usually wanes after a few generations, either because the number of susceptibles falls below some critical level, or because intervention measures become effective.

Some epidemics may have ***features of both common source epidemics and propagated*** epidemics. The pattern of a common source outbreak followed by secondary person-to-person spread is not uncommon. These are called ***mixed epidemics***.

Finally, some epidemics are neither common source in its usual sense nor propagated from person-to-person. Outbreaks of zoonotic or vector-borne disease may result from sufficient prevalence of infection in host species, sufficient presence of vectors, and sufficient human vector interaction.

## The Epidemiologic Approach

An epidemiologist determines *What, When, Where, Who, and Why*. However, the epidemiologist is more likely to describe these concepts in slightly different terms: **case definition, time, place, person, and causes.**

As with all scientific endeavors, the practice of epidemiology relies on a systematic approach. In very simple terms, the epidemiologist:

• **Counts** cases or health events, and describes them in terms of time, place, and person;

• **Divides** the number of cases by an appropriate denominator to calculate rates; and

• **Compares** these rates over time or for different groups of people.

Before counting cases, however, the epidemiologist must decide what a case is. This is done by developing a case definition. Then, using this case definition, the epidemiologist finds and

collects information about the case-patients. The epidemiologist then performs descriptive epidemiology by characterizing the cases collectively according to **time, place, and person.**

**Case Definition:***A case definition is a set of standard criteria for deciding whether a person has a particular disease or other health-related condition*. By using a standard case definition we ensure that every case is diagnosed in the same way, regardless of when or where it occurred, or who identified it. We can then compare the number of cases of the disease that occurred in one time or place with the number that occurred at another time or another place.

With a standard case definition, when we find a difference in disease occurrence, we know it is likely to be a real difference rather than the result of differences in how cases were diagnosed.

A case definition consists of *clinical criteria and, sometimes, limitations on time, place, and person.* The clinical criteria usually include confirmatory laboratory tests, if available, or combinations of symptoms (subjective complaints), signs (objective physical findings), and other findings.

A case definition may have several sets of criteria, depending on how certain the diagnosis is. For example, during an outbreak of measles, we might classify a person with a fever and rash as having a **suspect, probable, or confirmed case of measles**, depending on what additional evidence of measles was present. In other situations, we temporarily classify a case as suspect or probable until laboratory results are available. When we receive the laboratory report, we then reclassify the case as either **confirmed or "not a case**," depending on the lab results. In the midst of a large outbreak of a disease caused by a known agent, we may permanently classify some cases as suspect or probable, because it is unnecessary and wasteful to run laboratory tests on every patient with a consistent clinical picture and a history of exposure (e.g., chickenpox).

Case definitions should not rely on laboratory culture results alone, since organisms are sometimes present without causing disease.

Case definitions may also vary according to the purpose for classifying the occurrences of a disease. For example, health officials need to know as soon as possible if anyone has symptoms of plague or foodborne botulism so that they can begin planning what actions to take. For such rare but potentially severe communicable diseases, where it is important to identify every possible case, health officials use a ***sensitive, or "loose" case definition***.

On the other hand, investigators of the causes of a disease outbreak want to be certain that any person included in the investigation really had the disease. The investigator will prefer a **specific or "strict" case definition**. For instance, in an outbreak of Salmonella agona, the investigators would be more likely to identify the source of the infection if they included only persons who were confirmed to have been infected with that organism, rather than including anyone with acute diarrhoea, because some persons may have had diarrhoea from a different cause. In this

setting, the only disadvantage of a strict case definition is an underestimate of the total number of cases.

**Time**

Disease rates change over time. Some of these changes occur regularly and can be predicted. For example, the seasonal increase of influenza cases with the onset of cold weather is a pattern that is familiar to everyone. By knowing when flu outbreaks will occur, health departments can time their flu shot campaigns effectively. Other disease rates make unpredictable changes. By examining events that precede a disease rate increase or decrease, we may identify causes and appropriate actions to control or prevent further occurrence of the disease. Depending on what event we are describing, we may be interested in a period of years or decades, or we may limit the period to days, weeks, or months when the number of cases reported is greater than normal **(an epidemic period).**

**-Secular (long-term) trends.** Graphing the annual cases or rate of a disease over a period of years ***shows long-term or secular trends*** in the occurrence of the disease. We commonly use these trends to suggest or predict the future incidence of a disease

**-Seasonality.** By graphing the occurrence of a disease by week or month over the course of a year or more we can show its seasonal pattern, if any. Some diseases are known to have characteristic seasonal distributions.

**-Day of week and time of day.** Displaying data by days of the week or time of day may also be informative. Analysis at these shorter time periods is especially important for conditions that are potentially related to occupational or environmental exposures, which may occur at regularly scheduled intervals.

**-Epidemic period**. To show the time course of a disease outbreak or epidemic, we use a specialized graph called an **epidemic curve**

**Place**

We describe a health event by place to gain insight into the geographical extent of the problem. For place, we may use place of residence, birthplace, place of employment, school district, hospital unit, etc., depending on which may be related to the occurrence of the health event. Similarly, we may use large or small geographic units: country, state, county, census tract, street address, map coordinates, or some other standard geographical designation. Sometimes, we may find it useful to analyse data according to place categories such as urban or rural, domestic or foreign, and institutional or non-institutional.

**Person**

In descriptive epidemiology, when we organize or analyse data by "person" there are several person categories available to us. We may use inherent characteristics of people (for example, age, race, sex), their acquired characteristics (immune or marital status), their activities (occupation, leisure activities, use of medications/tobacco/drugs), or the conditions under which they live (socioeconomic status, access to medical care). These categories determine to a large degree who is at greatest risk of experiencing some undesirable health condition, such as becoming infected with a particular disease organism. We may show person data in either tables or graphs.

**-Age.** Age is probably the single most important "person" attribute, because almost every health-related event or state varies with age. A number of factors that also vary with age are behind this association: susceptibility, opportunity for exposure, latency or incubation period of the disease, and physiologic response (which affects, among other things, disease development).

**-Sex.** In general, males have higher rates of illness and death than females do for a wide range of diseases. For some diseases, this sex-related difference is because of genetic, hormonal, anatomic, or other inherent differences between the sexes. These inherent differences affect their susceptibility or physiologic responses.

**-Ethnic and racial groups**. In examining epidemiologic data, we are interested in any group of people who have lived together long enough to acquire common characteristics, either biologically or socially. Several terms are commonly used to identify such groups: race, nationality, religion, or local reproductive or social groups, such as tribes and other geographically or socially isolated groups.

**-Socioeconomic status**. Socioeconomic status is difficult to quantify. It is made up of many variables such as occupation, family income, educational achievement, living conditions, and social standing. The variables that are easiest to measure may not reflect the overall concept. Nevertheless, we commonly use occupation, family income, and educational achievement, while recognizing that these do not measure socioeconomic status precisely.

level of disease prevention,

Scope of, epidemiology,

## Uses and purposes of epidemiology.

Epidemiology and the information generated by epidemiologic methods have many uses. These uses are categorized and described below.

1) **Population or community health assessment**. To set policy and plan programs, public health officials must assess the health of the population or community they serve and must determine whether health services are available, accessible, effective, and efficient. To do this, they must find answers to many questions: What are the actual and potential

health problems in the community? Where are they? Who is at risk? Which problems are declining over time? Which ones are increasing or have the potential to increase? How do these patterns relate to the level and distribution of services available?

2) **Individual decisions**. People may not realize that they use epidemiologic information in their daily decisions. When they decide to stop smoking, take the stairs instead of the elevator, or choose one method of contraception instead of another, they may be influenced, consciously or unconsciously, by epidemiologists' assessment of risk.

3) **Completing the clinical picture**. When studying a disease outbreak, epidemiologists depend on clinical physicians and laboratory scientists for the proper diagnosis of individual patients. But epidemiologists also contribute to physicians' understanding of the clinical picture and natural history of disease.

4) **Search for causes.** Much of epidemiologic research is devoted to a search for causes, factors which influence one's risk of disease. Sometimes this is an academic pursuit, but more often the goal is to identify a cause so that appropriate public health action might be taken. It has been said that epidemiology can never prove a causal relationship between an exposure and a disease. Nevertheless, epidemiology often provides enough information to support effective action. Identify the risk factors/cause of a disease

5) Determine the extent to which the disease is found in the community

6) Determine the natural history and **prognosis** of a disease

7) Evaluate new and existing preventive and therapeutic measures and modes of health care delivery

8) Provide foundation for developing public policy relating to health issues

**: MEASURES OF MORBIDITY, MORTALITY AND ASSOCIATION**

Define and use

- ✓ Ratio
- ✓ Proportion
- ✓ Rate
- ✓ Odds

♦Define and use

- ✓ Prevalence
- ✓ Incidence

- Cumulative incidence/risk
- Incidence rate/density
- odds

| **Measures used in epidemiology** | **Purpose** | **Example** |
|---|---|---|
| **Class of Measure** | | |
| **Disease frequency** | Description | |
| | Surveillance | •Incidence |
| | Risk assessment | •Cumulative incidence/risk |
| | | •Incidence rate/density |
| | | •odds |
| | | •Prevalence |
| | | •Point prevalence |
| | | •Period prevalence |
| **Association** | Etiology | Relative risk (risk ratio) |
| | Prognosis | Rate ratio |
| | | Odds ratio |
| **Impact** | Etiology | Attributable risk |
| | Health appraisal | Attrib. risk percent |
| | Policy formulation | Pop. Attrib. risk percent |

**Measures of frequency**

♦The basic tools to describe **quantitatively** the causes and patterns of disease, or any other event related to health in human populations.

♦For example:

How many people are affected by a certain disease?

What is the rate at which the disease in occurring through time?

How does the disease burden vary by geographical region, by sex, by age, or various modes of exposure? Etc.,

**Vital statistics and demographics**

Vital statistics are important to researchers, epidemiologist, health planners, and other health professionals to:

1. determine the health status of a community
2. to decide how best to provide a health service
3. to plan a public health program
4. to evaluate a program's effectiveness
    - Demographic variables describe a population's characteristics

**Sources of Vital Statistics And Demographic Data**

Three main sources of vital statistics

1. Census
2. Registration of vital events
3. Morbidity surveys

**1. The Census**

- Kenya has conducted census of population since 1948, held every 10 years
- Each household and resident is enumerated
- Information obtained on each person includes

1. gender
2. age
3. race
4. marital status
5. place of residence
6. relationship to or position as head of household

Census is a systematic sample of households that provides the following information

1. income
2. housing
3. number of children born
4. education
5. employment status
6. means of transportation to work
7. occupation

Census tables are published for:

- Country
- Province
- County
- District

- Division
- Location
- Sublocation
- Village
- Ethnic group

### 3. REGISTRATION OF VITAL EVENTS

Vital events are:

1. births
2. deaths
3. marriages
4. divorces

State law (Kenya) requires that all vital events be registered

**Registration Of Vital Events**

Birth certificates serve as proof of:

1. Citizenship
2. Age
3. Birthplace
4. Parentage

Death certificates are required as:

1. Burial documents
2. Settlement of estates and insurance claims

**Annual Registration Of Vital Events**

Birth registration

-All births required by law to be registered

Birth Certificate Information

1. Name
2. Sex
3. Date and time of birth
4. Race of parents
5. Birth order
6. Occupation of father
7. Place of birth
8. Residence of mother
9. Physician's (or attendant's) certification

Death Certificate

1. Name
2. Date and time of death
3. Race
4. Age
5. Place of birth
6. Names of decedent's parents
7. Name and address of survivor (or informant)
8. Marital status

9. Occupation
10. Place of residence
11. Cause(s) of death
12. Place of death
13. Burial data
14. If death due to injury: accident, suicide, or homicide
15. Physician's (or coroner's) certification

MoPH&S (Department of Disease Control)

- Health surveillance, monitoring and analysis
- Investigation of disease outbreaks, epidemics and risk to health
- Designing and establishing disease prevention programmes

Mortality Data

1. Death certificate number
2. District where the death occurred
3. Date of the death
4. Copies can be ordered from the Districts'vital statistics office

**Nosologist** – working for the central ministries; these individuals perform the task of classifying deaths into various numerical categories using the two current volumes on how to classify a particular cause of death (COD)

**3. MORBIDITY SURVEYS**

- This gives data on the prevalence of disease)
- It is more difficult to gather than mortality data
- Gathering morbidity data

- Compulsory reporting of specific conditions

- Still wide gaps in data today

- Data flow

✓ Local

✓ Regional

✓ National

Alternative methods of gathering estimates of morbidity data

1. Reportable diseases
2. National Health Survey
3. Hospital records data
4. Industrial hygiene records

5. School Nurse records

6. Medical care subgroups (most often: prepaid medical plans)

7. Chronic-disease registries (most often: tumor registries)

8. Insurance industry data

**MORBIDITY SURVEYS**, Examples

- Kenya Demographic & Health Survey
- Household health expenditure & Utilization survey
- Kenya Aids Indicator Survey
- Malaria Survey
- Population and Housing Census
- National Health Survey
- Kenya Urban Reproductive Health Initiative (KURHI)

Published medical care data results. Includes:

a. incidence

b. prevalence rates for many diseases

c. length of hospital stays

d. hospitalizations by cause

e. number of days of disability

f. patterns of ambulatory care service

**Chronic-disease registries**

1. Most are cancer related (therefore know as cancer or tumor registries) defined as a "facility for the collection, storage, analysis, and interpretation of data on persons with cancer e.g. BRECC registry

2. Other registries

a. cardiovascular disease

b. tuberculosis

c. diabetes

d. psychiatric disease

3. Registry types

a. hospital-based – they work within the walls of a hospital or group of hospitals

b. population-based – they serve a population of defined composition and size

**VITAL STATISTICS RATIOS,PROPORTIONS and RATES,**

**Ratio** The quotient of 2 numbers

• Numerator NOT necessarily INCLUDED in the denominator

• Allows comparing quantities of different nature Ratio

**Examples of Ratios**

♦ # beds per doctor – 850 beds/10 doctors – R = 85 beds for 1 doctor

♦ # participants per facilitator

♦ # inhabitants per latrine

♦ Sex ratio: Male / Female Female / Male

♦ Odds ratio

♦ Rate ratio

♦ Prevalence ratio

**Proportion** – is an expression of the form where $\left(\frac{a}{a+b}\right)c$

*a, a + b,* and *c* are defined for rates

**Proportion:**

Is a quotient of 2 numbers

• Numerator NECESSARILY INCLUDED in the denominator

• Quantities have to be of the same nature

• Proportion always ranges between 0 and 1

• Percentage = proportion x 100

**Example 1**

**Population 3500 women**

**6500 men**

**Proportion of men = 6500 / (3500 + 6500) = 0.65 or 65 %**

**Male to female ratio= 6500 / 3500 = 1.86**

**Female to male ratio = 3500/6500 = 0.54**

**Example 2**

**AIDS cases: 4000 male cases**

**2000 female cases**

**Q: What is the proportion of male cases among all cases?**

**Female cases among all cases?**

A. **Rate** – is an expression like where $\left[\frac{a}{(a+b)t}\right]c$

- *a* = the number of persons experiencing a particular event during a given period
- *a + b* = the number of persons who are at risk of experiencing the particular event during the same period

- $t$ = the total time at risk
- $c$ = a multiplier, such as 100, 1000, 10,000, or 100,000
- The purpose of the multiplier, or base, is to avoid the inconvenience of working with minute decimal fractions

**Rate** is a quotient of 2 numbers

- Speed of occurrence of an event over time
- **Numerator** - number/EVENTS observed for a given time
- **Denominator** - population in which the events occur (population at risk)
- includes time

**Rate** is something that may change over time

Something that is observed during some time

•Measures the speed of occurrence of an event

•Measures the probability to become sick by unit of time

•Measures the risk of disease

However rate is frequently used instead of ratio or proportion !!

Time is included in the denominator !!

**Example of calculating a rate**

♦ Mortality rate of tetanus in X country in 1995

– Tetanus deaths: 17

– Population in 1995: 58 million

Mortality rate =0.029/100,000/year

♦ Rate may be expressed in any power of 10 – 100, 1,000, 10,000, 100,000

Three kinds of rates

**a. Crude Rates**

- i. computed for an entire population
- ii. disregard differences that usually exist by age, sex, race, or some category of disease

**b. Specific Rates**

- i. consider the differences among subgroups consider the differences
- ii. computed by age, race, sex, or some other variable

**c. Adjusted (or standardized) Rates**

- - Used to make valid summary comparisons between two or more groups possessing different age (or other) distributions

**Odds**

Probability that an event will happen **divided by** Probability that an event will not happen

**MEASURES OF MORBIDITY**

Two types of measures:

1. **Prevalence:** Measures population diseases status

Prevalence: Number of cases of disease at a specific time/

Population at risk at that time

- Proportion of a population affected by a disease at a given time.
- Expressed as a percentage (%)

Types of Prevalence

- **Point prevalence** (Proportion of a population that is affected by disease at a given point in time.)
- **Period prevalence** (Prevalence in a period of time)

**Uses of Prevalence Data**

• Assessing health care needs

• Planning health services

• Measure occurrence of conditions with gradual onset

• Study chronic diseases

2. **Incidence** :

- Whereas prevalence is the frequency of existing cases in a population, incidence is frequency of new cases in a defined population over a specified period of time.
- Incidence assess frequency of disease onset
- There are 3 different ways of measuring incidence

•Cumulative incidence/risk

•Incidence density or incidence rate

•odds

**Cumulative Incidence (CI)**

Number of NEW cases of disease during a period/

Population at risk during this period (**disease free at the begining)**

**Odds**

♦ Similar to cumulative incidence but rather than use the number of disease free people at the beginning of the period (population at risk), we use number of disease free people at end of the specified time for the denominator

♦ Odds of disease = number of new cases during a period

number of people still disease free by end of period

**Note**

- Both cumulative incidence/risk and odds assume that the population at risk is followed up over a specified time period.
- Also assumed is that the those who were included at the start of the period are counted at the end.
- This is called a closed population or a cohort

**Incidence Rate/Density**

- Defined as the number of newly reported cases of a given disease in a calendar year divided by the population on July 1 of that year, with the quotient multiplied by a convenient factor, usually, 1000, 100,000, or 1,000,000

IR= Number of NEW cases of disease during a period

Total person-time at risk in this period of observation

Also called **force of morbidity** or or**incidence density**

Denominator: - is a measure of time

- the sum of each individual's time at risk and free from disease

Incidence rate must take into account;

-number of individuals who become ill in a population

-and the time periods experienced by members of the population during which the events occur

- Incidence rate looks at incidence in dynamic/open population where

– People enter and exit population at risk at different points

– Follow up for long periods

– People are at risk for different lengths

- Instead of counting the disease free individuals at the start, the time that each individual spends in the study before becoming a case is calculated.
- This is called the person time at risk

**Comparing Incidence and Prevalence**

**Incidence**

• New cases or events over period of time

• Useful studying factors causing disease, disease "risk"

**Prevalence**

• All cases at point/period of time

• Useful for measuring size of problem and planning

**Relationship of Incidence to Prevalence**

• Prevalence depends on both on incidence rate and duration of disease

• Because prevalence affected by factors such as migration and duration, incidence is preferred for studying etiology.

**Special types of Incidence**

**Morbidity rate=# cases**

**Population at risk**

**Mortality rate=# deaths**

**Population at risk**

**Case Fatality rate=# deaths from a disease**

**Total cases of that disease**

**Attack rate=# cases during |epidemic"**

**Population at risk**

**Attack Rate**

- An attack rate is an incidence rate calculated for a specific disease for a limited period of time during an epidemic
- Usually expressed for the entire epidemic period, from the first to the last case

**Attack Rate**=Number of new cases of a specified disease reported during an epidemic period of time

Population at risk during the same time interval

**Secondary Attack Rate** =Number of new cases of a specified disease among contacts of known cases

Size of contact population at risk

**Example: Attack rate**

Seven cases of hepatitis A occurred among 70 children attending a childcare center. Each infected child came from a different family. The total number of persons in the 7 affected families was 32. One incubation period later, 5 family members of the 7 infected children also developed hepatitis

**A. Calculate the attack rate in the child care center**

**B. Calculate the secondary attack rate**

**PREVALENCE PROPORTION**

- Defined as the number of existing cases of a given disease at a given time divided by the population at that time, with the quotient multiplied by 1000, 100,000, or 1,000,000

**CASE-FATALITY PROPORTION**

- Defined as the number of deaths assigned to a given cause in a certain period by the number of cases of the disease reported during the same period, with the quotient multiplied by 100

**MEASURES OF MORTALITY**

When the event under study is death rather than the occurrence of disease, we usually use the term mortality (rate) rather than cumulative incidence.

♦ Crude Death Rate (CDR)

♦ Cause-specific Death Rate

♦ Neonatal Mortality Rate

♦ Perinatal Mortality Rate (PMR)

♦ Infant Mortality Rate (IMR)

♦ Child Mortality Rate (CMR)

♦ Maternal Mortality Rate (MMR)

- Each rate is a measure of the relative frequency of deaths that occurred in a given population over a specific period
- Mortality Rate – must know the population and time at risk to compute the mortality rate

**ANNUAL CRUDE DEATH RATE (CDR)**

- Defined as the number of deaths in a calendar year divided by the population on July 1 of that year, with the quotient multiplied by 1000
- Universally used
- A generalized indicator of the health of a population

**AGE-SPECIFIC DEATH RATE(ASDR)**

- Defined as the number of deaths in a specific age group in a calendar year divided by the population of the same age group on July 1 of that year, with the quotient multiplied by 1000

**CAUSE-SPECIFIC DEATH RATE**

- Defined as the number of deaths assigned to a specific cause in a calendar year divided by the population on July 1 of that year, with the quotient multiplied by 100,000

**CAUSE- /RACE SPECIFIC DEATH RATE**

- One of many possible examples of how the idea of specific death rates may be extended simultaneously to cover two characteristics

**PROPORTIONAL MORTALITY RATE**

- Defined as the number of deaths assigned to a specific cause in a calendar year divided by the total number of deaths in that year, with the quotient multiplied by 100

**MATERNAL MORTALITY RATIO**

- Defined as the number of deaths assigned to puerperal causes (i.e. related to childbearing) in a calendar year divided by the number of live births in that year, with the quotient multiplied by 100,000

**INFANT MORTALITY RATE**

- Defined as the number of deaths of persons of age 0-1 in a calendar year divided by the number of live births in that year, with the quotient multiplied by 1000

**NEONATAL MORTALITY PROPORTION**

- Defined as the number of deaths of neonates (i.e., infants less than 28 days of age) that occurred in a calendar year divided by the number of live births in that year, with the quotient multiplied by 1000

**FETAL DEATH RATIO**

- Fetal death is defined as the delivery of a fetus that shows no evidence of life (no heart action, breathing, or movement of voluntary muscles) if the $20^{th}$ week of gestation has been completed or if the period of gestation was unstated
- Fetal death ration is defined as the number of fetal deaths in a calendar year divided by the number of live births in that year, with the quotient multiplied by 1000.

- Note that this ratio only applies to fetal deaths that occur in the second half of pregnancy. No reporting is required for early miscarriage

**PERINATAL MORTALITY PROPORTION**

- Defined as the number of fetal plus neonatal deaths divided by the number of live births plus fetal deaths, with the quotient multiplied by 1000

**MEASURES OF FERTILITY**

- Indispensable for approaching population control problems
- Particularly useful in planning maternal and child health services
- Helps school boards plan for future needs for facilities and teachers

**CRUDE BIRTH RATE(CBR)**

- Defined as the number of live births in a calendar year divided by the population on July 1 of that year, with the quotient multiplied by 1000
- Non-too-sensitive measure as the population (denominator) includes both men and women

**GENERAL FERTILITY RATE**

Defined as the number of live births in a calendar year divided by the number of women ages 15-44 at midyear, with the quotient multiplied by 1000