



## Principles of Epidemiology:

**Epidemiology:** the science which deals with what falls upon people,

- It is an investigative method to detect the **cause or source of diseases**, disorders, syndromes, conditions, or perils الأخطار that cause pain, injury, illness, disability, or death.
- It studies the **occurrence and distribution** of health-related diseases or events in specified populations, including the **study of the determinants** influencing such states, and the application of this knowledge to control the health problem.
- It also involves **characterizing the distribution** of health status, diseases, or other health problems in terms of age, sex, race, geography, religion, education, occupation, behaviors, time, place, person, etc.
- It 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.
- In the work of communicable and non-communicable diseases, the work of **epidemiologists range from outbreak investigation to study design, data collection and analysis** including the development of **statistical models** to test hypotheses and the documentation of results for submission to peer-reviewed journals.
- Epidemiologists may **draw on a number of other scientific disciplines** such as biology in understanding disease processes and social science disciplines including sociology and philosophy in order to better understand proximate and distal risk factors.

## Purposes of Epidemiology:

1. To explain the **etiology** (cause) of a single disease or group of diseases using information management.
2. To study the **history** and trends of a disease.
3. To determine **if data are consistent** with proposed hypothesis.
4. To provide a basis for developing **control measures and prevention** procedures for groups and at risk populations.
5. it **DOES NOT** provide solutions or medical intervention (eg; medicine, treatment, protocols,..)

\*these things are decided based on epidemiological multidisciplinary approaches.

## - Terms:

- The **Epidemiologist:** a professional who **study and control** the factors that influence the **occurrence of disease** or health-related conditions and events in specified populations, has an experience in **population thinking** and **epidemiologic methods**, and is knowledgeable about **public health** and **causal inference** in health.

- **Disease:** a 1. **pattern of response** by a living organism to the invasion of a foreign substance or injury which causes an alteration of the organisms normal functioning.
- also, it is an 2. **abnormal state** in which the body is not capable of responding to or carrying on its normally required functions.
- **Pathogens:** **organisms** or substances such as bacteria, viruses, or parasites that are **capable of producing diseases**.
- **Pathogenesis:** the development, production, or **process of generating a disease**.
- **Pathogenicity:** the **potential ability** and **strength** of a pathogenic substance to cause disease (the difference in the **extent** of the disease from one pathogen to another).
- **Infective diseases:** are those which **the pathogen** has the capability to **enter, survive, and multiply in the host** (communicable disease).
- **Virulence:** 1. the **extent of pathogenicity** or strength of different organisms.
- 2. the **ability** of the pathogen to **grow, thrive, and to develop** all factor into virulence.
- 3. the **capacity and strength of the (disease)** to produce severe and fatal cases of illness.
- **There is NO difference between virulence and pathogenicity.**
- **Invasiveness:** the **ability to get into** a susceptible **host** and cause a disease within the host
- The **capacity** of a microorganism to enter into and grow in or upon tissues of a **host**.
- The **ability to invade the host**, as opposed to the ability to cause disease (pathogenicity)
- **Etiology:** the **factors** contributing to the **source of or causation of** a disease.
- **Toxins:** a **poisonous substance** that is a specific **product of the metabolic activities of a living organism** and is usually very unstable (notably toxic when introduced into tissues, & typically capable of inducing **antibody** formation).
- **Antibiotics:** a substance produced by or a **semisynthetic substance derived from a microorganism** and able in dilute solution to **inhibit or kill another microorganism**.
- **Endemic:** the ongoing, usual level of, or **constant presence of a disease in a given population**. Or, **disease present among a population at all times**. Eg: Malaria in some African Regions
- **Hyperendemic:** **persistent level of activity** beyond or **above the expected prevalence**.
- **Holoendemic:** a disease that is **highly prevalent** in a population & is commonly **acquired early in children** of the population. (differs from endemic, in that the whole population has it)
- **Epidemic:** **outbreak** or occurrence of **one specific disease from a single source**, in a group population, community, or geographical area, **in excess of the usual level of expectancy**. Can progress into a pandemic.
- **Pandemic:** **epidemic that is widespread** across a country, continent, or large populace, possible worldwide.
- Claiming diseases as an epidemic vs pandemic is decided by international organizations, it has extreme and substantial political and geographical applications on all people.
- Despite having cases recorded all around the world, **SARS is considered an epidemic because of multifactorial interference** from political and economic groups as well as international organizations. Covid wasn't considered a pandemic till relatively late because of the same pressures.
- **Incidence:** the **extent** that people, within a population who do not have a disease, develop the disease during a specific time period. [**# of new cases of disease / total # at risk**].

- **Prevalence**: the **number of people** within a population who have a certain disease at a given point in time. # cases existing at one time.

- **Prevalence** relies on 2 factors:

1. How many people have had the disease in the past

2. Duration of the disease in the population

Incidence = # of **New Cases** in a Given Population in a Specified Time/Population at Risk in That Time Period.

Prevalence = # of **Existing Cases** in a Given Population at a Single Point in Time/Population at That Time.

- **Comparing Population Characteristics:**

**Rates** help us compare health problems among different populations that include two or more groups who differ by a selected characteristic.

- **The Epidemiology Triangle:**

- Outbreaks in a population often involves several factor and entities.

- Many people, objects, avenues of transmission, and organisms can be involved in the spread of disease.

- The epidemiology triangle **help explain the multifaceted phenomena of disease transmission**.

- Many diseases rely on an agent or single factor for an infectious disease to occur.

- Epidemiologist use an ecological view to assess the interaction of various elements and factors in the environment and disease-related implications.

- **When more than a single cause must be present for a disease to occur, this is called multiple causation.**

- The interrelatedness of **4 factors contribute to the outbreak of a disease:**

1. Role of the host

2. Agent

3. Environmental circumstances

4. Time

- **The epidemiology triangle** is used to **analyze the role and interrelatedness of each of the four factors** in epidemiology of infectious diseases, that is the influence, reactivity and effect each factor has on the other three.

1. **The agent** is the cause of the disease (can be living or nonliving)

• Can be bacteria, virus, parasite, fungus, mold

• Chemicals (solvents), Radiation, heat, natural toxins (snake or spider venom)

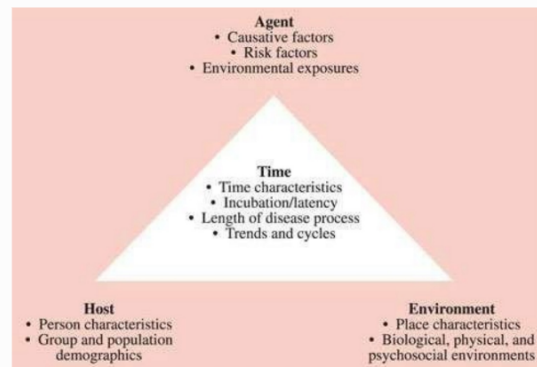
2. **The host** is an organism, usually human or animal, that harbors the disease.

• Level of immunity, genetic make-up, state of health, and overall fitness within the host can determine the effect of a disease can have upon it.

3. **The environment** is the favorable surroundings and conditions external to the human or animal that cause or allow the disease or allow disease transmission.

• Environmental factors can include the biological & the social aspects, cultural, and physical aspects of the environment.

4. **The time** accounts for incubation periods, life expectancy of the host or pathogen, duration of the course of illness or condition (acute, subacute, or chronic)



- The mission of the epidemiologist is to break one of the legs of the triangle, so disrupts the connection between environment, host, & agent, stopping the outbreak continuation.
- The goals of public health are control and prevention of disease, & by breaking one of the triangle legs, public health intervention can partially realize these goals & stop epidemics.
- An epidemic can be stopped when one of the elements of the triangle is interfered with, altered, changed or removed from existence.

## Broad Types of Epidemiology

### DESCRIPTIVE EPI

- Examining the distribution of a disease in a population, and observing the basic features of its distribution in terms of time, place, and person. (try to formulate hypothesis, look into associations)
- Typical study design: community health survey; cross-sectional study, descriptive study

### ANALYTIC EPI

- Testing a specific hypothesis about the relationship of a disease to a specific cause, by conducting an epidemiologic study that relates the exposure of interest to the outcome of interest (Cause-effect relationship).
- Typical study designs: cohort, case-control, experimental design

Research has to do with temporality of the study (time). For example, we can hypothesize that a uni student with depression and low grades, is depressed because of his low grades or achieves low grades bec of his depression. We must follow and study him from his senior year of school to decide on the temporality of the relationship.

## - Basics of Descriptive Epidemiology:

The three essential characteristics of disease we look for in descriptive epidemiology are:

1• PERSON 2• PLACE 3• TIME

### 1. Personal Characteristics (whom)

- Age • Gender • Socio-economic status (education, occupation, income) • Marital status
- Ethnicity العرقي/الانتماء/race/genetic profile • Behavior/habits.

### 2. Place (where?)

- Geographically restricted or widespread (outbreak, epidemic, pandemic)? Off-shore (tsunami...).
- Climate effects (temperature, humidity, combined effects,..).
- Urban / sub-urban-squatter مالک الأرض / rural.
- Relation to environmental exposure (water, food supply, etc).
- Multiple clusters or one?

### 3. Time (when?)

- Changing or stable?.
- Clustered (epidemic) or evenly distributed (endemic).
- Time-trends: Point source, propagated, seasonal, combinations.

## - Disease Transmission:

- 1) Fomites: inanimate objects الجمادات: pencils, pens, doorknobs, infected blankets.
  - 2) Vector: any living non-human carrier of disease: insects: fly, flea, mosquito; rodents; deer, some viruses use bacteria as vectors. وسيط
- Vectors are carriers.

Disease Transmission



3) **Reservoirs**: مصطلح أشمل humans, animals, plants, soils or inanimate organic matter (feces or food) in which infectious organisms live and multiply.

- Humans often serve as reservoir and host.

4) **Zoonosis**: animal to human transmission, differs from vector, in "zoonosis" the disease originates in animals and doesn't need a vector.

- **Carrier**: one that spreads or harbors an infectious organism

• **Some carriers may be infected and not be sick. e.g. Typhoid Mary**

• ((Mary Mallon (1869-1938) was the first person in the US to be identified as a **healthy carrier** of typhoid fever. Over the course of her career as a cooker, she infected 47 people, three of whom died from the disease. Her notoriety is in part due to her vehement denial of her own role in spreading the disease, together with her refusal to cease working as a cooker. She was forcibly quarantined twice by public health authorities and died in quarantine. It is possible that she was born with the disease, as her mother had typhoid fever during her pregnancy.))

• **Active carrier**: individual exposed to and harbors a disease-causing organism.

• **Convalescent carrier** متماثل للشفاء: exposed to and harbors disease-causing organism (pathogen) and is in the recovery phase but is still infectious.

• **Healthy carrier**: exposed to and harbors pathogen, has not shown any symptoms.

• **Incubatory carrier**: exposed to and harbors a disease and is in the beginning stages of the disease, showing symptoms, and has the ability to transmit the disease.

• **Intermittent carrier**: exposed to & harbors disease & can intermittently spread the disease.

• **Passive carrier**: exposed to and harbors disease causing organism, but has no signs or symptoms (same as the healthy carrier).

**HEALTHY CARRIER = PASSIVE CARRIER.**

• These terms are not mutually exclusive and may overlap; therefore **an active carrier may also be a convalescent carrier, etc.**

- **Modes Disease Transmission:**

- methods by which an agent can be passed from one host to the next.

- or can exit the host to infect another susceptible host (either person or animal).

• **Two general modes: 1) direct 2) indirect**

1) **Direct transmission or person to person:**

• **Immediate transfer of agent from a reservoir to a susceptible host.**

• Can occur through direct contact such as touching contaminated hands, kissing or sex.

2) **Indirect transmission:** واسطة

• agents are **transferred by intermediate organism**, means or process to a susceptible host.

• **Ways:** ●airborne, ●waterborne, ●vehicleborne, ●vectorborne.

●Airborne (eg: **covid19**): Droplets or dust particles in air, by sneezing, coughing, talking.

●Waterborne (eg: **cholera**): in drinking water, swimming pool, streams or swimming lakes.

●Vehicleborne: Related to fomites

●Vectorborne:

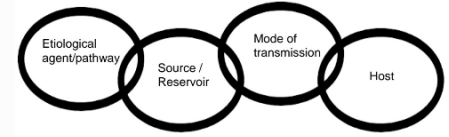
A) **Mechanical** transmission: when a pathogen uses a host (fly, flea, louse, or rat) as a mechanism for a ride or nourishment.

B) **Biological** transmission: when a pathogen undergoes changes as part of its life cycle, while it is in the host, before being transmitted to a new host. **Helps develop pathogen's**

## "invasiveness".

### - Chain of Transmission:

• Close association between the **triangle of epidemiology** and the **chain of transmission** (it's a continuous cycle)



• Disease transmission occurs when the pathogen or agent **leaves** the reservoir through a portal or exit and is **spread** by one of several modes of transmission.

• **Breaks in the chain of transmission will stop the spread of disease.**

• To engage in this chain of transmission, the pathogen must have both characteristics of **pathogenicity and invasiveness.**

### - Levels of Disease: (3 levels)

1) **Acute** relatively severe, of short duration and often treatable, usually the patient either recovers or dies.

2) **Subacute** intermediate in severity and duration, having some acute aspects to the disease but of longer duration and with a degree of severity that detracts from a complete state of health, patient expected to eventually heal.

3) **Chronic** less severe but of long & continuous duration, lasting over a long time, if not a lifetime, patient may not fully recover & the disease can get worse overtime.

• Life not immediately threatened, but may be over long term.

### - Immunity and Immunization:

• According to CDC, unless 80% or greater of population is vaccinated, epidemics can occur.

• 3 types of humans immunity:

1) **Acquired Immunity** obtained by having had a dose of a disease that stimulates the natural immune system OR artificially stimulating immune system (vaccine).

2) **Active Immunity** body produces its own antibodies, through a vaccine or in response to having a similar disease.

**No difference between active and acquired immunity, used interchangeably.**

3) **Passive Immunity** (natural passive) acquired through transplacental / breastfeeding transfer of a mother's immunity to diseases to the unborn child.

• Also when a person is given antibodies to a disease rather than producing them through his/her own immune system, this however is rare when we talk about global health issues.

(More common in communicable diseases, and smaller populations)

### - Outbreak Investigation: (10 steps)

1. establishing the **existence** of an outbreak.

2. preparing for **fieldwork.**

3. verifying the **diagnosis.**

4. **defining and identifying** cases.

5. using **descriptive** epidemiology.

6. developing **hypotheses.**

7. **evaluating the hypotheses.**

8. **refining the hypotheses.**

9. implementing **control** and **prevention** measures.

10. communicating **findings.**

