Major components of epidemiology:

1. **Population:** The main focus of epidemiology is on the effect of disease on the population rather than individuals. For example, malaria affects many people in Ethiopia but lung cancer is rare. If an individual develops lung cancer, it is likely that, he/she will die. Even though lung cancer is more killer, epidemiology gives more emphasis to malaria since it affects many people.
2. **Frequency:** This shows that epidemiology is mainly a quantitative science. Epidemiology is concerned with the frequency (occurrence) of diseases and other health related conditions. Frequency of diseases is measured by morbidity and mortality rates.
3. **Distribution:** Distribution refers to the geographical distribution of diseases, the distribution in time and distribution by types of persons affected.
4. **Determinants:** Determinants are factors which determine whether or not a person will get a disease.
5. **Health related conditions:** Epidemiology is concerned not only with diseases but also with other health related conditions because everything around us and what we do also affects our health. Health related conditions are conditions which directly or indirectly affect or influence health. These may be injuries, births, health related behaviors like smoking, unemployment, poverty etc.

Modern concept

b. **Vector borne:** In this type of transmission, the infectious agent is conveyed by an arthropod to a host. Vectors may be biological or mechanical.
    i. **Biological vector:** A vector is called biological if the agent multiples in the vector before transmission. Example: Anopheles mosquito is a biological vector for malaria.
    ii. **Mechanical vector:** A vector is called mechanical vector if the agent is directly infective to other hosts, without having to go through a period of multiplication or development in the vector. The vector simply carries the agent by its body parts (leg, proboscis etc.) to convey it to susceptible hosts. Example: Flies are mechanical vectors for the transmission of trachoma.
c. **Airborne:** It may occur by dust or droplet nuclei (direct residue or aerosols).
Example: Tuberculosis. When pulmonary tuberculosis patients cough, they emit many aerosols which consists the agents of tuberculosis. When these aerosols dry, droplet nuclei will be formed. These droplet nuclei will remain suspended in the air for some time. When another healthy susceptible individual breath, he/she will inhale the droplet nuclei and become infected with tuberculosis.

Portal of entry: It is the site where an infectious agent enters a susceptible host. Examples:

- Nasal mucosa is portal of entry for common cold.
- Conjunctiva is the portal of entry for trachoma.
- Injury site is portal of entry for tetanus.

Susceptible human host: The susceptible human host is the final link in the infectious process. Host susceptibility or resistance can be seen at individual and at the community level. Host resistance at the community level is called herd immunity. Herd immunity can be defined as the resistance of a population to the introduction and spread of an infectious agent, based on the immunity of a high proportion of individual members of the population, thereby lessening the likelihood of a person with a disease coming into contact with susceptibles. Example: If 90% of the children are vaccinated for measles, the remaining 10% of the children who are not vaccinated might not become infected with measles because most of the children (90%) are vaccinated. That means transmission from infected person to other susceptible children will not occur.

influences risk of subsequent disease. Other names of cohort study are Longitudinal study, Incidence study and forward study.

Examples:

Example	Exposure	Outcome
Smoking causes lung cancer	Smoking	Lung cancer
V. cholerae causes diarrhea	*V. cholerae*	Diarrhea
Salmonella causes diarrhea	Salmonella	Diarrhea
Rota virus causes diarrhea	Rota virus	Diarrhea

Other examples:

- The Framingham study
- Incidence of breast cancer and progesterone deficiency

Features of cohort studies:

1. Cohorts are identified prior to appearance of disease under investigation.
2. The study groups are observed over a period of time to determine the frequency of disease among them.
3. The study proceeds from effect to cause.

Indicators of cohort study:

1. When there is good evidence of exposure and disease.
2. When exposure is rare but incidence of disease is higher among exposed, e.g., special exposure groups like those in industries, exposure to radiation.
3. When follow up is easy, cohort is stable, co-operative and easily accessible.
4. When ample funds are available.

Types:

1. **Prospective cohort study:** It looks forward, looks to the future, examines future events, follows a condition and makes concern of disease into the future. Framingham study is an example of prospective cohort study.

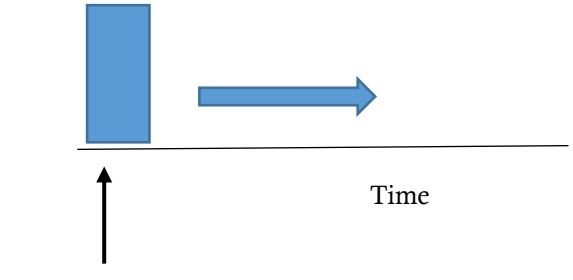

Fig: Prospective study

2. **Retrospective cohort study:** A retrospective cohort study is one in which the outcomes have all occurred before the start of investigation. Investigators goes back to the past to select study group from existing records of the past employment, medical or other records and traces them forward through time from the past date fixed on the records usually to the present. It is known with the name of Historical cohort and Noncurrent cohort.
   Example: Suppose that, we began our study on association between smoking habit and lung cancer in 2008. Now we find that an old roster of elementary schoolchildren from 1998 is available in our community and that they had been surveyed regarding their smoking habits in 1998. Using these data resources on 2008, we can begin to determine who in this population has developed lung cancer and who has not.

Field trials: Field trials, in contrast to randomized controlled trials, involve people who are healthy but presumed to be at risk. Data collection takes place in the field usually among non-institutionalized people in the general population. Field trials are logically complicated and expensive. They can be used to evaluate interventions at reducing exposure without necessarily measuring the occurrence of health effects.

Community trials: In this type of studies, the treatment groups are communities rather than individuals. Community trials are particularly appropriate for diseases that are influenced by social conditions and fro which prevention efforts target group behavior. Cardiovascular disease is a good example of a condition appropriate for community trials.

Limitations:

1. Only a small group of communities can be included and random allocation of communities is usually not practicable.
2. It is difficult to isolate the communities where intervention is taking place from general social changes that may be occurring.

Screening

Screening: Screening is a process of using tests on a large scale to identify the presence of disease in apparently healthy people.

Criteria:

1. Screening test do not usually establish a diagnosis.
2. Screening tests are done on people who have apparently no illness.
3. Screening test itself is very unlikely to cause harm.
4. Screening is also used to identify high exposure of risk factors.

Examples:

1. A skin test called the tuberculin or PPD test, for detecting tuberculosis.
2. The Beck Depression inventory for detecting depression.
3. The Pap smear test for cervical dysplasia or cervical cancer.
4. The fecal occult blood test for identifying possible signs of severe disorders such as colon cancer.
5. The mammogram for identifying the possible presence of breast cancer.
6. The prostate specific antigen (PSA) test for identifying the possible presence of prostate cancer.
7. Fasting blood cholesterol for heart disease.
8. Fasting blood sugar for diabetes.
9. Blood pressure for hypertension.
10. PKU for phenylketonuria in newborns.

WHO criteria for disease to be screened:

1. The condition should be an important health problem.
2. There should be a treatment for the condition.
3. Facilities for diagnosis and treatment should be available.
4. There should be a latent stage of the disease.
5. There should be a test or examination for the condition.
6. The test should be acceptable to the population.
7. The natural history of the disease should be adequately understood.
8. There should be an agreed policy on whom to treat.
9. The total cost of finding a case should be economically balanced in relation to medical expenditure as a whole.
10. Case finding should be a continuous process, not just a ‘once and for all’ project.

Wilson’s criteria for screening test:

1. The condition should be an important health problem.
2. The natural history of the condition should be understood.

Interpretation of relative risk or risk ratio (RR):

- RR = 1 suggests that, Risk in exposed is equal to risk in non-exposed.
- RR > 1 suggests that, Risk in exposed is greater than risk in non-exposed (positive association; possibly casual)
- RR < 1 suggests that, Risk in exposed is less than risk in non-exposed (negative association; possibly protective).

Interpretation of ODDs ratio

- OR = 1 suggests that, odds of exposure is the same for cases and controls (no association between disease and exposure).
- OR > 1 suggests that, odds of exposure among cases is greater than among controls (a positive association between disease and exposure)
- OR < 1 suggests that, odds of exposure among cases in less than among controls (a negative or positive association between disease and exposure).

Stating ODDs ratio results and Relative Risk (Risk Ratio) results:

OR = 5.44

Those with the disease are 5.44 times as likely to have had the exposure compared to those without the disease.

RR = 4.41

Those with the exposure are 4.41 times as likely to develop the disease compared to those without the exposure.

10. Steps in Epidemic Investigation

Diseases occur in a community at different levels at a particular point in time. Some diseases are usually present at a predictable level. This is called the expected level. But sometimes they occur in excess of what is unexpected. The examples of expected level are endemic and hyper endemic (Hyper endemic means persistently high level of disease occurrence). When the disease occur as epidemic, outbreak and pandemic, it is considered as excess of what is expected.

Types of epidemics: Epidemics (outbreaks) can be classified according to the method of spread or propagation, nature and length of exposure to the infectious agent and duration.

1. **Common source epidemics:** Disease occurs as a result of exposure of a group of susceptible persons to a common source of a pathogen, often at the same time or within a brief time period. When the exposure is simultaneous, the resulting cases develop within one incubation period of the disease and this is called a point source epidemic. The epidemic curve in a point source epidemic will commonly show a sharp rise and fall. Food borne epidemic following an event where the food was served to many people is a good example of point source epidemic. If the exposure to a common source continues over time it will result in a continuous common source epidemic. A waterborne outbreak that spreads through a contaminated community water supply is an example of a common source epidemic with continuous exposure. The epidemic curve may have a wide peak because of the range of exposures and the range of incubation periods.

2. **Propagated or progressive epidemics:** The infectious agent is transferred from one host to another. It can occur through direct person to person transmission or it can involve more complex cycles in which the agent must pass through a vector as in malaria. Propagated spread usually results in an epidemic curve with a relatively gentle upslope and somewhat steeper tail. An outbreak of malaria is a good example of propagated epidemic.

   When it is difficult to differentiate the two types of epidemics by the epidemic curve, spot map (studying the geographic distribution) can help.

3. **Mixed epidemics:** The epidemic begins with a single, common source of an infectious agent with subsequent propagated spread. Many food-borne pathogens result in mixed epidemics.

Investigation of an Epidemic

The purpose is to determine the specific cause or causes of the outbreak at the earliest time and to take appropriate measure directed at controlling the epidemic and preventing future occurrences. The following questions should be answered when investigating an epidemic:

- What is the etiological agent responsible for the epidemic?
- What is/are the predominant modes of transmission?
- What specific source(s) of disease can be identified? Examples: Human carriers, breeding sites for vectors etc.
- What specific practices or environmental deficiencies have contributed to the outbreak? Examples: Improper food handling, human made breeding sites for mosquitoes.
- What is the chain of events that led to the outbreak? Example: Accumulation of susceptible hosts in an area.

Uncovering outbreaks: Outbreaks are detected in one of the following ways:

1. Through timely analysis of routine surveillance data.

2. Report from clinician.
3. Report from the community, either from the affected group or concerned citizen.

Steps in epidemic investigation

There is no fixed step in the investigation of epidemics but the following step can be considered as one option.

1. **Prepare for fieldwork:** Before leaving for the field, one should be well prepared to undertake the investigation. Preparation can include –
    - Investigation must have the appropriate scientific knowledge, supplies and equipment to carry out the investigation. It might be difficult for the health extension worker to fully investigate the epidemic. Hence, he/she should inform and involve other high level health professionals from the outset.
    - Collect sample questionnaire.
    - Arrange transportation and organize personnel matters.

2. **Verify (confirm) the existence of an epidemic:** This initial determination is often made on the basis of available data. One has to compare the number of cases with the past levels to identify whether the present occurrence is in excess of its usual frequency. Instead of comparing absolute numbers, it is advisable to compare rates like incidence rate.

3. **Verify (confirm the diagnosis):** One has to always consider whether the initial reports are correct. One has to carry out clinical and laboratory investigations on the reported cases. For example, the already collected blood film slides can be seen by laboratory experts to check whether the initial report was correct. It is important to investigate the index case (the first case that comes to the attention of health authorities) and other early cases. The importance of the index case and other early cases for diseases that are known to occur in epidemic form, such as relapsing fever, is an indication to health authorities of the possible start of an outbreak. The sooner the index case and other early cases are investigated, the greater the opportunity to arrest outbreak at stage possible.

4. **Identify and count cases:** One has to prepare case definition before starting identification of cases. Case definition is defined as a standard set of criteria to differentiate between cases and non-cases.

5. **Describe the epidemic with respect to person, place and time:** Each case must be defined according to standard epidemic parameters: the date of onset of the illness, the place where the person lives or become ill and the sociodemographic characteristics (age, sex, education level, occupation).

6. **Identify the causes of the epidemic:** All factors that can contribute to the occurrence of the epidemic should be assessed. The epidemic investigating team should try to answer questions like:

    - Why did this epidemic occur?
    - Are there many susceptible individuals?
    - Is the temperature favorable for the transmission of the disease?
    - Are there breeding sites for the breeding of vectors?

7. **Management of epidemic and follow up:** Although it is discussed late, investigation must start as soon as possible depending on the specific circumstances. One might aim control measures at the specific agent, source or reservoir. For example, an outbreak might be controlled by destroying contaminated foods, disinfecting contaminated water, destroying mosquito breeding sites or an infectious food handler could be suspended from the job and treated.