

EPIDEMIOLOGY

Introduction

Epidemiology is the basic science of preventive and social medicine.

The term epidemiology is derived from three Greek words :-

- (i) Epi – among
- (ii) Demos – people, and
- (iii) Logos – study

Epidemiology means the study of disease in the human population.

Definitions

Acc. to **Parkin** (1873): Epidemiology is "that branch of medical science which treats of epidemics."

Epidemiology has been defined by **John M. Last** in 1988 as, "The study of the distribution and determinants of health related states or events in specified populations, and the application of this study to the control of health problems."

Acc. to **Lilienfeld** (1980), "Epidemiology is the study of the distribution of a disease or a physiological condition in the human population and of the factors that influence this distribution."

The historical developments in the field of epidemiology and the changing trend in conceptual aspects of epidemiology reveal its wide range of scope. It is now concerned with all health related states, events and illness in population groups and with factors, including health services that affect them.

The Modern epidemiology deals with:- measurements of occurrence of health related states or events which include diseases, disabilities, death etc; study of frequency and distribution disease pattern, study determinants of health related states and events; and planning of health care services.

Purposes of Epidemiology

- To prevent, control and eradicate health related problems.
- To reduce / minimize the impact of these problems.
- To promote health and quality of life of people at large.

Aims of Epidemiology

- To describe the distribution and size of disease problems in human populations.
- To identify the etiological factors in the pathogenesis of disease.
- To provide the data essential in planning, implementation and evaluation of services for the prevention, control and treatment of disease and setting up priorities among those services.

The ultimate aim of epidemiology is ->

- to eliminate or reduce the health problem or its consequences.
- to improve medical care and provide administrative guidance for community health services.
- to promote the health and well being of society as a whole.

Epidemiological Methods / Types

1. Observational Studies

△ Descriptive Studies

- Time
- Place
- Person

△ Analytical Studies

- Cross-sectional study
- Case control study
- Cohort studies
 - Prospective
 - Retrospective
 - Combination of prospective and retrospective cohort study

2. Experimental Studies

△ Randomized Controlled Trials (RCTs)

- Clinical trials
- Preventive trials
- Cessation experiments
- Risk factor trials

△ Non-Randomized Trials

- Community trials
- Natural experiments

OBSERVATIONAL STUDIES

Observational Studies allow nature to take its own course. The investigator observes and measures the outcome without intervening i.e., without applying or withdrawing any suspected causative factors or variables.

These studies are broadly divided into two categories :-

- **Descriptive Studies**
- **Analytical Studies**

➤ **Descriptive Studies**

Descriptive studies are the first step in epidemiological investigations. They provide data about the distribution and frequency of disease or health-related states of the population.

They answer the following core questions:

- When is the disease occurring? – Time distribution
- Where is it occurring? – Place distribution
- Who is getting the disease? – Person distribution

There are various procedures in descriptive studies which are listed below:-

- Defining the population to be studied.
- Defining the disease under study.
- Describing the disease by time, person, and place.
- Measurement of disease.
- Comparing with known studies.
- Formulation of an etiological hypothesis.

(a) **Time** distribution is divided into three types of fluctuations:

- Short-term fluctuation
- Periodic fluctuation
- Long-term fluctuation

△ **Short-term fluctuation**: This refers to the occurrence of a disease in an epidemic form.

△ **Periodic fluctuation**: This refers to seasonal variation in the occurrence of a disease. E.g., Many communicable diseases like measles, upper-respiratory infections, malaria, etc. Measles occur usually in early spring, whereas upper respiratory infections show a rise in winter months.

△ **Long-Term Fluctuations**: This refers to changes in the occurrence of diseases over a long period of time, generally many years or decades. It implies a definitive upward or downward movement in the occurrence of some diseases.

- Diabetes mellitus, coronary heart diseases are showing an upward trend.
- Typhoid fever, diphtheria and polio are showing a downward trend.

(b) **Person**: Describe the occurrence of disease by person according to age, sex, occupation, marital status, habits, social class, ethnicity, behavior, stress, migration etc.

Age:

Old age - Atherosclerosis
Middle age - Cancer
Childhood - Measles

Sex: Certain chronic diseases are more common in women than in men, such as [diabetes, hyperthyroidism, and obesity]. [Lung cancer and coronary heart diseases] are more common in men than in women.

Occupation: Different occupations are related to different diseases such as a person working in coal mines have silicosis occurring commonly, and farmers working in fields have farmer's lung disease.

(c) **Place**: Disease is described in terms of geography. Disease distribution differs within countries and between countries.

These differences may be classified as :-

- **International differences**: e.g., Cancer of cervix and of oral cavity are common in India.
- **National**: *Endemic goiter*, leprosy, malaria and guinea worm disease have shown variation in India.
- **Rural-urban diff**:
❖ Cardiovascular diseases, mental illness and drug abuse are more common in urban areas.

- ❖ Skin diseases and worm infestations are more common in rural areas.
- **Local distribution:** Disease distribution may vary within the inner part and the outer part of the city. Infected sources of water may cause an outbreak of cholera and other water-borne diseases.

Cross-Sectional Studies

- Also known as prevalence study.
- Prevalence measured by conducting a survey of the population of interest.
- Useful for:
 - ❖ program planning
 - ❖ resource allocation
 - ❖ generate hypothesis
- Describe association between exposure and disease prevalence.
- Cross-sectional is the collection of data for more than one case at one moment in time.
- Incross-sectional studies :- Individuals are classified as diseased and disease free andexposed and not exposed to the risk factor at single point of time.
- Helpsto know:
 - ❖ prevalence rate
 - ❖ riskfactors
- Itprovides association not causation.

Population :- (a). Exposed
(b). Not exposed

Exposed

- Do not develop the disease (Estimate exposure and outcome at one point of time)
- Develop the disease

Not exposed

- Do not develop the disease
- Develop the disease

Cross-Sectional Studies

Advantages

- Less time consuming than case control or cohort studies.

- Inexpensive.
- Good, quick picture of prevalence of exposure and prevalence of outcome.

Disadvantages

- Difficult to determine temporal relationship between exposure and outcome (lack time element).
- Not suitable for rare diseases.
- Unable to measure incidence.

Analytical Studies

- Used to help to identify the cause of disease.
- Typically involves designing a test of hypotheses developed using descriptive epidemiology.
- A method for testing a hypothesis as part of an investigation of the association between a disease and possible cause of that disease.
- Describe association between exposure and outcome.
Risk factor -----> Disease

Types

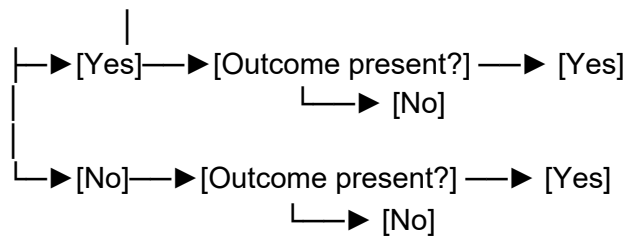
- A. Cohort Studies
- B. Case-Control Studies

[A] Cohort Studies

- A cohort study typically examines multiple health effects of an exposure; subjects are defined according to their exposure level and followed over time for outcome occurrence.
- Also known as prospective study, longitudinal study, incidence study and forward looking study.
- The rates of disease incidence among the exposed and unexposed groups are determined and compared.
- Measure of association "relative risk".

Study Design Timeline **Flowchart**

[Study participant] —> [Risk factor present?]

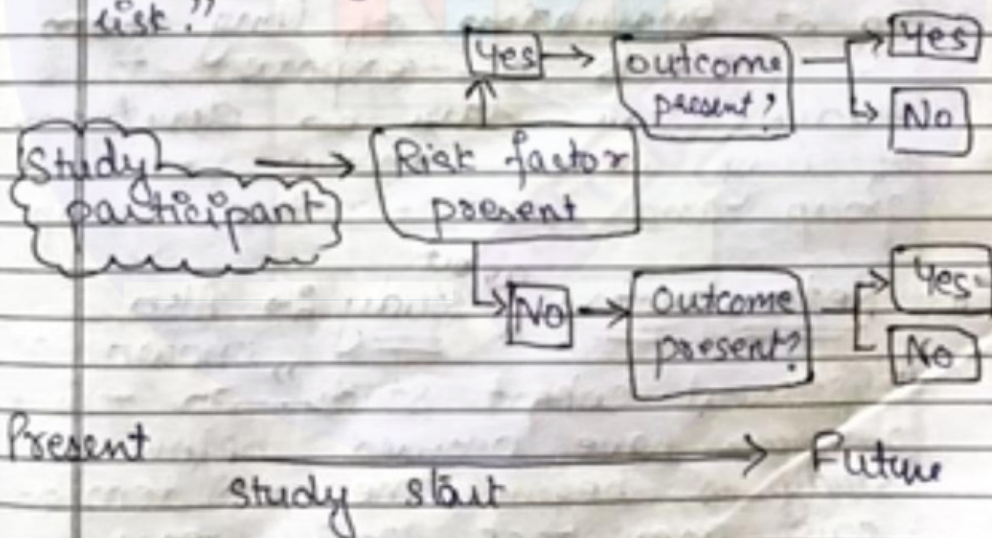


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Types of Cohort Studies

The study design branches into three types:

- Prospective cohort study
- Retrospective cohort study
- Combination of prospective and retrospective cohort study

△ Prospective Cohort

This type of study is one in which the disease has not yet occurred at the time study begins. The study begins in the present and continues in the future to see the effects of some factor on the outcome.

Eg: evaluation of long term effects of exposure to radioactive rays on development of lung cancer among exposed group and not exposed group.

△ Retrospective Cohort Study

Also known as "Historical cohort study."

In this study, outcomes have occurred before the study is begun.

The epidemiologist goes back 10–30 years to select his study subjects from the existing records medical, employment or others and goes forward to trace them, usually up to the present.

Eg: A study of the role of arsenic in human carcinogenesis.

Retrospective studies are usually more economical and produce results earlier than the prospective cohort studies.

△ Combination of Retrospective and Prospective Cohort Studies

Such study combines the features of retrospective as well as prospective cohort studies. A cohort of patients having received exposure to some putative etiological factor can be evaluated for outcome of disease or death in the past 10–20 years and the cohort may be followed in the future to observe disease or death occurring in the coming years.

The Advantages and Disadvantages of Cohort Studies:

Advantages

- Can evaluate multiple effects of a single exposure.
- More efficient for rare exposures and outcomes with long induction and latency periods.
- Can directly measure incidence.

- Clear chronological relationship between exposure and outcome.

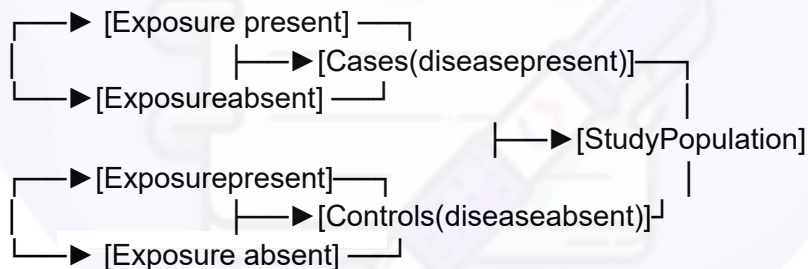
Disadvantages

- Expensive
- Time-consuming
- Inefficient for rare diseases with long latency.
- Loss to follow up.

[B] Case Control Studies

- Examines multiple exposures in relation to an outcome; subjects are defined as cases and controls, and exposure histories are compared.
- First, identify the cases and the controls. Then, look back in time to learn which subjects in each group had the exposure.
- Efficient for rare diseases.
- Measure of association "odds ratio".

Study Design Timeline **Flowchart**

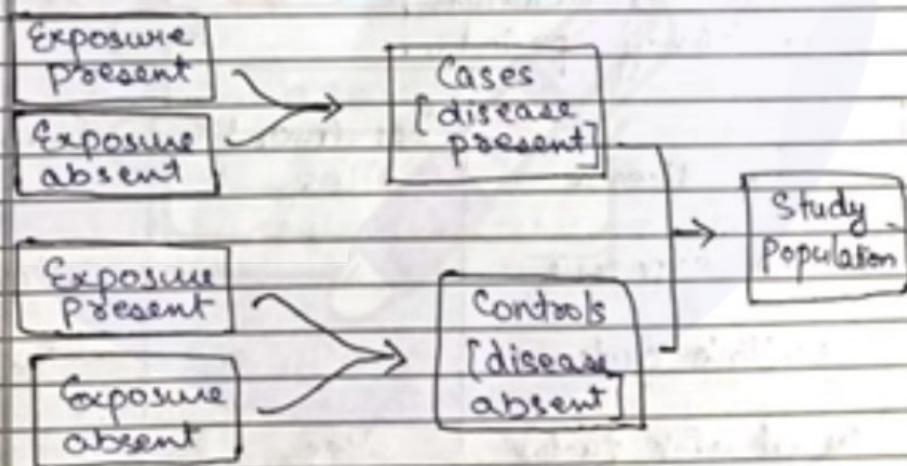


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[B] Case Control Studies

→ Examines multiple exposures in relation to an outcome; subjects are defined as cases and controls, and exposures histories are compared.

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- Efficient for rare diseases.
- Measure of association "odds ratio".



Time
Past ← Present
study begins

Case Control Studies Comparison

Advantages

- Relatively inexpensive.
- Less time consuming than cohort studies
- Can evaluate effects of multiple exposures.
- Efficient for rare outcomes or outcomes with long induction or latency periods.

Disadvantage

- Subject to recall bias (based on subjects memory and reports).
- Inefficient for rare exposures (such as difficult to establish clear chronology of exposure and outcome).

Study Design Selection Table

Feature / Scenario Case Control Cohort

Rare disease Yes

Rare exposure ☐ Yes

Multiple outcome ☐ Yes

Several risk factors ☐ Yes

Dose-response relation ☐ Disease with Yes

long latent period ☐ Yes

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Case Control Studies

DATE: / /
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Advantages

- Relatively inexpensive
- less-time consuming than Cohort Studies.
- Can evaluate effects of multiple exposures.
- Efficient for rare outcomes or outcomes with long induction or latency periods.

Disadvantages

- Subject to recall bias [based on subjects memory and reports].
- Inefficient for rare exposures [such as difficult to establish clear chronology of exposure and outcome].

	Case control	Cohort
Rare disease	Yes	
Rare exposure		Yes
Multiple outcome		Yes
Several risk factor	Yes	
Dose-response relation		Yes
Disease with long latent period	Yes	

(iii) Experimental Studies

(Also known as intervention studies).

- Best study design to prove causation.
- Experimental epidemiology employs methods in which intervention or manipulation of some cause or variable in the causative factors is done in the experimental group, while no change is made in the control group and an effect in outcome is observed in both the groups.
- The experimental study differs from the observational studies, where no intervention is made & only the results or outcome of events are observed as they occur naturally.

Aims

- To provide scientific proof of etiological factors.
- To provide a method of measuring the effectiveness and efficiency of health services.

Types of Experimental Studies

The study design branches into two categories:

- Randomized Controlled trials
- Non-randomized (or non-experimental) trials

(i) Randomized Controlled trials

- RCT are those studies which involve random assignment of study subjects into experimental and control groups to avoid bias and to assure comparability of the groups.
- Experimental group receives or does not receive the treatment or intervention whose effect is studied on the outcome.

Base Steps

- (a) Drawing up a protocol.
- (b) Selecting reference and experimental population.
- (c) Randomization.
- (d) Manipulation or intervention.

(e) Follow-up.

(f) Assessment of outcome.

Types of RCT

(i) **Clinical Trials** : These are conducted to evaluate the effects of therapeutic agents like drugs or a surgical procedure in reducing mortality or morbidity.

(ii) **Preventive trials** :- These are conducted to evaluate the effects of some primary prevention measure in prevention of a particular disease in the community.

(iii) **Risk factor trials** :- These are concerned with modification of a risk factor which is associated with development of a particular disease.

(iv) **Cessation experiments** :- These are concerned with evaluating the effects of removal of a suspected factor.

Eg: Cessation of smoking on reduction of lung cancer.

(v) **Trial of etiological agents** :- This is concerned with testing the effect of an etiological agent suspected to be associated with a disease.

(vi) **Evaluation of health services** :- These trials are concerned with assessing the effect of health services on the promotion of community health, reduction in morbidity or treatment of disease in the community.

(ii) Non Randomized or non experimental trails or studies

Experimental studies are not always possible due to ethical, administrative and other reasons, so non-randomized trails are resorted to sentences.

Non-randomized or non-experimental studies have been conducted usefully in the field of public health and preventive medicine.

Types of non-RCT or non-ES [Experimental Studies]

The study design branches into three types:

- Uncontrolled trails
- Natural exp- [exp-] -eriments
- Before and after comparison studies

(i) Uncontrolled Trails

These are trails with no comparison groups.

Eg: Uncontrolled studies of cervical cancer screening showing that Pap test is effective reducing mortality from cervical cancer.

(ii) **Natural Experiments** :- In these, the epidemiologist takes the advantage of a natural circumstance which mimics an experiment to see the effect of some factor on outcome. Eg:- effect of stress among earthquake survivors on cardiovascular morbidity and mortality.

(iii) **Types of Before and after comparison studies**

- Before and after comparison studies without control.
- Before and after comparison studies with control.

Before and after comparison studies without control :- In these studies, the incidence of disease before and after introduction of the experimental variable or treatment variable is compared. The experiment serves as its own control.

Before and after comparison studies with control :- In these studies, a natural group is utilized, i.e., the one provided by nature. The treatment variable Eg :- preventive measure is applied to one community, whereas it is not applied to another community which is similar to the first community where treatment is applied.

