UNIT 9 INTRODUCTION TO EPIDEMIOLOGY

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9.1 INTRODUCTION

In the Greek language, 'epi' means **on** or **upon** or **over**, 'demo' means **people** and 'logy' means the **study of**. Thus 'epidemiology' as a word means the study on/of people. For example, 'Framingham Heart Study' and 'Nurses Health Study' are well known epidemiological studies.

To learn a subject it is a good practice to first go through its historical development (origin). So, Sec. 9.2 is devoted to this purpose. Secondly, we should know the definition of epidemiology. Definition of epidemiology and explanation of the terms involved in its definition are given in Sec. 9.3. After that the distinction between descriptive and analytic epidemiology is discussed in Sec. 9.4. An important concept of causation and causal inference in epidemiology is discussed in Sec. 9.5. Then the natural history of a disease and levels of a disease prevention are discussed in Sec. 9.6 and Sec. 9.7, respectively. Some of the uses of epidemiology are listed in Sec. 9.8. A brief summary of what we have covered in this unit is given in Sec. 9.9. Solutions/Answers of the exercises are provided in Sec. 9.10. The unit ends by providing the meanings of some keywords in Sec. 10.11.

Objectives

After studying this unit, you should be able to:

- define epidemiology and describe uses of epidemiology;
- explain the difference between descriptive and analytic epidemiology;
- explain what we mean by the natural history of a disease and different levels of prevention of a disease;
- build an idea of causation and causal inference in epidemiology; and

9.2 BRIEF HISTORICAL OVERVIEW OF EPIDEMIOLOGY

When we try to search out the origin of epidemiology through different books on epidemiology or web, we find that approximately 2500 years ago epidemiological thinking first develop in the work of Hippocrates. A brief overview of the contribution made by some of the great people to develop epidemiological thinking is highlighted as follows:

Contribution by Hippocrates (460-377 BC)

The credit of first developing the basic epidemiological thinking goes to Hippocrates. In his treatise "**Airs, Waters, and Places**", he suggested some characteristics of the environment as well as of the people which may be responsible for the development of disease. About the three words, **air**, **water** and **places** involved in the title, he advised,

"whoever wishes to investigate medicine properly" should take into account the role of air, water and places. Here he also advised to take into account the role of individual habits. What he said is quoted within inverted commas:

- **Air** ("the hot and the cold");
- **Water** ("marshy and soft, or hard, and running from elevated and rocky situations, and then if saltish and unfit for cooking");
- **Places** ("naked and deficient in water, or wooded and well watered, and whether it lies in a hollow, confined situation, or is elevated and cold");
- **Individual Habits** ("whether they are fond of drinking and eating to excess, and given to indolence, or are fond of exercise and labour, and not given to excess in eating and drinking").

Today we know that most of the diseases have directly or indirectly related to these factors. So what Hippocrates suggested approximately 2500 years ago on the basis of his observation seems rational rather than written from a supernatural view point.

So, the focus of Hippocrates was on environmental and behavioural issues that might be associated with disease.

Contribution by John Graunt (1620-1674)

John Graunt who is known as one of the first demographers, studied the weekly reports known as Bills of Mortality. Using these data, he:

- compared the mortality rates between males and females and found that mortality among men is higher than among women.
- also reported age specific mortality.
- noticed the seasonal fluctuation in mortality and so reported seasonal mortality trends.
- also looked at the causes of deaths, causes of disease and quantified patterns of death and disease occurrence in London, etc.

Contribution by James Lind (1716-1794)

James Lind also made several contributions in the development of epidemiology. Perhaps, he was the first person, who conducted an experimental study. He was a Naval Surgeon. In 1747, he conducted an experiment on the 12

sailors, all of them were suffering from scurvy (see margin remark). He divided the 12 sailors into six groups, each containing two sailors, and decided that all the six groups would get something additional to their common diet. The additional things given to the six groups were:

- Quart of cider
- Sea water
- Vinegar
- Sulfuric acid
- A spicy paste made of mustard
- Two oranges and one lemon

Scurvy is a disease which occurs due to a deficiency of vitamin C. It is known today, but at that time it was not known.

Then he followed them for some days. The group getting two oranges and one lemon along with the common diet experienced a remarkable recovery and one of them was fit for duty just in six days. Note that, in this study, it was James Lind, who decided the groups of the participants not the participants themselves. Remember this point, because this is the **key feature** which distinguishes between **experimental** and **non-experimental** studies defined in Sec. 11.3 of Unit 11 of this block.

Contribution by William Farr (1807-1883) and John Snow (1813-1858)

William Farr was the statistical superintendent of the General Registrar office for England and Wales. So he was responsible for the collection of health related data, analysis of the collected data, and publication of the information about the mortality figures, causes of mortality and medical data to indicate the health situation of that time and to make recommendations for improvement of public health. William Farr created a lot of awareness in his time through his reports. He:

- analysed Britain's vital statistics and developed many measures of vital statistics, which are used even today.
- categorised the mortality figures with respect to sex, age, occupations, etc.

His reports were helping the people involved in health planning and other policy makers. He also did a lot of work in classification of the disease and possible factors associated in development of the disease. One such report published in 1800's related to cholera outbreak in London. In his weekly reports on cholera, he provided many details, including age and sex of the individuals who died from cholera, temperatures of the days on which they died, the day of the week, elevation, crowding, amount of rainfall, wind, etc. When, he was reporting these details, the actual factors responsible for cholera were unknown during those days. So he was providing these details to find out the causes of cholera. You might have noted that some of these factors were also suggested by Hippocrates. And this approach for searching out the causes/risk factors of a disease indicates the epidemiological thinking in the mind of William Farr. William Farr was reporting what he observed through data. In those days, it was believed that it was polluted air, which was causing cholera. And the data reported by Farr also supported this belief because the rate of mortality was higher in low elevations compared to higher elevations since air is more polluted in low elevation compared to higher elevation.

John Snow was also living in London and being a physician, an anesthesiologist, he was caring the patients suffering from cholera and so he was familiar with the signs and symptoms of patients suffering from cholera.

He had also the information that patients were complaining of belly pains and being a physician, he also knew something about gastrology. On the basis of all this information he knew that the cause of cholera is polluted water not the polluted air. He also showed it through the data reported by William Farr himself. He compared the number of deaths in the areas where water was supplied from polluted areas of the Thames River and from less polluted areas. William Farr was himself convinced by the opinion of John Snow. John Snow did another landmark study of cholera outbreak in 1854 in Soho district near London. First of all, he noted the places of cholera cases and then he searched out the sources of the water in these areas. He found that the main source of water was a pump near the polluted area of the Thames River. He suggested to the officials to remove the handle of that pump. On his recommendation the handle of the pump was removed and the problem of cholera was resolved. William Farr and John Snow made lots of contributions in the development of epidemiological thinking and development of some methods in this direction, all of which cannot be discussed here. But before ending this section, let us make you aware about some other well known persons in the field of epidemiology to name a few: Girolamo Fracastoro (1478-1553), Percivall Pott (1714-1788), Edward Jenner (1749-1823), Sir Edwin Chadwick (1800-1890), W.H. Frost (1880-1938), Austin Bradford Hill (1897-1991), Richard Doll (1912-2005), etc.

Now, you can try the following exercises.

E1) What was the main contribution of James Lind in the history of epidemiology?

(A) He did a lot of work during the cholera outbreak of 1854.

(B) He conducted an experimental study on sailors suffering from scurvy disease.

(C) He wrote a book on the Bills of Mortality.

(D) He focused on environmental and behavioural issues to search out the causes of disease.

E2) What is true about the contribution of Hippocrates in the history of epidemiology?

(A) He focused on environmental and behavioural issues to search out the causes of a disease.

(B) His point of view on the observations of the diseases was more rational rather than supernatural.

(C) He wrote a book entitled “Airs, Waters, and Places”.

(D) All the above.

E3) What is true about the contribution of John Snow in the history of epidemiology?

(A) He did a lot of work during the cholera outbreak of 1854.

(B) He showed that cause of cholera was the polluted water not the polluted air.

(C) He identified a pump which was the source of polluted water and handle of the pump was removed by the authority.

(D) All the above.

So far, you have become familiar with the historical development of epidemiology and how it evolved over time. In the next section we shall give definition of epidemiology.

9.3 DEFINITION OF EPIDEMIOLOGY

From the discussion of Sec. 9.2, you got some idea about how epidemiological thinking developed and evolved over time. This section is devoted to a definition of epidemiology. But before going towards the definition of epidemiology, first, we have to be clear about the meaning of some key words involved in the definition. These key words are:

- Study
- Frequency
- Distribution
- Determinants
- Health related states
- Specified population
- Control
- Application

What an epidemiologist means by these words, which are used in defining the epidemiology are explained one at a time as follows:

Study

By the term **study** in epidemiology or epidemiological study, we mean collection of data regarding a disease or any other health related outcome of our interest, analysis of the collected data by applying appropriate statistical technique(s), and finally interpretation of the finding(s) of the study to communicate the message to the population so that awareness can be created in the population. Generally, we compare the exposure (e.g., smoking) and outcome (e.g., lung cancer) status of the two groups (e.g., smokers and non-smokers) in epidemiological studies. The two groups that we compare may be formed on the basis of:

- sex (male versus female)
- age (younger versus older)
- place (two different geographical locations)
- time (a period of time when disease is common versus the time when disease is not common), etc.

You will study some of such examples in Unit 11. In epidemiological studies, we use lots of concepts, methods and techniques of other disciplines such as biology, statistics, behavioural sciences, etc.

Frequency

Frequency may refer either to the number of counts of new cases or existing cases, at a point in time, of a disease or any other health related outcome of interest in the population under study or in the groups that we are going to compare. When frequency refers to only new cases, then we use measures of outcomes as the cumulative incidence or incidence rate, this is discussed in

detail in the next unit. When frequency refers to existing cases, at a point in time, then we use prevalence as the measure of outcome, this is also discussed in detail in the next unit.

Distribution

From epidemiological point of view, distribution means how the frequency of a disease or any other health related outcome of our interest is distributed in a population under study or in different groups or what are the patterns of the disease frequency due to time, place and person. What we mean by "due to time, place and person" are explained as follows:

Time: The time of variation in frequency or pattern of a disease may be a day, week, month, season, year, decade or any other breakdown of time. In the next section, you will see that epidemiology provides the answer of 5 W's (Who, Where, When, What and Why) and one H (How) related to a disease/health outcome. Out of these 5 W's **when** represents time. For example, when are they getting this disease/health outcome?

Place: By place distribution, we mean the variation in the occurrence of disease frequency with respect to geographical locations such as one village versus another village, one block versus another block, one district versus another district, one state versus another state, one country versus another country, rural versus urban, etc. Out of the above 5 W's **where** represents place. For example, where are they getting this disease/health outcome?

Person: The distribution of disease frequency or pattern of disease frequency or any other health related outcome in a population under study may also vary according to personal characteristics such as age, sex, marital status, race, occupation, immunity status, socio-economic status, etc. Out of the above 5 W's **who** represents a person. For example, who is getting this disease/health outcome?

Determinants

Determinants in epidemiology refer to those risk factors which are either necessary for development of a disease or increases the chances of developing the disease. For example, smoking, occupation, dust, lack of iodine, climate, temperature, crowding, water, air pollution, etc., are risk factors for many diseases. In epidemiology, determinants are categorised as 'Host Determinants', 'Agent Determinants', and 'Environment Determinants'. These are discussed in Sec. 9.5 of this unit in detail.

Health Related States

By health related states, we mean all health related outcomes for which epidemiological studies can be done to search out causes responsible for these outcomes. For example, causes of death, disease, birth defects, disabilities, injuries, etc.

Specific Population

Epidemiological studies are carried out on the groups of people rather than individuals and the ultimate goal of epidemiological studies is to convey a health related message to the whole human population. Thus, human population always remains in the back of mind of epidemiologists while conducting a study. But most of the studies are carried out to identify certain

risk factors for a disease under study. For this purpose, first of all we identify target population from human population, then we identify a subset of this target population which is known as study population.Finally, we draw a random sample from this study population which form study participants. All this is shown in Fig. 9.1 and defined as follows:

Target Population: Population about which inferences are to be drawn from the study is known as the target population.

Study Population: A subset of the target population from which study participants are selected is known as the study population.

Sample: A group of subjects drawn from the study population, which provide data to the study to estimate the population parameters is known as sample.

For example, suppose we are planning for a screening programme (see margin remark) for the breast cancer then all women will form the target population and all women in the age group 50-69 years will form the study population because more cases of breast cancer lie in this age group and so the sample of the study population will come from the women of age between 50-69 years.

screening programme means giving a screening test to a specific population with a goal to identify the disease in an early stage when treatment is more effective or less expensive or both, you will get all these details in Unit 12 of this course. For example, RT-PCR test for COVID-19.

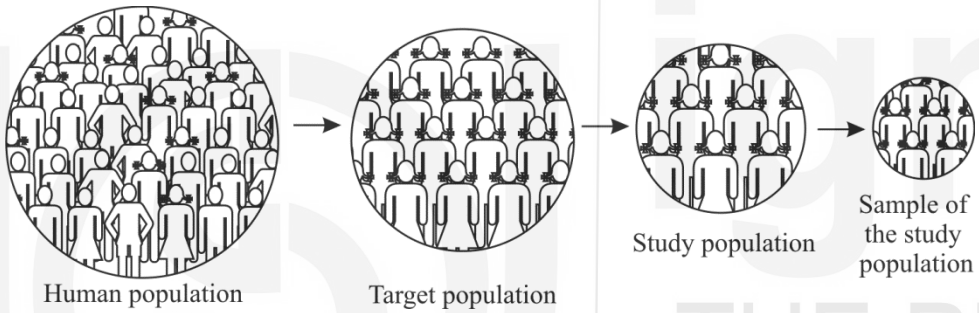


Fig. 9.1: Connection between target population, study population and sample.

Control

To treat a patient, as a doctor does in a hospital, is not in the domain of an epidemiologist. But epidemiologists help in controlling the disease in the population in two ways:

i) To create the awareness in the population about risk factors through the findings of their studies.

ii) By conducting screening program in the population.

Application

Epidemiological studies are not simply studies of diseases or any other health related outcome, but these studies have direct application in the clinical medicine practices. Knowledge gained from epidemiological studies helps the clinical medicine practitioners to adopt proper treatment of disease. Also the findings of epidemiological studies create awareness among the population about the possible risk factors of a disease and it helps people to take necessary precautions and contributes towards the health of the whole population. The screening programme (e.g. RT-PCR test camps organised by different governments in different countries) also helps in early identification of a disease, so that treatment may be more effective or less expensive or both and consequently improve survival period.

Now, you are in a position to understand the definition of epidemiology given as follows:

Definition of Epidemiology: It is a "study of the distribution and determinants of health related states or events in specified population and application of this study to control health problems".

Now, you can try the following exercises.

E4) Epidemiology is the study of

(A) Only the distribution of disease.

(B) Only the determinants of disease.

(C) Both the distribution and determinants of disease.

E5) Classify the following characteristics as a person (A), place (B), Time (C)

1. Season
2. Years
3. Place of residence
4. Place of birth
5. Gender
6. Socio-economic status
7. Age

E6) Which one of the following is the definition of epidemiology?

(A) Study of the distribution and determinants of health related states in individuals

(B) Study of the distribution and determinants of health related states in people

(C) Study of the distribution and determinants of health related states in communities

(D) Study of the distribution and determinants of health related states in populations.

E7) In the definition of epidemiology "distribution" refers to: (choose all which are correct)

(A) When (B) Where (C) Who (D) Why

We have defined epidemiology. Now whenever you refer an already conducted epidemiology study, you will see that there may or may not be a comparision group. On the basis of whether there is a comparision group or not epidemiological studies are broadly classified as analytic and descriptive epidemiological studies which are discussed in the next section.

9.4 DESCRIPTIVE AND ANALYTIC EPIDEMIOLOGY

In this section, first of all we shall define three terms: endemic, epidemic and pandemic, and then we discremenate between the descriptive and analytic epidemiology.

Endemic: If a particular disease more or less remains at a constant level in a particular location or region or population then it is known as baseline or endemic level of the disease.

Epidemic: When the number of cases of a particular disease crosses its baseline or endemic level and rapidly spreads in much larger area (may be in the whole country through a small region of the country) then in such a case we use the word epidemic for the disease.

Pandemic: When an epidemic goes beyond national borders and spreads word-wide it is known as pandemic disease. For example, AIDS, swine flu, COVID-19, etc.

On the basis of the role of an investigator, epidemiological studies can be classified into two main categories namely experimental and non-experimental studies. In **experimental studies,** the investigator **himself/herself decides** the **groups** of **participants** while in **non-experimental studies participants themselves decide their groups**. For example, the study done by James Lind on 12 patients (already discussed in Sec. 9.2) all suffering from the disease scurvy, is an example of an experimental study (since in this study groups of the sailors were decided by James Lind not by the sailors themselves).

In Unit 11 of this block you will study about some non-experimental studies. Non-experimental studies are also known as observational studies. On the basis of whether our epidemiological study involves a comparison group or not, observational studies can be further classified as analytic epidemiological study if comparison group is there and descriptive epidemiological study if there is no comparison group. This classification and other classification of some common epidemiological studies are shown in Fig 9.2.

Now, let us discriminate between the descriptive and analytic epidemiology.

Descriptive Epidemiology

Descriptive epidemiology deals with the **frequency** and the **distribution** of a disease or any other health related outcome in the population under study with respect to the **characteristics** of:

- **Person** such as age, sex, marital status, race, socio-economic status, etc.
- **Place** such as village, city, block, district, state, country or any other type of geographic area;
- **Time** such as long term trend, short term variation by week or day or hour.

The information collected about the disease or any other health related outcome by surveying the population under study is analysed and presented in terms of percentage or rates or ratios. So, from descriptive epidemiological studies, we can get the answers of the following types of questions:

- What is the distribution or pattern of a disease or any other health related outcome in the population under study?
- Which age group, which sex, which race, which economic class, etc., is commonly affected?
- Which places have more burden and which have less burden of the disease?
- What are the long term trends, what are the short term variations, what are the seasonal variations and what are the periodic fluctuations?

Thus, we see that descriptive epidemiological studies provide the answers of **four W's** namely, **who** (**person/**who is getting this disease/outcome?), **where** (**place/**where are they getting this disease/outcome?) **when** (**time/**when are they getting this disease/outcome?), **what** (what disease/outcome are they getting?) regarding a disease or any other health related outcome. Also, descriptive epidemiological studies provide clues to the aetiology of disease(s) and these information can be used to generate hypotheses, but descriptive studies usually cannot be used to test these hypotheses. To test these hypotheses, we need comparison group and hence, we need analytic epidemiological studies (give a look at Fig. 9.2) which are being discussed next.

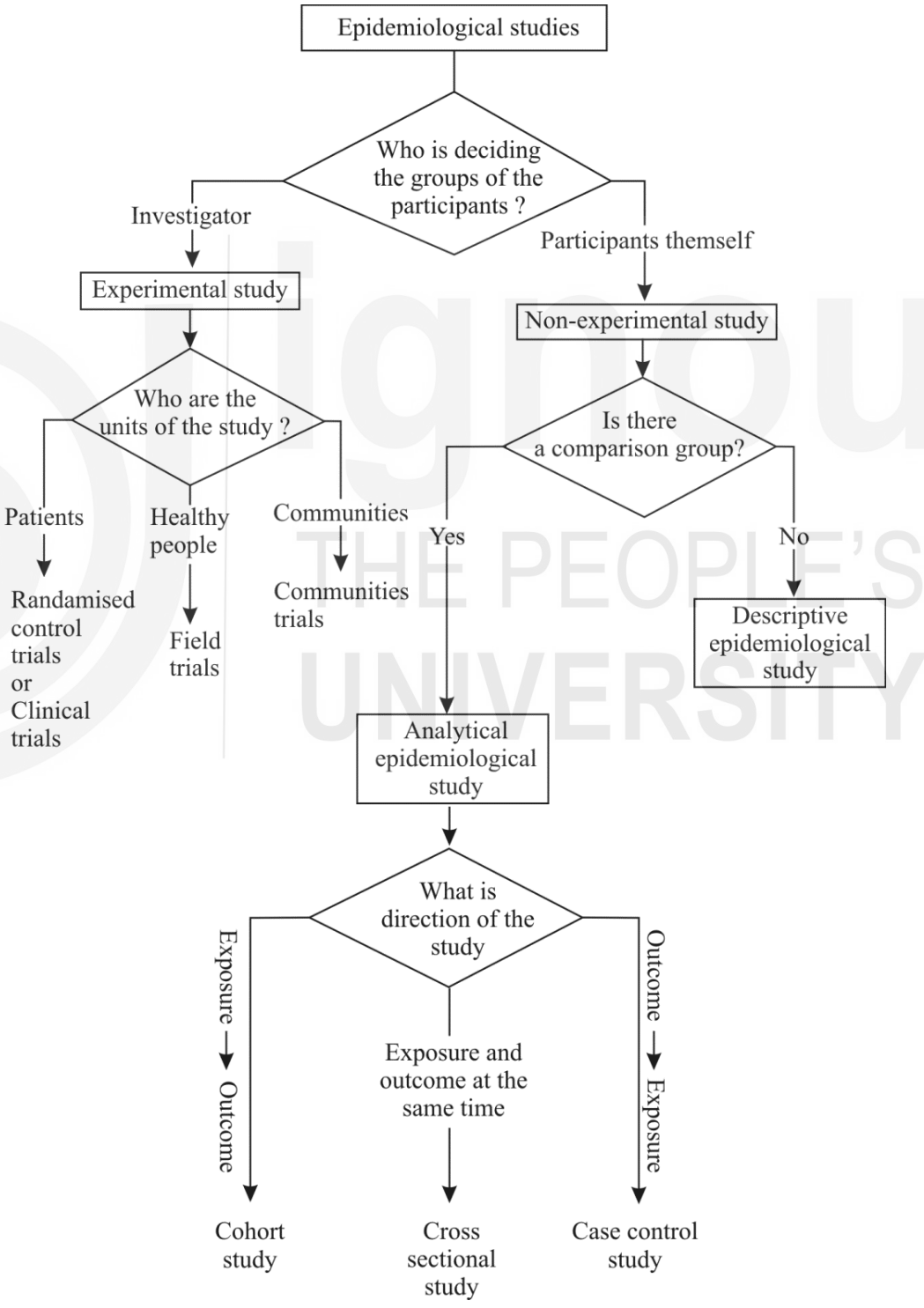


Fig. 9.2: Classification of epidemiological studies.

Analytic Epidemiology

We have seen that descriptive epidemiology gives us the information about the distribution or pattern of frequency of a disease or any other health related outcome in the population under study with respect to person, place and time. Also, descriptive epidemiology provides clues to the aetiology of a disease and these clues are used to develop hypotheses about the association between exposure and outcome. But when we want to test these hypotheses or want to investigate what are the underlying causes of these patterns of frequency of disease or any other health related outcome, we use the analytic epidemiology. To do so we need a comparison group. For example, if data of a descriptive epidemiological study indicate that the relative frequency of the lung cancer in the smokers is twice that of the non-smokers. Then to test this hypothesis, we need to follow a group of smokers and a group of non-smokers. Here, the group of non-smokers is a comparison group for the group of smokers. So, the need of a **comparison group** is the **key feature** of analytic epidemiology. In analytic epidemiology, the comparison groups may be:

Smokers versus non-smokers,

Male versus female,

Obese persons versus normal weight persons,

Younger versus older, etc.

Thus we see that analytic epidemiology provides the answers of **one W** and **one H,** namely, **why** and **how**.

Thus, in analytic epidemiology, our focus remains on searching the causes and effects of a disease or any other health related outcome. So, analytic epidemiology provides the answers to the following types of questions:

- What are the underlying causes of patterns of frequency of a diseases seen in descriptive epidemiological study?
- What are the factors that influence the occurrence of a disease?, etc.

We now highlight some key points of descriptive versus analytic epidemiology in Table 9.1 given as follows:

Table 9.1 Key Points of Descriptive versus Analytic Epidemiology

Descriptive Epidemiology	Analytic Epidemiology
Search for clues	Clues are already available
Helps in developing a hypothesis	Helps in testing the developed hypothesis
No comparison group needed	Comparison group needed
Provides the answers of **the 4 W's** **Who** (**person/**who is getting this disease/outcome?) **Where** (**place/**where are they getting this disease/outcome?) **When** (**time/**when are they getting this disease/outcome?), **What** (what disease/outcome are they getting?)	Provides the answers of one **W** (why) and/or one **H** (how) **Why** they are affected? **How** they are affected?

Now, you can try the following exercises.

E8) Epidemiology provides the answer of 5 W's (what, who, where, when, why) and one H (how) regarding a disease/health outcome.

(A) True (B) False

E9) To conduct an analytic epidemiological study, we need a comparison group.

(A) True (B) False

9.5 EPIDEMIOLOGICAL MODELS OF DISEASE CAUSATION

Epidemiologists assume that a disease or any other health related outcome does not occur randomly in a population, but there are some factors known as risk factors, which are responsible for the occurrence of the disease. In this section, we shall discuss about two such models, namely, Epidemiologic Triad and Causal Pies (a model proposed by Rothman in 1976) regarding the causation of a disease.

Epidemiologic Triad

This model simply states that a disease is caused by the interaction of agent, host and environment and is shown in Fig. 9.3. In this model, what we mean by agent, host and environment are explained below:

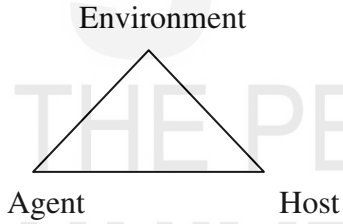


Fig.9.3: Epidemiologic triad.

Agent: In this model, by agent we mean a factor or risk factor, whose presence is necessary for the development of a disease, but the presence of the agent alone is not always sufficient to develop the disease. The agent may be biological, chemical, physical and nutritional. For example, bacteria, viruses (biological); poison, alcohol, smoke (chemical); auto, radiation, fire, trauma (physical); and lack or excess of nutritions (nutritional).

Host: In this model, by host we mean, a person who can get a disease. Some characteristics of the host which may be helpful for development of a disease are age, sex, ethnicity, religion, customs, occupation, heredity, marital status, family background, previous diseases, immunity status, etc.

Environment: In this model, environment means all extrinsic (external) factors other than the agent, which facilitate the interaction of host and agent. Some such environmental factors are temperature, humidity, altitude, crowding, housing, neighbourhood, food, water, radiation, air pollution, noise, etc.

Causal Pies (A Model by Rothman's)

The epidemiological triad model is applicable to infectious diseases, but it does

not work well for many non-infectious diseases having multiple causes for development of a disease. Causal pies is one such model proposed by Rothman in 1976. It works for the diseases which develop on the interactions of many risk factors. In this model, each risk factor, which contributes to a disease, is shown as a component or part of a pie and disease develops only after completion of the pie. Each individual risk factor is known as **component cause** and the causes which complete the pie together known as **sufficient cause**. But a disease may have more than one sufficient cause and a component cause which appears in all possible pies for a disease is known as **necessary cause** for the development of the disease. For example, four sufficient causes are shown in Fig. 9.4 for a particular disease, where A, B, C, D, E, F, G, H, I, J, K represent individual causes or risk factors for a disease.

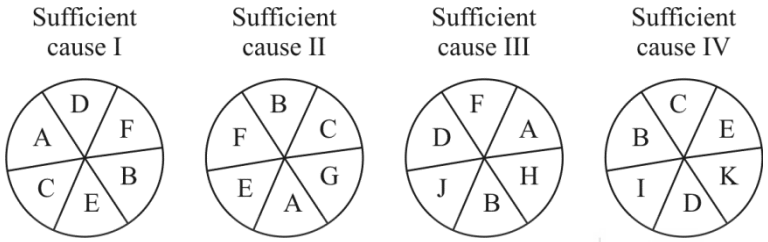


Fig. 9.4: Rothman's causal pies.

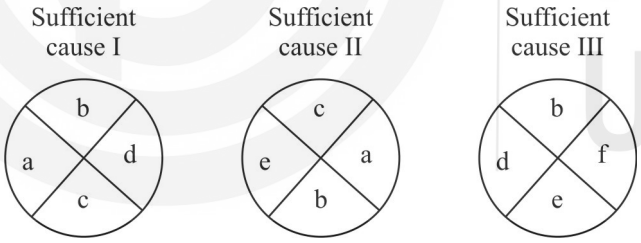
In Fig. 9.4, we note that cause B appears in all pies, so the component cause B is necessary for the development of the disease.

Now, you can try the following exercises.

E10) The "epidemiological triad" model refers to:

(A) Agent, host and environment (B) Time (C) Place (D) Person

E11) Suppose, for a particular disease only three Rothman's causal pies are possible as shown below:



Then which is the necessary cause for this disease.

(A) a (B) b (C) c (D) d

Generally, a person visits to a doctor after development of the signs and symptoms of a disease. But disease biologically onsets in a person at some point in time before the development of its signs and symptoms. The progression of a disease from the point in time when disease biologically onsets in a person till the time of starting of the treatment is known as **natural history of disease** and is discussed in the next section.

9.6 NATURAL HISTORY OF DISEASE

In Sec. 9.5, we discussed two models namely 'Epidemiological Triad' and 'Causal Pies' which were talking about the initial set up towards the development of a disease in the host. In this section, we shall talk about the

natural history of a disease starting from the initial set up until the treatment starts. This is defined as:

The progression of a disease process in an individual from the moment of exposure to causative agents until treatment starts is called **natural history of the disease**.

Different phases of the natural history of disease are explained in this section and are shown in Fig. 9.5.

Suppose, after the interaction of host, agents and environment, a disease biologically onsets at a point in time of the life of the host which is generally not easy to identify, even though to understand the concept, let us consider that point in time, say, A as shown in Fig. 9.5. At this point, if we apply some screening test, generally, it cannot be detected by the test. For example, a mammogram is a screening test for the breast cancer, but breast cancer is not detected by mammogram at the point of its biological onset. We can say that biologically a disease has onset in the host, but he/she is not aware about it, and the disease may take few minutes to few years for developing the signs and symptoms after its point of onsetting biologically. Let the signs and symptoms of the disease develop at point C, but before point C there will be a point, say, B from which point onward the disease can be detected by a screening test (see Fig. 9.5). The time period from point A to point C is known as **total pre-clinical phase (TPCP)** and the time period between point B and point C is known as **detectable pre-clinical phase (DPCP)** (see Fig. 9.5). Usually, after the development of the signs and symptoms of a disease, the host visits the doctor (say, at point D) and the doctor diagnoses (say, at point E) and starts the treatment (say, at point F). The time period between points C and F is known as **clinical phase** (see Fig. 9.5). Now, at point F host gets the treatment and the result of the treatment may be cure or control or disability or death. The different phases of the natural history of a disease are shown in Fig. 9.5):

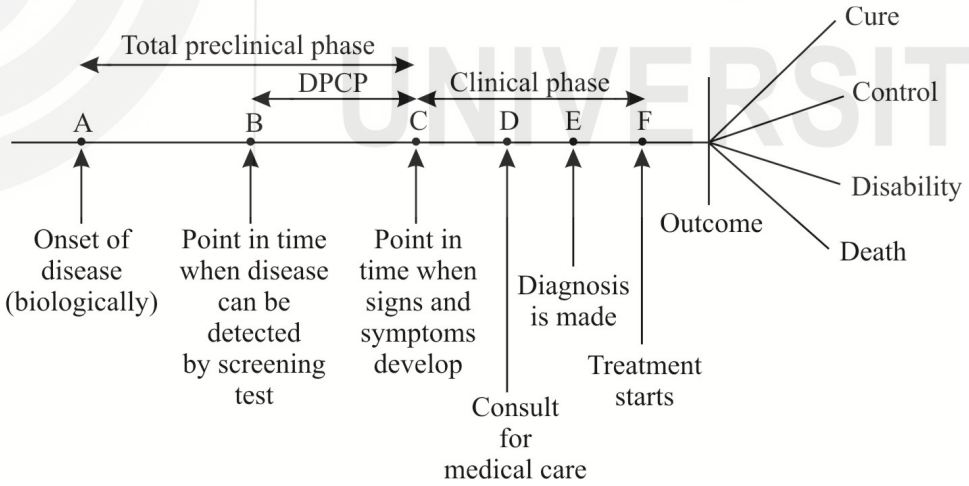


Fig. 9.5: Natural history of a disease.

Now, you can try the following exercises.

E12) The beginning of the pre-clinical phase of disease is marked by:

(A) Point in time when disease can be detected by the screening test.

(B) Point in time when signs and symptoms develop.

(C) Point in time when treatment starts.

(D) Point in time when disease, biologically onsets.

E13) The beginning of the clinical phase of disease is marked by the point in time when signs and symptoms of the disease develop.

(A) True (B) False

E14) The "natural history of a disease" refers to

(A) The period of time in the life of an individual when disease biologically onsets to development of its signs and symptoms.

(B) The period of time in the life of an individual when signs and symptoms develop to the point in time when treatment starts.

(C) Progression of a disease process in an individual from the moment of exposure to causative agents until treatment starts.

(D) The period of time in the life of an individual when disease can be detected by screening test to the point in time when treatment starts.

9.7 LEVELS OF DISEASE PREVENTION

You might have heard the quote "Prevention (precaution) is better than cure". In this section, we shall discuss three levels of disease prevention known as primary prevention, secondary prevention and tertiary prevention.

From the discussion in Sec. 9.6, we have become familiar with the natural history of a disease in general. The primary, secondary and tertiary preventions have direct connection with different phases of the natural history of a disease as shown in Fig. 9.6 and explained one at a time as follows.

Primary Prevention

By primary prevention, we mean all those preventions which one can take/follow/adopt to prevent a disease or any other health related outcome from occurring. In other words, it refers to all those types of preventions which an individual can be recommended before onset of the disease biologically (see Fig. 9.6).

Some examples of the primary preventions may be vaccination (since vaccines prevent diseases from being interacted), yoga, meditation, morning walk, use of stairs instead of the lift or escalator, intake of fruits and vegetables in adequate quantity, use of clean water for drinking, use of condoms to prevent HIV infection, avoiding smoking and drinking alcohol, use of seat belt while driving, use of helmet, etc.

Secondary Prevention

Secondary prevention refers to early detection of a disease after its biological onset, but before the development of signs and symptoms of the disease. That is, the phase of secondary prevention in the natural history of disease is from point A to point C (see Fig. 9.6). The main objective of the secondary prevention is to detect the disease in early stages before the development of the signs and symptoms so that its treatment may be more effective compared to the treatment applied after development of the signs and symptoms.

Some examples of the secondary prevention are self-examination of mammography for breast cancer, blood pressure measurements, chest X-rays for diagnosis of tuberculosis, checking for suspicious skin growths and treat

skin cancer early, RT-PCR test to detect infection of COVID-19 in early stage, etc. The detection of disease in early stages before the development of the signs and symptoms promotes public health and one such tool is screening programme which is discussed in Unit 12 in detail.

Tertiary Prevention

Tertiary prevention refers to treatment of the person who has already developed signs and symptoms of the disease. That is, the phase of tertiary prevention in the natural history of the disease is from point C onward (see Fig. 9.6):

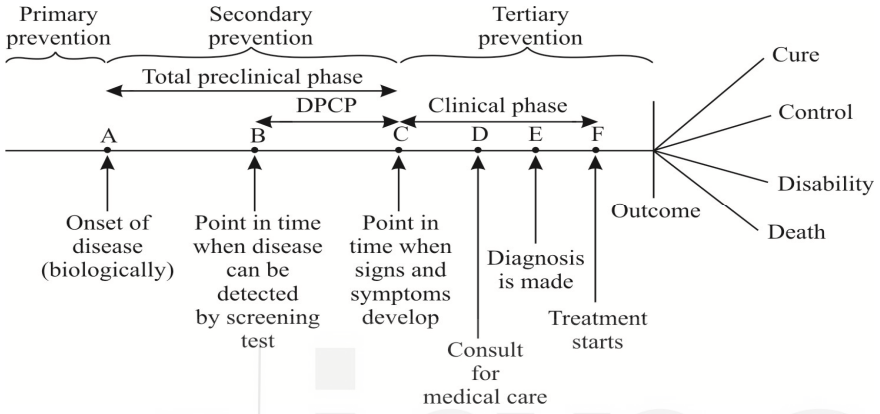


Fig. 9.6: Natural history of a disease with primary, secondary and tertiary prevention.

So, tertiary prevention refers to curing established disease. The goal of tertiary prevention is to slow down the disease progression, prevent complication (prevent the disease from causing other problems), prevent pain from disease, provide better care, help people to recover from the disease, prevent further physical deterioration/disabilities and improve the quality of life.

Some examples, of tertiary prevention are rehabilitation of patients with poliomyelitis, blindness, injuries, stroke, leprosy, AIDS, etc., which provide special training to such people so that they can do some gainful work and become economically self supporting, education on diabetes control, self-management programs for persons living with chronic conditions, etc.

Now, you can try the following exercises.

E15) Which level of a disease prevention refers to the prevention of complication and pain from the disease and focuses on rehabilitation of the patients having different types of disabilities from the disease

(A) Primary prevention (B) Secondary prevention

(C) Tertiary prevention

E16) Use of smoke detectors in a building refers to which level of prevention

(A) Primary prevention (B) Secondary prevention

(C) Tertiary prevention

E17) Equiping a city with fire brigades refers to which level of prevention

(A) Primary prevention (B) Secondary prevention

(C) Tertiary prevention

E18) Tertiary prevention reduces complications and disabilities

(A) True (B) False

E19) Primary prevention includes strategies designed to reduce the incidence of disease

(A) True (B) False

E20) Typically, most of the health care professionals practice what type of disease prevention?

(A) Primary prevention (B) Secondary prevention

(C) Tertiary prevention

E21) Instructing the patients of first heart attack about, how to modify their diets and take their medications to prevent second heart attack is an example of

(A) Primary prevention (B) Secondary prevention

(C) Tertiary prevention

We now describe some uses of epidemiology in the next section.

9.8 USES OF EPIDEMIOLOGY

Some uses of epidemiology are listed below:

- Epidemiology provides a mean to study disease profiles and time trends in human population and thereby rise and fall of the disease in the human population.
- Epidemiological studies help in the identification and quantification of health problems in a community and thereby, community diagnosis.
- Evaluation is an equally important concern of epidemiology. Any measures taken to control or prevent a disease must be followed by an evaluation to find out whether the measures undertaken are effective in reducing the frequency of the disease or not.
- Epidemiological methods are also useful in the evaluation of individual risk, chance and syndrome identification. In conclusion, they provide data for planning or decision making of health agency and administration.
- To practice surveillance for a specific disease in order to be able to act quickly and so cut short any outbreak (example cholera).
- To investigate an outbreak of a communicable disease, analyse the reasons for it, plan a feasible remedy and carries it out, and monitor the effects of the remedy on the outbreak.

9.9 SUMMARY

Let us now summarise the main points, which have been covered in this unit.

1) **Epidemiology** as a word means the study on/of people. And it is defined as "study of the distribution and determinants of health related states or events in specified population and application of this study to control health problems".

2) **Endemic:** If a particular disease more or less remains at a constant level in a particular location or region or population then it is known as the baseline or the endemic level of the disease.

3) **Epidemic:** When the number of cases of a particular disease crosses its baseline or endemic level and rapidly spreads in the much larger area may be in the whole country through a region of a country then in such a case we use the word epidemic for the disease.

4) **Pandemic:** When an epidemic goes beyond national borders and spreads word-wide it is known as pandemic disease. For example, COVID-19.

5) **Descriptive epidemiology** deals with the frequency and the distribution of disease or any other health related outcome in the population under study with respect to the characteristics of person, place and time. Descriptive epidemiological studies provide the answers of **four W's** namely, **who** (**person/**who is getting this disease/outcome?), **where** (**place/**where are they getting this disease/outcome?) **when** (**time/**when are they getting this disease/outcome?), **what** (what disease/outcome are they getting?)

6) The need of a comparison group is the key feature of **Analytic epidemiology**. It provides the answers of **one W** and **one H** namely **why** (**why** they are affected) and **how** (**how** they are affected).

7) **The epidemiological triad model** simply states that disease is caused by the interaction of agent, host and environment.

8) Progression of a disease process in an individual from the moment of exposure to causative agents until treatment starts is called the **natural history of disease.**

9) **Primary prevention** refers to all those preventions which one can take/follow/adopt to prevent the disease or any other health related outcome from occurring.

10) **Secondary prevention** refers to early detection of the disease after its biological onset, but before the development of signs and symptoms of the disease.

11) **Tertiary prevention** refers to treatment of the person who has already developed signs and symptoms of the disease.

9.10 SOLUTIONS/ANSWERS

E1) James Lind was perhaps the first person who conducted an experiment study on 12 sailors all suffering from scurvy disease. So, option (B) is correct.

E2) Option (D) is correct because all that is mentioned in the options (A), (B) and (C) is related to the contribution made by Hippocrates in the history of epidemiology.

E3) Option (D) is correct because all that is mentioned in the options (A), (B) and (C) is related to the contribution made by John Snow in the history of epidemiology.

E4) Answer is C, because it is clear from the definition of epidemiology which is given as:

It is a "study of the distribution and determinants of health-related states or events in specified populations and application of this study to control health problems".

E5) 1. The correct answer is C, because season is a time characteristic.
2. The correct answer is C, because the year is also a time characteristic.
3. The correct answer is B, because place of residence is a geographic characteristic.
4. The correct answer is B, because place of birth is also a geographic characteristic.
5. The correct answer is A, because gender is a demographic characteristic.
6. The correct answer is A, because socio-economic status is also a demographic characteristic.
7. The correct answer is A, because age is a demographic characteristic.

E6) We know that epidemiological studies are targeted to human population, so (D) is the correct option.

E7) We know that distribution refers to what are the patterns of the disease frequency due to time (when), place (where) and person (who)? So (A), (B), (C) all are correct options.

E8) It is true, because descriptive epidemiology provides the answers of 4 W's (what, who, where, when) and analytic epidemiology provides the answer of one W (why) and one H (how).

E9) In analytical epidemiological study, generally, we compare data of two groups of our interest as per the problem in hand. So we need a comparison group to conduct an analytical epidemiological study and hence given statement is true.

E10) The "epidemiologic triad" model states that disease is caused by the interaction of agent, host and environment, so option (A) is correct.

E11) Since component cause b appears in all possible sufficient causes for this particular disease, cause b is necessary for the development of this particular disease.

E12) In the natural history of disease, pre-clinical phase is the time period from the point in time from biologically onset of disease to the point in time when signs and symptoms of the disease develop. So option (D) is correct.

E13) As signs and symptoms of the disease develop pre-clinical phase ends and clinical phase starts, so it is a true statement.

E14) The correct option is (C) all other options talk about the phases of the natural history of disease.

E15) It is tertiary prevention, which refers to curing of an established disease, prevention of complication and also focuses on the rehabilitation of the patients with disabilities, so the correct option is (C).

E16) We know that secondary prevention refers to early detection of the disease so that its treatment may be more effective. Similarly, to detect the causes of fire in early stage smoke detectors are used in a building, so correct option is (B).

E17) We know that tertiary prevention refers to treatment of established disease to prevent complication and other serious consequences. Similarly, fire brigades are also used after the establishment of fire to prevent further serious consequences. So, the correct option is (C).

E18) As we know that tertiary prevention refers to curing established disease. So reduce complication and disabilities also comes under tertiary prevention.

E19) We know that primary prevention refers to all those preventions which one can take to prevent the occurrence of disease. And so reduces the incidence of disease. Hence (A) is the correct option.

E20) As we know that generally people visit to the doctors after development of signs and symptoms of the disease. And it is tertiary prevention, which refers to treatment of the person who has already developed signs and symptoms of the disease. So (C) is the correct option.

E21) Being the patients of heart attack, they have already developed the signs and symptoms of the disease and so it is an example of tertiary prevention. Hence (C) is the correct option.

9.11 KEYWORDS/GLOSSARY

Agent	:	Causative factor invading a susceptible host through a favourable environment to produce disease, which may be biological, chemical or physical in nature.
Demographer	:	A person who studies the characteristics of the human population, such as size, density, growth, distribution and their vital statistics.
Ethnicity	:	Belonging to a social group that has a common national or cultural tradition.
Aetiology	:	Study of causes of a disease or any other health related outcome.
Host	:	A person who is affected by an agent or who develops disease.
Immune	:	The ability of an organism to resist a particular infection or toxin by the action of specific antibodies or sensitised white blood cells.
Syndrome	:	A combination of symptoms characteristic of a disease or any other health related outcome.

Framingham Heart Study: It is a cohort study started in 1948 in Framingham, Massachusetts, United States. At that time risk factors for cardiovascular disease were not known. So the main purpose of this study was to identify risk factors for cardiovascular disease. In this study 5209 people were enrolled having age between 30 to 62 years and planed to follow them for 20 years. More detail on this famous cohort study can be obtained on the following link:

https://courses.edx.org/courses/HarvardX/PH207x/2012_Fall/courseware/Week_2/week2:epi2/