

Epidemiology: definition, historical background and uses

Historical background

Terminology

The word *epidemiology* is derived from the Greek words *epi* (on, upon), *demos* (people) and *logos* (study, science). Therefore epidemiology literally means study of things that happen upon people. The first appearance of the word in English dates back to 1850 when the *London Epidemiological Society* was founded.

Hippocrates' epidemiologic advice

Epidemiological thinking is based on two assumptions. The first assumption is that disease does not occur at random and the second is that there are factors which can either cause a disease or prevent it. In this sense epidemiological thinking could be considered as old as medicine itself. For example in the 5th century B.C., Hippocrates, the father of medicine has said that occurrence of human disease is related to external as well as internal factors. Hippocrates(ca. 460 BC– ca. 370 BC), has given the following “epidemiologic” advice to doctors, which mentions many factors for disease causation such as season, the winds, the water, location, the nature of land and life.

Whoever wants to investigate medicine properly should proceed thus: in the first place to consider the **seasons of the year** and what effects each of them produces. Then **the winds, the hot and the cold**, especially such as are common to all countries, and then such as are peculiar to each locality. In the same manner, when one comes to one city to which he is a stranger, he should consider its situation, how it lies as to the winds and rising of the sun; for its influences is not the same whether it lies to the north or to the south, to the rising sun or to the setting sun. one should consider most attentively **the waters which the inhabitants use**, whether they be marshy and soft or hard and running from elevated and rocky situations, and then if saltish and unfit for cooking; and **the ground** whether it be naked and deficient in water or wooded and well watered, and whether it lies in a hollow, confined situation or is elevated and cold; and **the mode in which inhabitants live**, and what are their pursuits, whether they are fond of drinking and eating to excess and given to indolence or are fond of exercise and labor.

Other pioneers

In 1662, a London merchant called **John Graunt** (1620-1674) analyzed mortality data in his publication *The nature and political observations made upon the bills of mortality*. John Graunt used routine mortality data to investigate patterns of death among males and females, children and different occupation. He found that there were more male deaths than females and that death differed according to season of the years and in different occupations. However what Graunt was not fully appreciated for many years.

In 1839 an English physician called **William Farr** (1807-1883) took charge of medical statistics for England and Wales. He established a system for routine and regular collection of information of the numbers and causes of death and he analyzed this information in annual reports which he used to write for the health authority for 40 years. Farr compared the mortality rates between male and females, married and unmarried people, workers and other occupations and people living in higher lands and those living in less elevated areas. He observed that there was an association between elevation above sea level and deaths from cholera.

John Snow's observations on cholera

Another British physician called John Snow(1813-1858) has played an important role in advancing epidemiological thinking and practice and therefore is considered the father of epidemiology. Snow lived during the cholera outbreaks of London and tried to investigate the causes of the epidemic. At that time London drinking water was supplied by several private companies taking water from river Thames. Snow noted from his observations and those of William Farr that death rates were different in areas supplied by different water companies. Based on this, he suggested that cholera was transmitted by contaminated water. In 1854, the worst outbreak of cholera occurred in Broad street area where over 500 people died in two weeks. John Snow collected information on cholera deaths from the beginning of that epidemic from August 1853 to January 1854 in a home to home visit and tabulated his results to investigate the association between water company and death (see table below). He found that death rate was dramatically higher among inhabitants supplied by Southwark and Vauxhall Company which was taking the water from the contaminated part of Thames. Therefore Snow consolidated his hypothesis that cholera was related to drinking water. Snow published his notes in a book called *On the mode of communication of cholera*.

Water company	Number of houses	Cholera deaths	Death rate per 10,000 houses
Southwark and Vauxhall	40,046	1263	315
Lambeth	26,107	98	37
Rest of London	256,423	1422	59

Source: Hennekens, *epidemiology in medicine*

Development of epidemiology has been slow throughout history. It took more than 2000 years from the epidemiologic advice of Hippocrates to the solid observations of Snow to demonstrate an association between a risk factor and a disease.

Modern definition of epidemiology

Epidemiology studies distribution of diseases in populations and why they are distributed in a particular way in the population. In his *Dictionary of epidemiology*, John Last provides a comprehensive definition which encompasses the major features of epidemiology as a science discipline and practical application.

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

Understanding epidemiology requires explanation of the keywords underlined in the definition.

Health-related events

Although study of individual diseases comprises a major part of epidemiological effort, epidemiology is not confined to diseases. Any condition, event, or state related to health of individuals could be focus of epidemiological research. For example epidemiological research could explore smoking, breast-feeding, road traffic accidents, life style, environmental issues and others related to health.

Distribution

Epidemiology studies how diseases and health-related states are distributed in person, place and time. For example who are more affected by a disease, what are the geographical differences and how the occurrence of the disease varies by different seasons of the year.

Determinants

Individuals might have been exposed to certain factors that could determine their health. Epidemiology studies these potential risk factors in order to establish their role in the causation of the disease.

Specific populations

A major difference between epidemiology and clinical practice is that epidemiology is primarily concerned with populations not individuals. Epidemiology studies and reports on distribution of diseases and health-related states amongst clearly defined populations.

Application

Epidemiology plays an important role in improving population health. The findings of epidemiological studies provide evidence base for taking measures to control diseases and health-related problems

Uses of epidemiology

As epidemiology studies the distribution and determinants of health-related problems, it is considered a key part of public health essential for understanding diseases and their occurrence in the population. While mathematics and statistical methods are important in epidemiology, epidemiology involves a huge amount of practical research in order to collect information for analysis to provide an understanding of the health situation. In addition, the ultimate objective of epidemiology is control of health-related problems which is achieved by application of the findings of epidemiological studies. Therefore epidemiology is indispensable for understanding health and disease and public health planning and implementation.

Broadly speaking the role of epidemiology can be classified into three areas which are:

- Describing patterns of health and disease in populations
- Interpreting the findings
- Application of the results to improve public health practice

For example, we might use descriptive epidemiology to provide a picture of death rates among various age groups of the Kurdish population and to describe whether the mortality pattern has changed over the last 2 decades or not. Analytical epidemiology can search for interpretations of the differences in death rates amongst different age groups and over time. Findings of epidemiological research in the above example can be applied to plan interventions to reduce deaths amongst certain groups if studies showed that there are preventable risk factors.

Uses of epidemiology as classically described J Morris include the following:

1. *Community health assessment*

The main use of epidemiology is to assess the state of health of the population. Epidemiological research methods are used to identify which disease and health-related problems are present in the population and how these diseases are distributed in place, person and time. Epidemiology can also estimate the burden of these problems on the health services. This information is vital for health policy and planning and implementing intervention to control these problems.

2. *Monitoring changes over time*

Population health status and problems change over time. Some diseases become less common, new disease emerge and various health hazards change over time. Repeated epidemiological studies could be used to assess and monitor these changes over a period of time. Until end of 19th century, infectious diseases were the major threat to human health but since 1900 onwards, the pattern has changed and non-communicable diseases have risen to the top of leading causes of death in the developed countries. For example in 1900, the top three killers in the USA were pneumonia, tuberculosis and diarrhea while they are currently cardiovascular diseases, cancer and chronic lower respiratory diseases. Identifying and monitoring these historical changes is possible using epidemiology.

3. *Searching for causes*

One of the most exciting uses of epidemiology is searching for causative factors of existing diseases and health-related states and of new diseases. Epidemiology can find associations between risk factors and diseases and provide hypothesis about such associations. Analytical epidemiology can use appropriate research methods and statistical analyses to test the hypothesis and provide evidence for the effect of those potential risk factors. For example a case-control study in 1950s found that smoking was associated with lung cancer. A large cohort study of medical professionals in the UK that lasted several decades provided invaluable information on risk factors of death from cardiovascular diseases. New health conditions are usually investigated by epidemiologists to identify their causes. For example when swine flu was first observed in humans in 2009, epidemiologists and other scientists were mobilized to investigate how it was spread and how to control its spread.

4. *Evaluation of health services*

How are the health services performing? Is the vaccination program effective? Is an antenatal clinic successful in improving health of pregnant women? Are patients satisfied with the care they receive? These are questions about the effectiveness of health programs and interventions. We need to evaluate these programs in order to decide whether they are effective or they failed to improve the health of the

beneficiaries. We use various qualitative and quantitative research methods to evaluate these programs. Epidemiology can tell us whether a program was successful and how successful it was in meeting its objectives. Successful programs then could be continued and unsuccessful ones could be modified or discontinued. In this way epidemiology helps health services to improve effectiveness and save money.

5. *Estimating individual chances of getting affected*

Epidemiology calculates risk of disease in the population. For example when we say that the annual risk rate of burns in pre-school children in Sulaymaniyah is 1 per 100, this means that on average any pre-school child in this city has a one in a hundred chance of suffering a burn injury each year. When we say that 5-year survival of a particular cancer patient is 20% this means that on average, one of five such patients will survive 5 years. In other words such a patient has a 20% chance of surviving 5 years. We have to remember, however, that this is an average probability and does not mean that all individual patients will exactly survive for this length of time.

6. *Completing the clinical picture*

Individual patients of a particular disease may not demonstrate all symptoms of the disease. There are a lot of sub-clinical cases, cases with most common symptoms or cases with rare symptoms of the disease. As epidemiology collects information on a large number of patients, it will provide a more complete clinical picture of the disease. It can provide information about the most common signs and symptoms as well as the rare ones, their frequency, severity and chance of death. In large scale community programs to control diseases where time and resources are limited and definitive clinical and lab diagnosis are not feasible; epidemiology can provide practical easy to use case definitions that can be used for preliminary diagnosis based on most common symptoms.

7. *Investigation of new products*

Epidemiological methods are used to test and investigate the effect of new interventions and products. For example before a new medication or vaccine is licensed for marketing it has to be tried on volunteers and then on a wider sample of subjects in order to determine its effectiveness and identify its side effects.

Further reading

1. Joseoh, M.R., *Epidemiology for undergraduates*. 2007, New Delhi: Jypee Brothers
2. Gordis, L., *Epidemiology*. 2nd ed. 2000, London: Saunders

These lectures are inspired by Epidemiology course material from LSHTM where the teacher studied