

Epidemiology in Medicine

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What is Epidemiology?

- Epidemiology - branch of public health which attempts to **discover the causes of disease in order to make disease prevention possible**.
- Epidemiological methods can be used in other contexts (particularly in **clinical research**).

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- Epidemiology comes from Greek words
epi – on or upon
demos – people
logos – the study of

Many definitions have been proposed but...

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- Epidemiology definition:
– "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**"

(Last, 1988)

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- **Study** – Epidemiology is a scientific discipline, sometimes called "the basic science of public health." It has, at its foundation, sound methods of scientific enquiry.
- **Distribution** – Epidemiology is concerned with the frequency and pattern of health events in a population (not only numbers but also the rate or risk of disease in the population)
- **Pattern** - refers to time, place and person characteristics

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- **Determinants** – Epidemiology is also used to search for causes and other factors that influence the occurrence of health related events
- **Analytic epidemiology** – provide the Why and How of such events by comparing groups with different rates of disease occurrence and with differences in demographic characteristics, genetic or immunologic, behaviors, environmental exposures and other so-called potential risk factors.

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- **Health-related states or events** – originally concerned with epidemics of communicable disease
Recently – applied to chronic diseases, injuries, birth defects, maternal-child health, occupational health and environmental health.
- **Specified populations** – clinicians are concerned with the health of an individual where as epidemiologists are concerned with the collective health of the people in the community or other area.
- **Application** – more than “the study of”
Epidemiology provides data for directing public health action.
'diagnosing' the health of a community, also may call upon experience and creativity when planning how to control and prevent disease in the community

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History of Epidemiology

- Epidemiology is as old as public health itself
- Hippocrates who observed that:
“Whoever wishes 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... when one comes into a city in which he is a stranger, he should consider its situation, how it lies as to the winds and the rising of the sun... One should consider most attentively the waters which the inhabitants use... and the ground... and the mode in which the 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”. (Hippocrates, 1938; quoted in Hennekens and Buring, 1987)

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- Contemporary public health movement and many of the sciences that deal with the promotion and preservation of health are rooted in the 19th century Hygienists Movement – focused their efforts on sanitation and improving environmental conditions.
- Hygienists main theory of disease – miasma theory

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- Miasma means bad air or pollution
Example – cholera was due to vapors, which have their highest concentrations at low elevations
- Microbiologic Revolution – as specific agents became known microbial theory flourished while miasma theory faded

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- Perhaps the most commonly quoted epidemiologic legend is that of Snow (1813-1858) who studied the causes of cholera in London in the mid-19th century – London cholera epidemic 1854
- Through series of theories and observations was able to show that cholera was transmitted by impure water.
- 32 years before discovery of *Vibrio cholerae*

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Timeline of Important Epidemiologic Events

- Hippocrates (460-377 B.C) – foundation of scientific medicine
- John Graunt (1620-1674) – epidemiologic utility of vital statistics
- Percival Pott (1713-1788) – elevated rates of scrotal cancer in chimney sweeps – early example of occupational epidemiology
- Edward Jenner (1749-1823) – smallpox vaccination
- Peter Ludwig Panum (1820-1885) – used modern infectious disease principles to determine the extent to which the agent was infectious and found differences in host susceptibility
- Jakob Henle, Louis Pasteur, Robert Koch – germ theory of disease

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- Emile Durkheim (1858-1917) – suicide relates to psychopathologic states – example of social epidemiology
- Joseph Goldberger (1874-1927) – relating pellagra to diets high in cereals and canned foods and free of fresh animal products – landmark study in nutritional epidemiology
- Post World War II – modern epidemiology era – emergence of chronic diseases, biostatistical understanding of causes and contributor to disease process.

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Epidemiology: Recent History

- 1850 - London Epidemiologic Society established by William Farr and colleagues
- 1854 - Snow's investigation of cholera outbreak in London
- 1865 - Galton published 'Hereditary Talent and Character'
- 1868 - Mendel's work on genetic assortment and combination
- 1872 - Darwin's 'Origin of Species'
- 1882 - Koch's discovery of the tubercle bacillus ushered in the era of microbiology

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- 1945 - Fundamental shift in paradigm after World War II to study chronic diseases
- 1948 - Framingham cohort study begun to study coronary artery disease
- 1956 - Discovery of DNA by Watson and Crick
- 1958 - Doll and Hill apply case-control study design to establish smoking as cause of lung cancer
- 1980 - DNA fingerprinting, Micro-computing industry begins
- 1982 - AIDS epidemic recognized in US, Cox proportional hazards regression analysis

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Epidemiology in the 21st Century

- At the beginning of the 21st century, the field of epidemiology is **changing rapidly**, not only with regards to its **basic methods**, but also with regards to the **hypotheses** which these methods are used to investigate.
- In particular, in recent years there has been a **revival in public health applications of epidemiology**, not only at the national level, but also at the international level, as epidemiologists tackle global problems such as climate change.

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Future

- Molecular biology will revolutionize the way epidemiologists evaluate gene-environment interaction
- Micro-computing will become more sophisticated and more widely available
- Biomedical science will make significant advances that will require evaluation of findings in populations

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Use Epidemiologic Methods For:

- **Population or community assessment**
 - to set policy and plan programs
 - health officials must assess the health of the population or community they serve
 - Assessing intervention programs, therapy
- **Individual decisions**
 - May not realize that they use epidemiologic information in their daily decisions
 - Stop smoking, using stairs instead of elevator, choosing food They may be influenced, conscious or unconsciously by epidemiologist.

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- **Completing the clinical picture**
 - Contribute to the physicians understanding of the clinical picture and natural history of the disease.
 - Outbreak investigation
- **Search for cause**
 - Much research devoted to a search for causes, factors which influence one's risk of disease
 - Academic pursuit
 - Identify a cause for public health action

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Classics Epidemiology

- 1. Smoking and lung cancer:
The association between smoking and lung cancer is now considered almost causal. Since the first epidemiological studies published in the 1950s, several studies have demonstrated the association between smoking and lung cancer. In particular, studies by Doll and Hill are considered classics (Doll & Hill 1964). Their seminal work also spurred work on other chronic diseases like CAD, stroke, etc.

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- 2. The Framingham Heart Study:
Few studies are as famous as the Framingham Heart Study (FHS). The study began in 1948 and is still going strong 50 years later (Messerli 1998). The study was done to identify risk factors for CAD and is a classic cohort (longitudinal) study.
Framingham is a town in Massachusetts (population of 28,000 when the study began). Thousands of the town residents were examined for CAD and risk factors. Subsequently, they were offered complete examination every 2 years since the study began. As new types of investigations appeared on the scene, they have been added to the examination.
The study findings have emerged in a large series of reports over the years (e.g. Kannel WB, et al 1961) and have contributed tremendously to our understanding of CAD and its risk factors. More than 1000 articles from FHS have been published to date. Analysis of the Framingham data also paved the way for the evolution of complex statistical modeling techniques like multivariate analyses.

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- 3. Polio Vaccine Field Trial:
The largest formal human experiment ever was done when the Salk polio vaccine was put through a field trial in 1954, with nearly a million school children as subjects.
The study clearly demonstrated the protective efficacy of the vaccine and provided the basis for an eradication program.

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Descriptive Epidemiology

- Typically, epidemiology is divided into two components: descriptive epidemiology and analytic epidemiology.
- **Descriptive epidemiology** focuses on identifying and reporting both the pattern and frequency of health events in a population
- **Analytic epidemiology** focuses on the search for the determinants of health outcomes
- These two components work together to increase our understanding of the health of a population.

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- Descriptive epidemiology focuses on both the pattern of health events as well as on their frequency in populations.
- Within the field of epidemiology, there are three types of data that are necessary for describing the patterns of health and disease in human populations.
- **These three pillars of descriptive epidemiologic analysis are:**
 1. Person
 2. Place
 3. Time

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Person characteristics

- Include **sociodemographic** characteristics such as
 - age, race/ethnicity, education,
 - income, insurance status,
 - occupation,
 - Parity, marital status
 - **behaviors** such as substance abuse, diet, sexual activity or use of health care services.
- For example - examinations of person behavior established a correlation between people who work night shifts and high blood pressure.
 - Not every person who works the night shift will have high blood pressure, but shift work has been shown to increase the risk for developing the condition.

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Place characteristics

- Include **geographic location** (e.g., urban versus rural), features of the geography (e.g., mountainous region, area with wells as the major water source), population density, as well geo-political boundaries (e.g., census tracts, states, cities, district, sub district), and location of worksites, schools, and health facilities.
- Place evaluation might lead one to suggest that people who live near lakes teeming with mosquitoes are at higher risk for developing West Nile Virus.
- Evaluation of place - also include where people work, the population numbers of a place (density), and the environments in which people live, work or attend school.

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Time characteristics

- Include **cyclical changes, long term secular trends,** and **even daily or hourly** occurrences during an epidemic.
- Might refer to the **time of year, or things that happen at a specific time each day or each hour.**
 - People are more prone to getting the flu during the late fall and early winter months.
- Prevalence of the flu during this period allows physicians to predict the most effective time to offer vaccinations.
- Time considerations in descriptive epidemiology have also led to interesting studies on when health events are more likely.

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Clinical Epidemiology

- Application of the science of epidemiology in a **clinical setting.**
- Clinical Epidemiology extends the principles of epidemiology to the critical evaluation of diagnostic and therapeutic modalities in clinical practice.
- Emphasis is on a **medically defined population**, as opposed to statistically formulated disease trends derived from examination of larger population categories

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Suggested Reading

- Epidemiology: An Introduction - by Kenneth J. Rothman;
- An Introduction to Epidemiology – Thomas C. Timmreck
- Principles of Epidemiology – CDC Atlanta
- Epidemiology Kept Simple – Gertsman
- Medical Epidemiology – Greenberg et al. (Lange medical)
- Kaedah Epidemiologi – Osman Ali (Dewan Bahasa dan Pustaka)

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Thank You

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