


Epidemiology of Diseases  
of Major Public Health Importance

# Epidemiology of Diseases of Public Health Importance



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## Purpose

- ◆ **Purpose of this course:**  
To assist the student to understand the epidemiological patterns, etiology and risk factors of selected major human diseases and problems from a population-based perspective.

In order to fulfill this purpose it is necessary to review elementary biomedical concepts, epidemiological terminology and basic research methods, as well as basic biostatistics, as the course examines specific diseases as they occur in populations, rather than in individual patients.

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## Objectives

- ◆ Become familiar with major epidemiological patterns of disease and problems affecting human populations by person, time and place.
- ◆ Review the nature of the exposure to physical, chemical, biological, psychological, social, and economical risk factors, which contribute to the cause of the diseases and other human health problems.
- ◆ Learn the specifics of etiology, life cycles of infectious agents, vectors and non-biological factors involved in the transmission and development of diseases and problems which are epidemiologically important.

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## Objectives (cont.)

- ◆ Learn the public health significance of the selected major diseases -infectious and chronic- and problems in terms of morbidity, mortality, socio-economic impact as well as the impact on the health care system.
- ◆ Review the application of diagnostic screening methods used to determine the prevalence and incidence of specific diseases.
- ◆ Understand concepts such as relative risk and attributable risk as these apply to the evaluation of risk factors in the planning, design and implementation of control and eradication programs.

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## Objectives (cont.)

- ◆ Identify the potential benefits obtained from controlling or eradicating a specific disease or human health problem.
- ◆ Apply a population-based perspective to an identified human health problem in order to propose ideas for future research.
- ◆ Demonstrate fundamental course principles and concepts when critiquing a published research article and writing a report and presentation on a public health problem.

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## Instructional Challenges

- ◆ Motivation
- ◆ Involvement
- ◆ Assessment to enhance learning

The first object of any act of learning, over and beyond the pleasure it may give, is that it should serve us in the future. Learning should not only take us somewhere; it should allow us later to go further more easily.

Jerome Bruner

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Quotations

- ◆ Motivation and enthusiasm are contagious; so lack of motivation and enthusiasm (Eison, 2001).
- ◆ Active learning instructional strategies 'involve students in doing things and thinking about the things that they are doing' (Bonwell & Eison, 1991).
- ◆ Lecture alone are too often a useless expenditure of force. The lecture pumps laboriously into sieves. The water may be wholesome; but it runs through. Mind must work to grow. (Charles W. Eliot, 1869).

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Quotations

- ◆ All genuine learning is active, not passive. It involves the use of the mind, not just the memory. It is the process of discovery in which the student is the main agent, not the teacher (Adler, 1982).
- ◆ True learning involves figuring out how to use what you already know in order to go beyond what you already think (Bruner, 1983).
- ◆ Nothing great was ever accomplished without enthusiasm. (Emerson)

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Materials credits

- ◆ This lecture contains information from several sources:
  - Outlines from syllabuses on several Epidemiology courses. (1992-2001. CPH. USF.)
  - Principles of Epidemiology. (2nd. Edition. CDC.)
  - Epidemiology for Public Health Practice (Friis & Sellers, 1996)
  - Community Health Analysis (Dever, 1991)
  - Epidemiology. 2nd. Edition (Gordis, 2000)
  - Epidemiology Medicine (Hennekens&Buring/89)
  - Dictionary of Epidemiology. (Last, 2000)
  - Others: Brownson & Petitti, Institute of Medicine.

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Definitions (General)

- ◆ **Public Health**
  - Organized community efforts aimed at the prevention of disease and promotion of health. It links many disciplines and rests upon the scientific core of **epidemiology**. (As a mission: "the fulfillment of society's interest in assuring the conditions in which people can be healthy.") (Institute of Medicine 1988).
- ◆ **EPIDEMIOLOGY is considered one of the basic sciences of Public Health.**

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Definitions (general)

- ◆ **Epidemiology**
  - The study of the distribution and determinants of disease frequency in human populations. (Hennekens & Buring, 1987)
  - Concerned with the distribution and determinants of health and diseases, morbidity, injuries, disability, and mortality in populations.(Friis & Sellers, 1996)
  - ... and the application of this study to control of health problems. (Last 1995)
  - "Epidemiology involves both science and public health practice" (CDC. Principles of Epidemiology. 2nd. Edition)

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Definitions (specifics)

- ◆ **Epidemiology is the study of the health of human populations.**
- Its functions are:**
  - ◆ To discover the agent, host, and environmental factors which affect health, in order to provide the scientific basis for the prevention of disease and injury and the promotion of health.
  - ◆ To determine the relative importance of causes of illness, disability, and death, in order to establish priorities for research and action.
  - ◆ To identify those sections of the population which have the greatest risk from specific causes of ill health, in order that the indicated action may be directed appropriate.
  - ◆ To evaluate the effectiveness of health programs, policies and services in improving the health of the population.

Epidemiology definition relevant to public health practice. (Terris, 1992 as cited by Brownson & Petiti) ...

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Definitions (Specifics)

- ◆ **Applied epidemiology.**
  - Epidemiologic practice which involves the identification and investigation of health problems or evaluation of health programs, policies, and service delivery and which results in appropriate and timely action to improve the health of the population. (Last's Dictionary, 2000)
  - Application and evaluation of epidemiologic discoveries and methods in public health and health care settings. (Brownson and Petitti, 1998)

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Definitions (Specifics)

- ◆ **Field epidemiology**
  - A subset of Applied Epidemiology. An immediate response to an urgent and unexpected health problem for which the epidemiologic investigation is conducted in the field and timely intervention is implemented to improve the health of the community. The extent of the investigation may be limited because of the imperative for timely intervention. (Last's Dictionary, 2000.)

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Health and Disease


- **Definition of Health.**
  - ◆ "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease and infirmity." (W.H.O. constitution, 1964)
- **Causation of disease.**
  - ◆ As we mentioned, one of the functions of epidemiology is to search for causes of disease. To discover the agent, host, and environmental factors which affect health, to provide the scientific basis for the prevention of disease and injury and the promotion of health.



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Disease Etiology. Causation.

- ◆ There are several models of disease causation.
- ◆ All require the precise interaction of factors and conditions before a disease will occur.
- ◆ Models are guidelines that provide a framework for considering causation at a practical level.
- ◆ 'Cause' is a concept that is still debated (that is why there are several models to try to explain it.)



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'Cause' and Models of causation.

- ◆ **Cause of disease** is defined as a factor (characteristic, behavior, event, etc.) that influences the occurrence of disease.
  - Increase in the factor leads to an increase in disease.
  - Reduction in the factor leads to a reduction in disease.
- ◆ **Models of causation (examples)**
  - Henle-Kock postulates
  - Hill's causality criteria
  - Epidemiologic triad (ecological model).
  - Multifactorial Model (Rothman's causal pies)
  - Social-Ecological Model
  - Holistic Model (W.H.O.)
  - Wellness Model

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Models of causation.

- ◆ **Henle-Kock Postulates** (1840 & 1882) for explaining the causative involvement of a microorganism in the pathogenesis of an infectious disease. *Original terminology:*
  - The parasite occurs in every case of the disease in question and under circumstances that can account for the pathologic changes and clinical course of the disease.
  - It occurs in no other disease as a fortuitous and nonpathogenic parasite
  - After being fully isolated from the body and repeatedly grown in pure culture, it can induce the disease anew. (Rivers 1937, as cited by Kelsey et al, 1996).

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Models of causation.

- ◆ **Sir Austin Bradford Hill's causation criteria (1965)**
  - Strength of the association (Scrotal cancer, 200 times)
  - Consistency upon repetition (Observed by different people in different places. )
  - Specificity (Always same effect, Bladder Ca & chemicals.)
  - Time sequence (First the exposure, then the disease)
  - Biologic gradient (Dose response relationship).
  - Plausibility (Ice cream and drowning; knowledge dependent.)
  - Coherence of explanation (Follows the natural history).
  - Experiment (natural experiment, fluoridated water).
  - Analogy (i.e. Effects of thalidomide and rubella; slighter evidence on other drugs & viruses during pregnancy could be accepted given the devastating effects).

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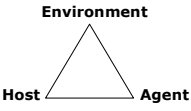
Models of causation.

- ◆ **Epidemiologic triad** (ecological model).
  - Host, environment, and agent.
- ◆ **Multifactorial Model** (Rothman's causal pies)
  - Component causes: sufficient and necessary causes.
- ◆ **Social-Ecological Model**
  - It replaces the agent with personal behavior factors.
- ◆ **Holistic Model** (W.H.O.)
  - The concept of health is an expansion of the social-ecological model.
- ◆ **Wellness Model**
  - Physical activity, nutritional awareness, stress management, self-responsibility.

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Epidemiologic triad  
(ecological model).

- ◆ **The epidemiologic triad** (triangle):
  - Traditional model of infectious disease causation.
  - It has three components:
    - ◆ *Agent*
    - ◆ *Susceptible host*
    - ◆ *Environment* (brings the other two together; influences the route of transmission of the agent from a source to the host).



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Epidemiologic Triad

- ◆ **Agent factors.**
  - Originally referred to an infectious microorganism:
    - ◆ Bacteria
    - ◆ Viruses
    - ◆ Fungi
    - ◆ Parasites: protozoa; helminths: roundworms, tapeworms.
    - ◆ Rickettsia
    - ◆ Prions
  - Generally, these agents must be present for an infectious disease to occur. (*Necessary, not always sufficient.*)

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Epidemiologic Triad

- ◆ **Agent factors.**
  - In noninfectious diseases referred to:
    - ◆ Physical:
      - Noise, vibrations, temperature, radiation, mechanic.
    - ◆ Chemical:
      - Solids (dust, fume), liquids (particles), gases.
    - ◆ Psychological
      - Stress, personality
    - ◆ Social
      - Family, school, education
    - ◆ Economical
      - Job, salary, lay off

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Epidemiologic Triad

- ◆ **Host factors.** Intrinsic factors that influence an individual's exposure, susceptibility, or response to a causative agent.
  - Factors that influence the likelihood of exposure:
    - ◆ Age, race, sex, SES, and behaviors (smoking, drug abuse, lifestyle, sexual practices, contraception, eating habits).
  - Factors that affect susceptibility and response to an agent:
    - ◆ Age, genetic composition, nutritional and immunologic status, anatomic structure, presence of disease or medications, psychological makeup.

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Epidemiologic Triad

- ◆ **Environmental factors.** Extrinsic factors which affect the agent and the opportunity for exposure.
  - Physical factors:
    - ◆ Geology
    - ◆ Climate
    - ◆ Physical surroundings (nursing home, hospitals)
  - Biologic factors:
    - ◆ Insects (vectors) that transmit the agent
  - Socioeconomic factors:
    - ◆ Crowding, sanitation, health services availability.

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Epidemiologic Triad

- ◆ The objective of this (or any other) epidemiologic model is to help us to find practical and effective prevention and control measures. In order to do so, we need to understand that:
  - The three components interrelate in a variety of complex ways to produce disease.
  - The balance and interactions are different for different diseases.
- ◆ Conclusion:
  - When searching for **causal** relationships, we should look at the three components and analyze their interactions.

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Multifactorial Model  
(Rothman's causal pies)


- ◆ The agent-host-environment model does not work well for some noninfectious diseases.
- ◆ A multifactorial model was developed. It is based in the multifactorial nature of causation in many diseases.
- ◆ "Component causes" are factors like those intrinsic host factors, the agent and the environmental factors.
- ◆ A single component cause is rarely a "sufficient cause" by itself. (ie, Mycobacterium T.B. is necessary but not sufficient to cause disease).

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Multifactorial Model  
(Rothman's causal pies)

- ◆ A particular disease may result from a variety of different "sufficient causes".

Sufficient cause I      Sufficient cause II      Sufficient cause III




- ◆ As we mentioned, M. tuberculosis is necessary (A) but not sufficient to cause disease.
- ◆ Lung cancer: smoking (B), asbestos (C); both are components, but not necessary causes. (Could occur w/o them)
- ◆ To apply this model we do not have to identify every component of a sufficient cause before we can take preventive action. We can block any single component. (ie eliminating smoking (B) would prevent LC in I & II, not in III.

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Part of the Agenda of the course

- ◆ Epidemiology as one of the basic sciences of P.H.
- ◆ Outbreak investigation
- ◆ Methods: measures in epidemiology, study design
- ◆ Public Health Surveillance
- ◆ Screening in the community



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Current challenges in Epidemiology

- ◆ Molecular Biology
- ◆ Ethical Issues
- ◆ Weak associations
- ◆ Measuring outcomes & quality of health care
- ◆ Settings priorities and measuring progress
- ◆ Investigating outbreaks
- ◆ Preventing chronic diseases
- ◆ Measuring the effects of PH interventions
- ◆ Informing public health policies
- ◆ Applying computer & information technologies
- ◆ Increasing epid. capacity in applied settings

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Molecular Biology

- ◆ Use of methods in molecular biology to enhance measurement of exposure, effect or susceptibility. (Therefore may lead to opportunities in prevention, early detection, and treatment).
- ◆ DNA: to identify molecular damage by disease or environmental exposures that define susceptibility.
- ◆ ie. Variability in response to Carcinogen: people with predisposing genetic traits are at greater risk. (Susceptible groups can be identified and new regulations or interventions can be developed).
- ◆ Ethical questions: Mutation in gene (BRCA1-17q12-21) increases the risk of breast cancer:80-90% lifetime risk. (Inf. to patient pop-based , confidentiality, job/ins.)

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Ethical Issues

- ◆ The balance between achieving medical progress and ensuring individual patient care is the essence of the ethical dilemma. (Pocock 1983)
- ◆ General ethical requirements of clinical research are outlined in the Declaration of Helsinki (World Medical Association 1960, 1975).
- ◆ Subjects should be adequately informed and protected from undue risks, and the potential societal benefits of epidemiology should be maximized. (Coughlin and Beauchamp 1996)
- ◆ International guidelines for ethical review of epidemiological studies. (Council for International Organizations of Medical Sciences, 1991)

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Ethical Issues (cont.)

**PROFESSIONAL RESPONSIBILITIES**

- ◆ Responsibilities to research Subjects
  - Welfare protection, Informed consent, Privacy, Confidentiality, Committee review.
- ◆ Responsibilities to Society
  - Provide benefits, Public trust, Avoid conflict of interest, Impartiality.
- ◆ Responsibilities to Employers & Funding Sources
  - Formulate responsibilities, Protect privileged information.
- ◆ Responsibilities to Professional Colleagues
  - Report methods and results, Report unacceptable behavior and conditions.

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Weak associations (measure and communication)

- ◆ Quantitatively, a weak epidemiologic association is one in which RR (or odds ratio) is less than 3.
- ◆ The closer the RR comes to unity, the more likely it can be explained by methodological difficulties: confounding, misclassification, o. sources of bias. (Better techniques in measuring risk -molecular techniques- or analytical techniques - multivariate models-to control for confounders)
- ◆ Challenges like:
  - Evaluating the independent and combined effects of chemical mixtures on disease risk.
  - Risk factor that have both effects: protective & deleterious. (ie, moderate alcohol use).
- ◆ Systematic approach to risk communication: individuals'll make informed decisions about their health.

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Measuring outcomes & quality of health care

- ◆ **Outcomes** are those changes, either favorable or adverse, in the actual or potential *health status* of persons, groups, or communities that can be attributable to medical care. (Donabedian 1985)
- ◆ **Outcomes research** is the study of end results of the structure and processes of health care on the health and well-being of patients and populations. (Feasley 1996) (Interdisciplinary: involves health serv. researchers, epidemiologists, economists, sociologists, statisticians, and ethicists; uses also elements of health economics and psychometrics).

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Preventing Chronic Diseases & other epidemics

- ◆ Public health priorities have shifted from a primary emphasis on microbiologic investigation of communicable diseases to emphasis on the etiologic role of behavioral and environmental risk factors and methods for preventing disease, disability, and death in a population.
- ◆ This has been called the "second epidemiologic revolution" (Terris 1983).
- ◆ Three leading causes of death:
  - In 1900: Pneumonia, TB and Gastritis killed 31%.
  - In 1998: Heart disease, Ca and stroke killed 63%.
- ◆ Others: unintentional injuries, violence, HIV.

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Measuring the Effects of P. H. Interventions

- ◆ Public health interventions at community level: county, town, neighborhood, school, work site, health plan, etc.
- ◆ Design and evaluating community-based interventions is one of the links between academia and health agencies.
- ◆ Interventions can be delivered via mass media, health and education professionals, community leaders, co-workers, neighbors, friends, family.
- ◆ Measuring the effects of community-level interventions can be challenged: evaluation data are typically collected at the individual level.

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Informing Public Health Policies

- ◆ Health policies should be based on epidemiology (Tennis 1980)
- ◆ Development of rational health policies takes into account efficiency, safety, and cost.
- ◆ The Epidemiologist is one in an interdisciplinary team.
- ◆ Methods based in epidemiologic principles that help inform policy decisions:
  - > Meta-analysis
  - > Decision analysis
  - > Cost-effectiveness analysis
- ◆ Basing policy on objective assessment of evidence (evidence-based policy) is increasing prominence in the policy-making area.

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Applying New Computer & Inf. Technologies

- ◆ **The relative new challenges for epidemiologists:**
  - > Expanded transmission of information:
  - > Analysis of secondary data:
  - > Enhanced information systems in PH and health care:

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Increasing Epidemiologic Capacity in Applied Settings

- ◆ There are relatively little empirical data but nevertheless it is widely accepted that a shortage of trained epidemiologists has existed in public health agencies for several decades (Detels 1979; Williams et al. 1988)
- ◆ Recent survey in 40 states health agencies found that among 11 key areas, epidemiology was rated as having the highest importance to respondents.
- ◆ Epidemiologic research in the public health agency setting is evolving.
- ◆ Successful educational programs need to maintain close contact with public health practice. (Committee for the Study of the Future of Public Health 1988).

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Summary

- ◆ The epidemiology scope is endless if the focus of being part of a team is not lost.
- ◆ Just remember: If findings from etiologic research are not put into practice, the epidemiologic puzzle is incomplete and the ultimate goal of epidemiology -to improve human health- will not be achieved. (Brownson 1998)