

# Epidemiology

## What is epidemiology?

**epi: "on or upon"**

**+**

**demos: "the (common) people"**

**+**

**logy: "study"**

**=**

## The historical context

Epidemiology originates from Hippocrates' observation more than 2000 years ago that environmental factors influence the occurrence of disease.

## What is epidemiology?

The study of the frequency, distribution and determinants of states of health in human populations and the application of this study to control health problems and improve health outcomes

## What is epidemiology?

The study of the frequency, distribution and determinants of states of health in human populations and the application of this study to control health problems and improve health outcomes

- Epidemiology as defined by Last is “the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the prevention and control of health problems”.
- Epidemiologists are concerned not only with death, illness and disability, but also with more positive health states and, most importantly, with the means to improve health. The term “disease” encompasses all unfavorable health changes, including injuries and mental health.

Box 1.2. Definition of epidemiology<sup>9</sup>

The word “epidemiology” is derived from the Greek words: *epi* “upon”, *demos* “people” and *logos* “study”.

This broad definition of epidemiology can be further elaborated as follows:

Term	Explanation
Study	includes: surveillance, observation, hypothesis testing, analytic research and experiments.
Distribution	refers to analysis of: times, persons, places and classes of people affected.
Determinants	include factors that influence health: biological, chemical, physical, social, cultural, economic, genetic and behavioural.
Health-related states and events	refer to: diseases, causes of death, behaviours such as use of tobacco, positive health states, reactions to preventive regimes and provision and use of health services.
Specified populations	include those with identifiable characteristics, such as occupational groups.
Application to prevention and control	the aims of public health—to promote, protect, and restore health.

- However, it was not until the nineteenth century that the distribution of disease in specific human population groups was measured to any large extent. This work marked not only the formal beginnings of epidemiology but also some of its most spectacular achievements.

- The finding by John Snow that the risk of cholera in London was related to the drinking of water supplied by a particular company provides a well-known example; the map highlights the clustering of cases. Snow's epidemiological studies were one aspect of a wide-ranging series of investigations that examined related physical, chemical, biological, sociological and political processes

**Table 1.1. Deaths from cholera in districts of London supplied by two water companies,<sup>3</sup> 8 July to 26 August 1854**

<b>Water supply company</b>	<b>Population 1851</b>	<b>Cholera deaths (n)</b>	<b>Cholera death rate (per 1000 population)</b>
Southwark	167 654	844	5.0
Lambeth	19 133	18	0.9

Comparing rates of disease in subgroups of the human population became common practice in the late nineteenth and early twentieth centuries. This approach was initially applied to the control of communicable diseases, but proved to be a useful way of linking environmental conditions or agents to specific diseases.

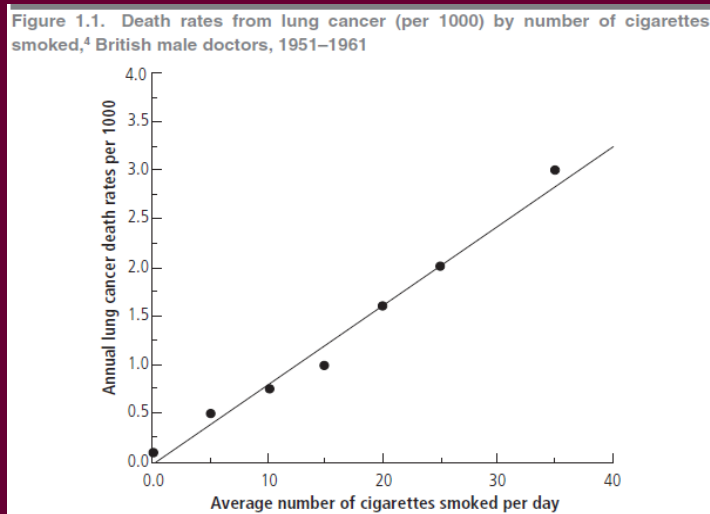
- In the second half of the twentieth century, these methods were applied to chronic noncommunicable diseases such as heart disease and cancer, especially in middle-and high-income countries

## Recent developments in epidemiology

Epidemiology in its modern form is a relatively new discipline and uses quantitative methods to study diseases in human populations to inform prevention and control efforts.



Richard Doll and Andrew Hill studied the relationship between tobacco use and lung cancer, beginning in the 1950s. Their work was preceded by experimental studies on the carcinogenicity of tobacco tars and by clinical observations linking tobacco use and other possible factors to lung cancer. By using long-term cohort studies, they were able to establish the association between smoking and lung cancer.



The British doctors' cohort has also shown a progressive decrease in death rates among non-smokers over subsequent decades. Male doctors born between 1900– 1930 who smoked cigarettes died, on average, about 10 years younger than lifelong non-smokers (Figure 1.2).

Smoking is a particularly clear-cut case, but for most diseases, several factors contribute to causation. Some factors are essential for the development of a disease and some increase the risk of developing disease.

New epidemiological methods were needed to analyze these relationships.

## Scope

A focus of an epidemiological study is the population defined in geographical or other terms; for example, a specific group of hospital patients or factory workers could be the unit of study.

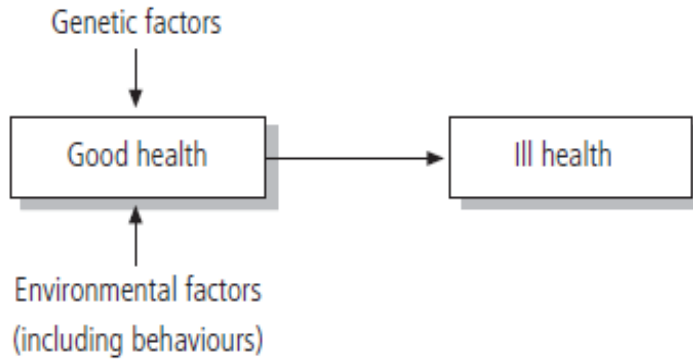
A common population used in epidemiology is one selected from a specific area or country at a specific time. This forms the base for defining subgroups with respect to sex, age group or ethnicity. The structures of populations vary between geographical areas and time periods. Epidemiological analyses must take such variation into account.

## Epidemiology and public health

Public health, broadly speaking, refers to collective actions to improve population health. Epidemiology, one of the tools for improving public health, is used in several ways (Figures 1.3).

Early studies in epidemiology were concerned with the causes (etiology) of communicable diseases, and such work continues to be essential since it can lead to the identification of preventive methods. In this sense, epidemiology is a basic medical science with the goal of improving the health of populations, and especially the health of the disadvantaged.

Figure 1.3. Causation



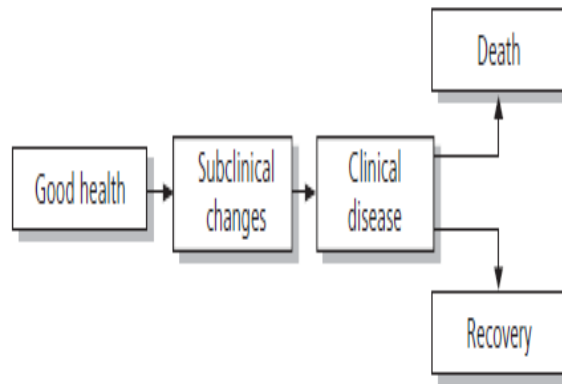
## Causation of disease

Although some diseases are caused solely by genetic factors, most result from an interaction between genetic and environmental factors. Diabetes, for example, has both genetic and environmental components. We define environment broadly to include any biological, chemical, physical, psychological, economic or cultural factors that can affect health.

## Natural history of disease

Epidemiology is also concerned with the course and outcome (natural history) of diseases in individuals and groups (Figure 1.4).

Figure 1.4. Natural history



## Differences between basic, clinical and public health science

	Basic	Clinical	Public Health
<b>What/who is studied</b>			
<b>Research goals</b>			

## Differences between basic, clinical and public health science

	Basic	Clinical	Public Health
<b>What/who is studied</b>	Cells, tissues, animals in labs	Ill patients who seek care or tx	Populations or communities
<b>Research goals</b>	Understand disease mechanisms, effects of toxic substances	Improve diagnosis and treatment of disease	Prevent disease, promote health

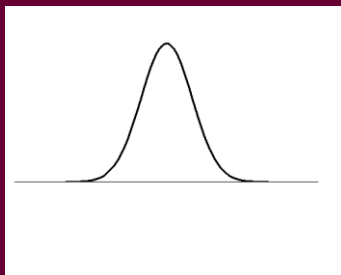
## In the lab...

- Mostly experimental
- Variables controlled by the investigator
- Highly equipment intensive
- All (or most) variables known
- Valid results (usually)
- Replication relatively easy
- Results sometimes uncertain for humans
- Little need for statistical manipulation of data

## In the community...

- Mostly observational
- Variables controlled by "nature"
- Highly labor intensive
- Some variables unknown
- Validity of data often questionable
- Replication difficult/impossible
- Meaning of results for humans clear
- Statistical control often very important

- Epidemiology is often interested in biological phenomenon with normal distributions (e.g., blood pressure, birth weight, adult weight, IQ)



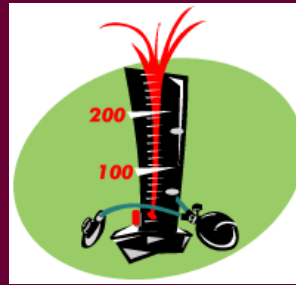
Disease states are often linked to the tails of some normally distributed phenomenon



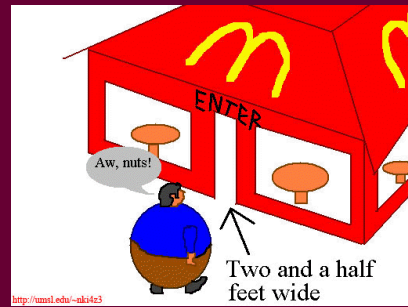
Because epidemiology is usually interested in cases of illness/disease, it is generally more interested in the tails of the distribution than in the entire distribution.



A physiologist may study blood pressure, the epidemiologist will probably study hypertension



The nutritionist studies adult weight, the epidemiologist studies obesity



## What are the objectives of epidemiology?

1. To determine the extent/frequency of disease (states of health) and/or behaviors in a community.
2. To identify the etiology or the cause/s of a disease and the factors that impact upon a person's risk for a disease.
3. To study the natural history and prognosis of disease.

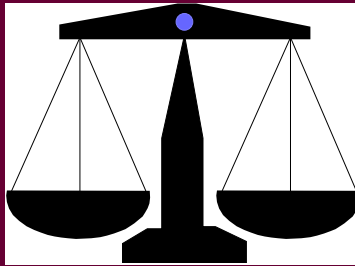
## What are the objectives of epidemiology?

4. To evaluate new preventive and therapeutic measures and new modes of health care delivery.
5. To provide the foundation for developing public policy and regulatory decisions relating to public health problems.

**"A MAJOR CHALLENGE FOR EPIDEMIOLOGY today is to become an effective instrument in the SHAPING AND EVALUATION OF HEALTH POLICIES AND PRACTICES... Epidemiologists must OBTAIN AND ANALYSE THE INFORMATION NEEDED and PRESENT IT to health planners IN SUCH A WAY THAT THIS INFORMATION CAN BE USED in policy, planning and evaluation.**

Michel Thuriaux, Epidemiology and Statistics Unit,  
WHO Regional Office for Europe, 1992

However, as epidemiologist/public health practitioners we most often need to act/intervene under conditions of uncertainty based on the available evidence



## Types of Epidemiology

## Descriptive & Analytical Epidemiology

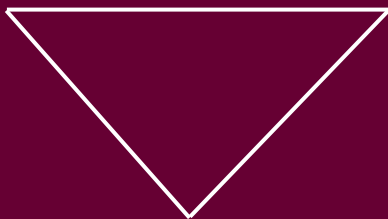
### Descriptive Epidemiology:

Examines the distribution of a disease/behavior/state of health in a defined population, and observes the features of its distribution in terms of person, place and time

What? Who? Where? When?

### Descriptive Epidemiology

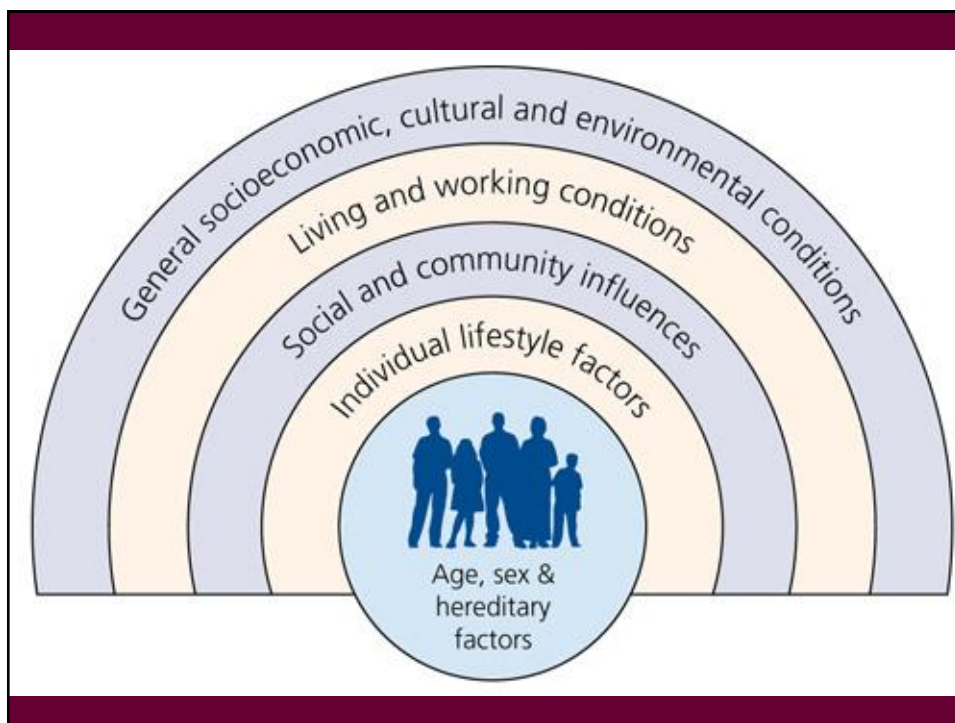
- Description of disease occurrence, by person, place and time
- Not intended to confirm causes



## Analytical Epidemiology

- Hypothesis-testing
- Tests a specific hypothesis about the relationship between a disease/behavior/state of health and a putative cause, by conducting epidemiologic investigations that relates the exposure of interest to the outcome of interest (or not)

WHY?



## Determinants of variations in morbidity and mortality

- **Proximate determinants:** Factors that directly influence the risk of disease and the outcomes of disease processes in individuals
- **Distal (underlying) determinants:** Social, economic and cultural factors that influence the health status of a population and its members through one or more of the proximate causes

## Proximate determinants of morbidity and mortality

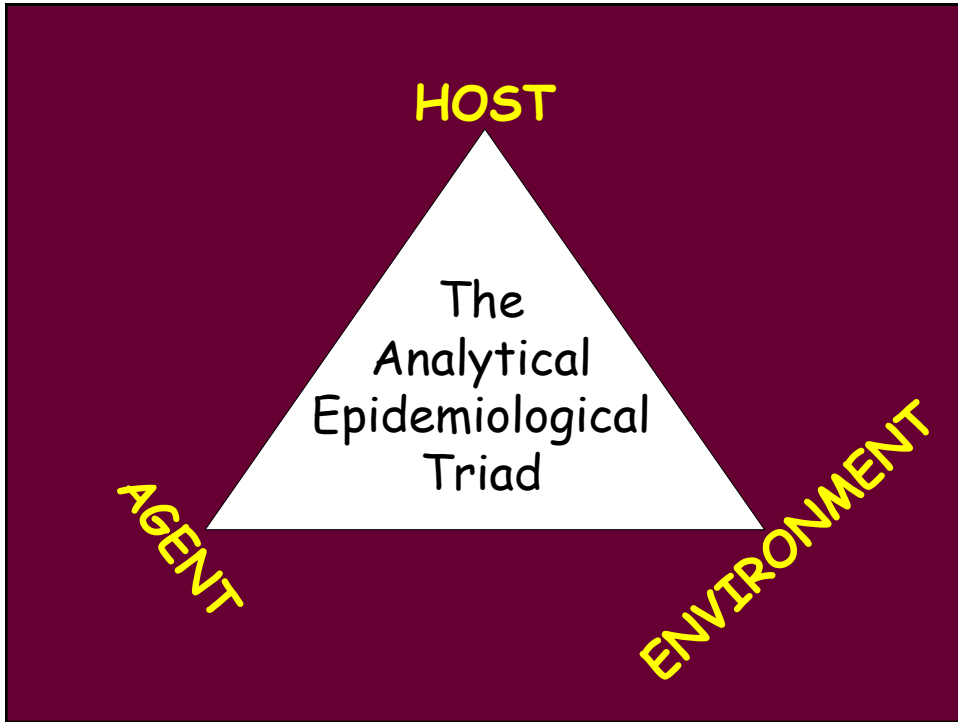
- **Personal behaviors:** diet, hygiene, physical activity, alcohol and tobacco use, sexual behavior, etc.
- **Environmental exposures:** exposure to infectious, chemical or physical agents, occupational hazards, etc.
- **Nutrition:** Under-nutrition, micronutrient deficiency, obesity
- **Injuries:** intentional or accidental injuries
- **Personal illness control:** specific preventive and sickness care actions

## Distal determinants of morbidity and mortality

- **Socio-economic factors:** personal and household wealth, community development, womens' education & employment
- **Institutional factors:** health systems, health regulations/laws, technological development, environmental interventions
- **Cultural factors:** traditional beliefs about illness & health, religious values, role & status of women, etc.
- **Broader context:** political economy, transportation and communication systems, etc.

## Analytical Epidemiology

- **Researcher attempts to control external influences by careful selection of subjects and/or statistical adjustments**
- **Observational or Experimental study designs**





## HOST FACTORS

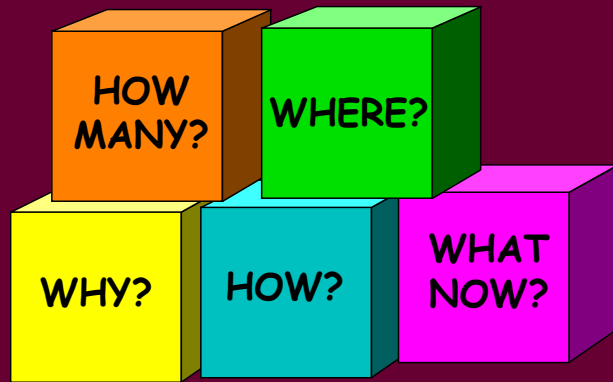
Age  
Genetic endowment  
Immunologic state  
Personal behavior

## ENVIRONMENT

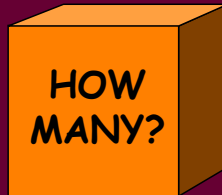
Crowding  
Atmosphere  
Modes of communication - phenomena in the environment that bring host and agent together, such as vector, vehicle, reservoir

## 5 Rubrics of Epidemiology

Anthony JC et al., 2005



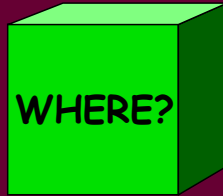
## 5 Rubrics of Epidemiology



### Quantity:

How many people in the population are affected as cases (prevalence), or are becoming cases (incidence)?

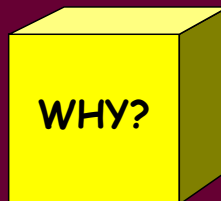
## 5 Rubrics of Epidemiology



### Location:

Where in the population are affected cases more likely to be found with respect to characteristics, conditions, and processes of person, place & time?

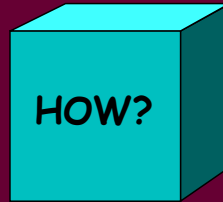
## 5 Rubrics of Epidemiology



### Causes:

What accounts for some people becoming affected and not others?

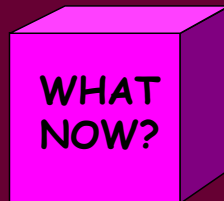
## 5 Rubrics of Epidemiology



### **Mechanisms:**

What sequences of states and processes influence who becomes and remains a case and who does not?

## 5 Rubrics of Epidemiology



### **Prevention & Intervention:**

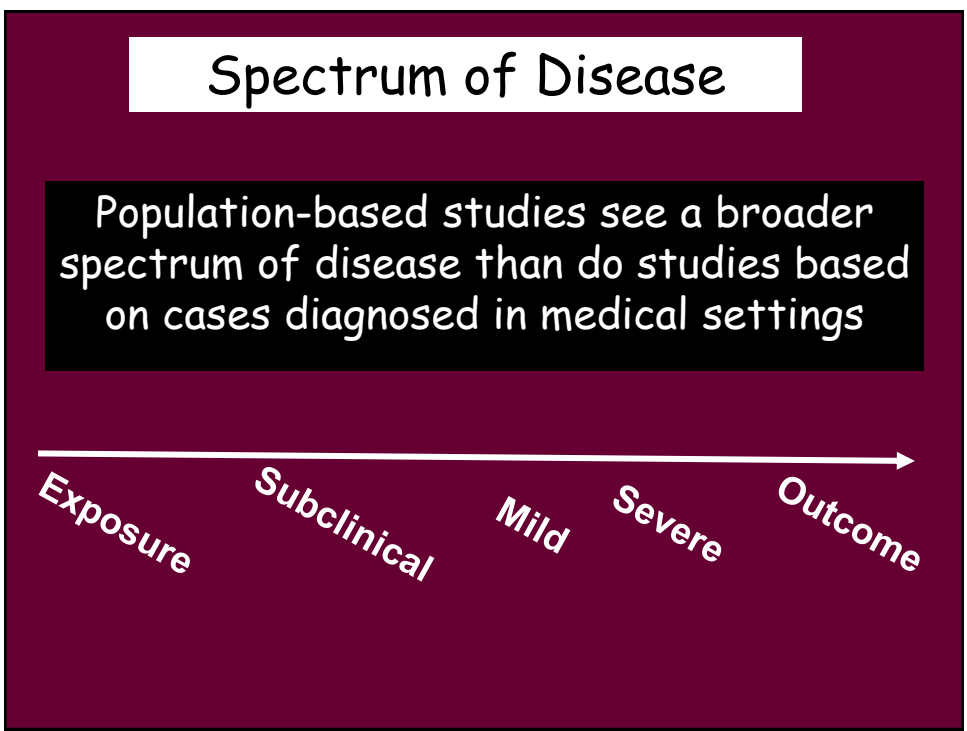
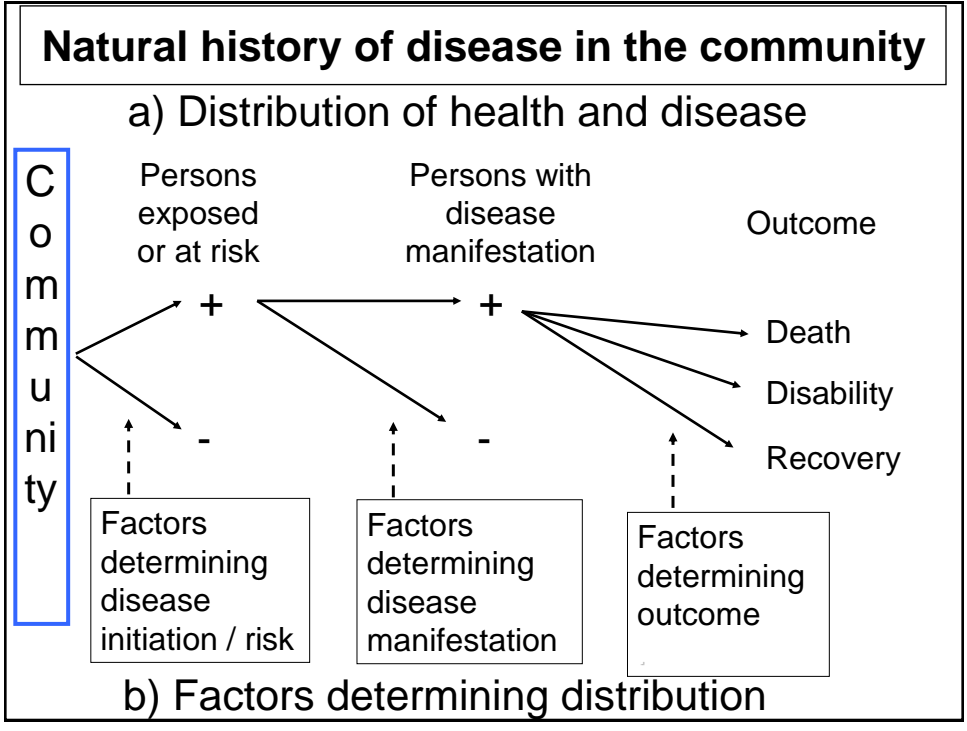
What can be done to prevent or delay onset of suffering, shorten its duration, and reduce the burden of disease from affected cases, their families, and society in general?

## Health States of PH Importance

- **Death** - not whether, but when
- **Disease** - a cluster of signs, symptoms and laboratory findings linked by a common patho-physiologic sequence, and that can cause human distress
- **Illness** - subjective state of the individual who feels aware of not being well. The ill person may or may not be suffering from disease
- **Sickness** - the social role assumed by an individual suffering from an illness

## Health States of PH Importance

- **Disability & Handicap** - difficulty in performing expected functions, especially those important to ordinary human life, i.e. interfering with work, activities of daily living, etc.
- **Destitution** - the economic burden imposed by a health state
- **Dysfunction, Discomfort, Dissatisfaction**





"Epidemiology functions as a lens through which a clinician can see along the dimension that stretches beyond the individual patient and beyond the threshold of the clinic/hospital, toward the population from which the patient came"

- Anthony et al., 1997

CAUSATI  
ON

A major goal of epidemiology is to assist in the prevention and control of disease and in the promotion of health by discovering the causes of disease and the ways in which they can be modified