MEDICAL UNIVERSITY – PLEVEN
FACULTY OF PUBLIC HEALTH
DEPARTMENT OF PUBLIC HEALTH SCIENCES

Lecture № 3

EPIDEMIOLOGY – PART 1

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LECTURE OUTLINE

1. **Definition and scope of epidemiology**
2. **Basic concepts**
3. **Measuring disease frequency**
4. **Comparing disease occurrence**
   - Absolute comparisson
   - Relative comparisson

DEFINITION AND SCOPE OF EPIDEMIOLOGY

Epidemiology: CDC Definition

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

Distribution

Determinants

Health-related States

specified Population

Application

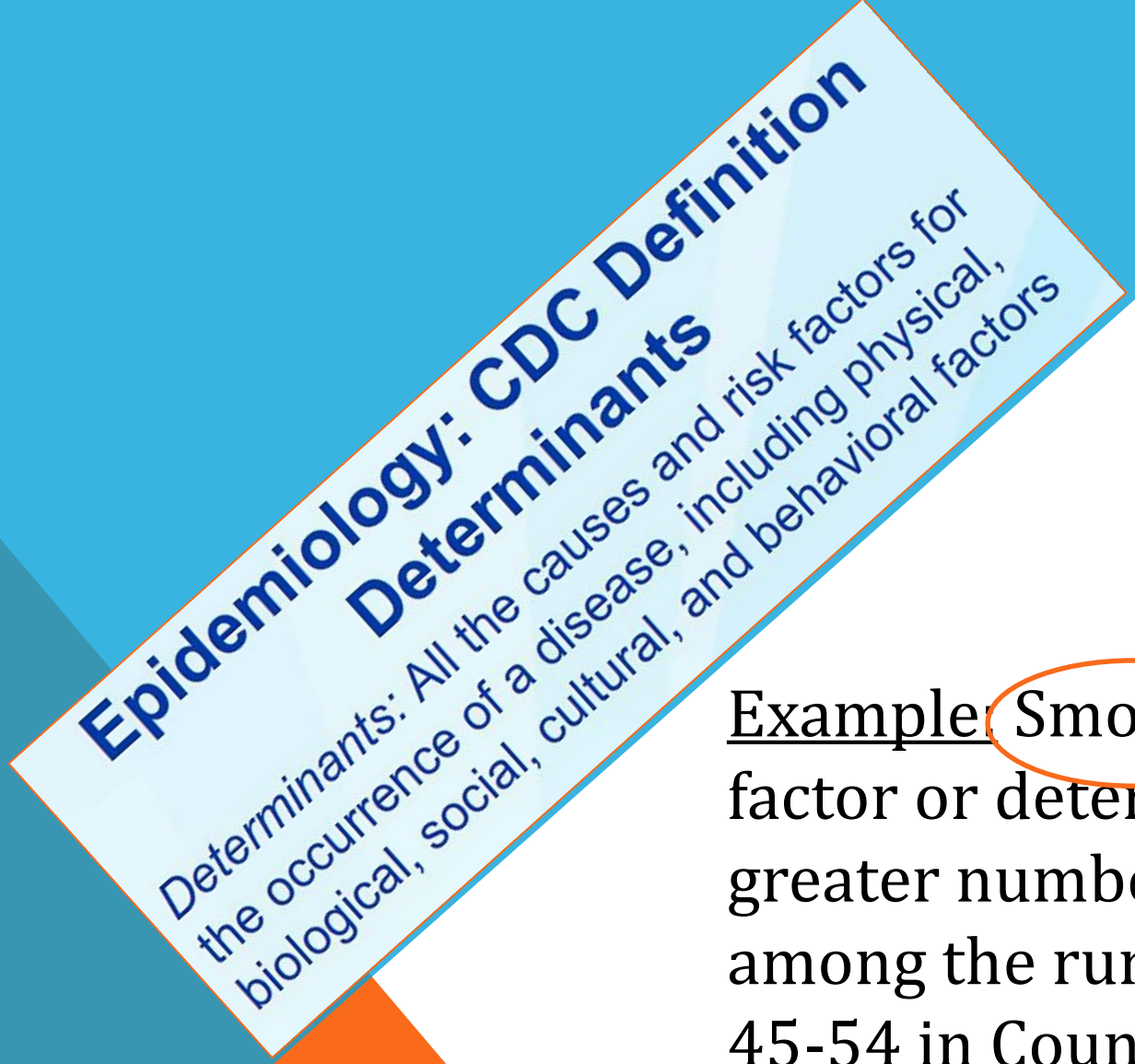
(Last, 2001)

Epidemiology: CDC Definition

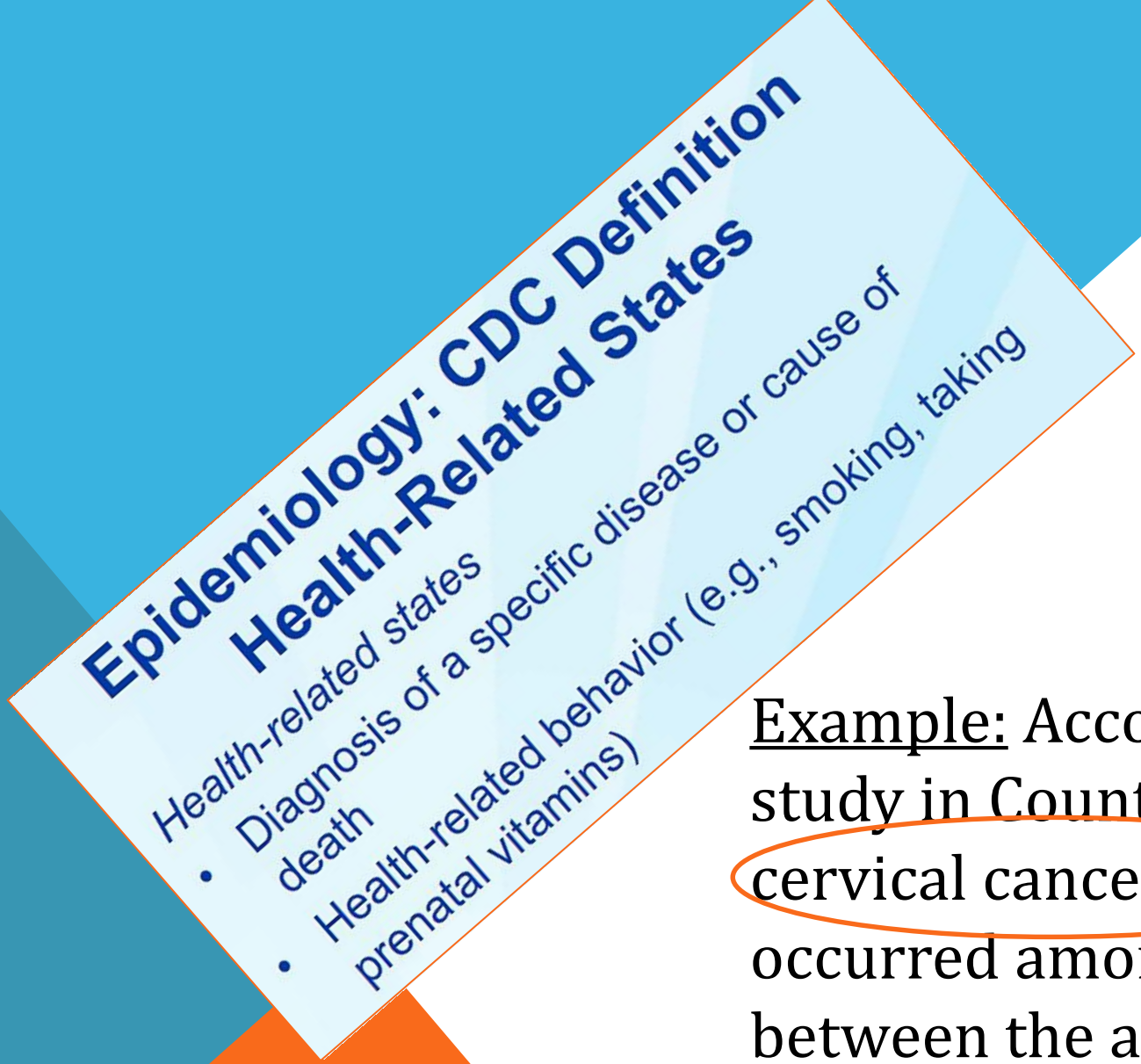
Distribution

Distribution: Occurrence of cases by **time, place, and person**

Example: According to a study of deaths in Country X in 2014, 1034 deaths of cervical cancer occurred among the rural women between the ages of 45-54.



Example: Smoking was a risk factor or determinant for the greater number of cancer deaths among the rural women ages of 45-54 in Country X.

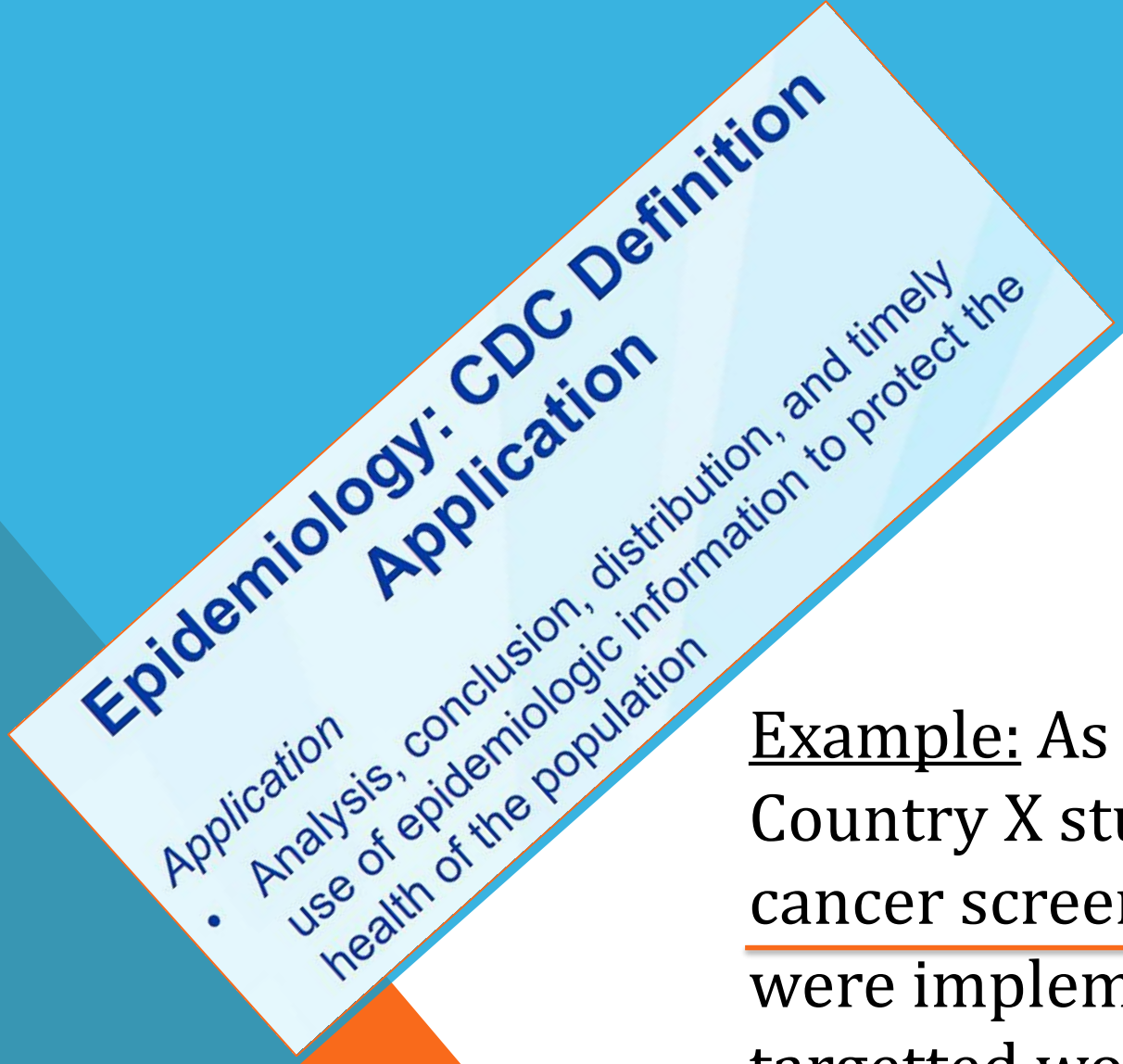


Example: According to 2014 study in Country X, 1034 cervical cancer deaths occurred among rural women between the ages of 45-54.

Epidemiology: CDC Definition Specified Population

Specified Population: A measurable group, defined by location, time, demographics, and other characteristics

Example: According to 2014 study in Country X, 1034 cervical cancer deaths occurred among rural women between the ages of 45-54.



Example: As a result of the Country X study, free cervical cancer screening programmes were implemented. They targetted women living in remote areas to find cancer in earlier stages and prevent death.

Epidemiology: CDC Definition

"The study of the distribution and determinants of
n specified po
s study to cont

Descriptive epidemiology

Analytic epidemiology

Distribution

Determinants

Health-related States

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Application

(Last, 2001)

Descriptive Epidemiology

- Studies the *pattern* of health events and their *frequency* in populations in terms of:
  - Person
  - Place
  - Time
- Purpose:
  - To identify problems for further study
  - To plan, provide, and evaluate health services

Analytic Epidemiology

- Studies the association between *risk factors* and disease
- Purpose:
  - To determine *why* disease rates are high (or low) in a particular group

Purpose of Epidemiology

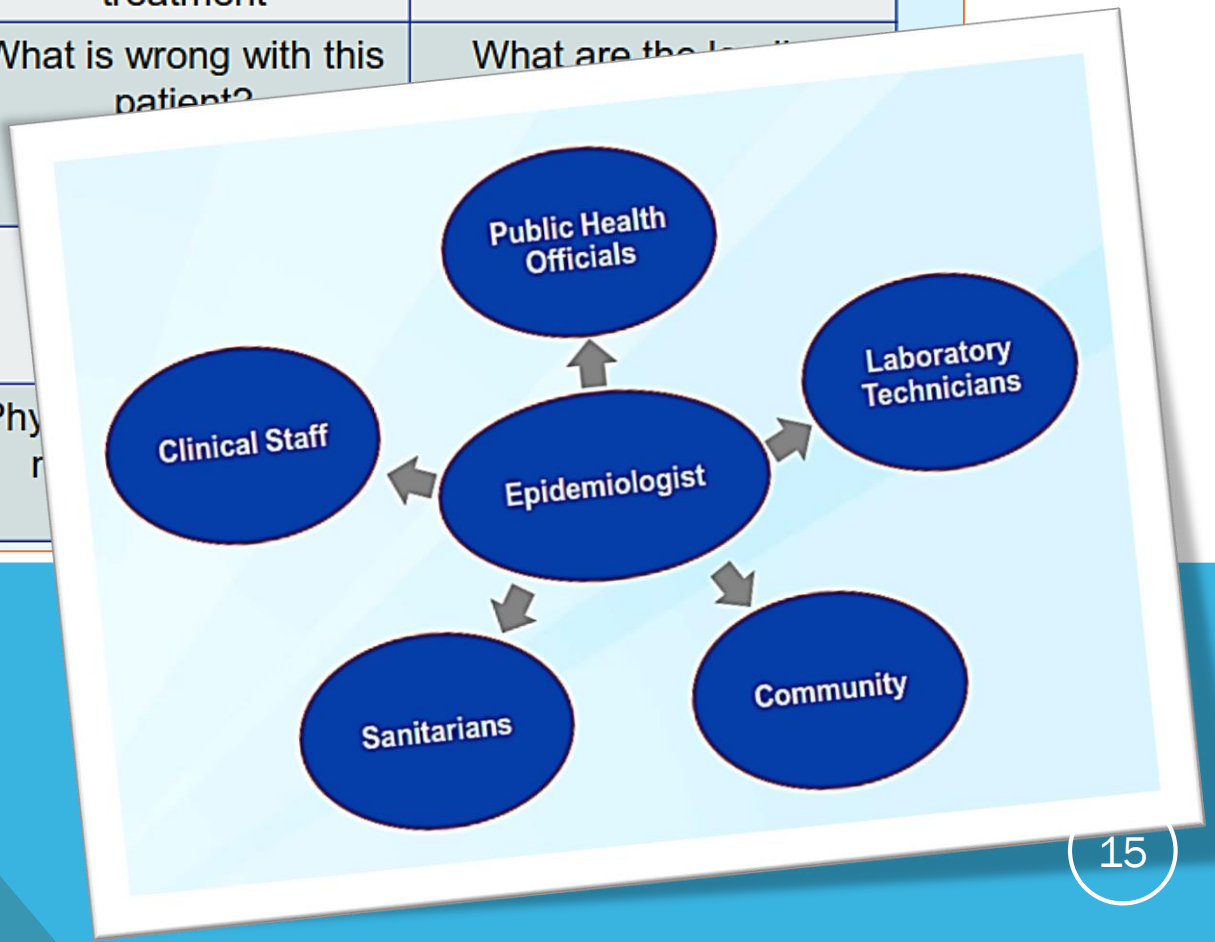
- To measure frequency of disease
  - Quantify disease
- To assess distribution of disease
  - Who is getting disease?
  - Where is disease occurring?
  - When is disease occurring?
- To form hypotheses about causes and preventive factors
- To identify determinants of disease
  - Hypotheses are tested using epidemiologic studies

Epidemiologic Assumptions

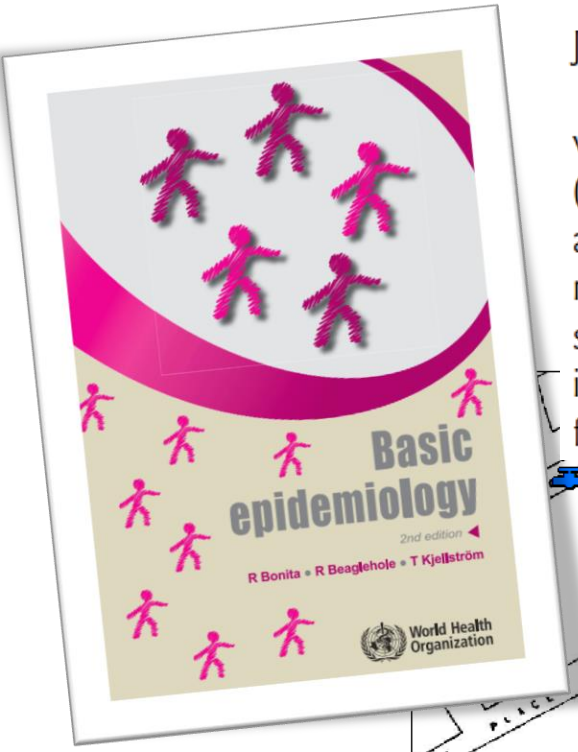
- Diseases and other health-related events do not occur at random
- Diseases and other health-related events usually have causal and preventive factors that can be found

Approaches in Medicine vs. Epidemiology: Who is Involved?

Approach/ Consideration	Clinical Medicine	Epidemiology
Focus	Individuals	Populations
Main Goal	Diagnosis and treatment	Prevention and control
Questions	What is wrong with this patient?	What are the h...
Treatment		
Who is involved?	Phy...	



HISTORICAL REMARKS



John Snow located the home of each person who died from cholera in London during 1848–49 and 1853–54, and noted an apparent association between the source of drinking-water and the deaths.[3] He compared cholera deaths in districts with different water supplies (Table 1.1) and showed that both the number of deaths and the rate of deaths were higher among people supplied water by the Southwark company. On the basis of his meticulous research, Snow constructed a theory about the communication of infectious diseases and suggested that cholera was spread by contaminated water. He was able to encourage improvements in the water supply long before the discovery of the organism responsible for cholera; his research had a direct and far-reaching impact on public policy.

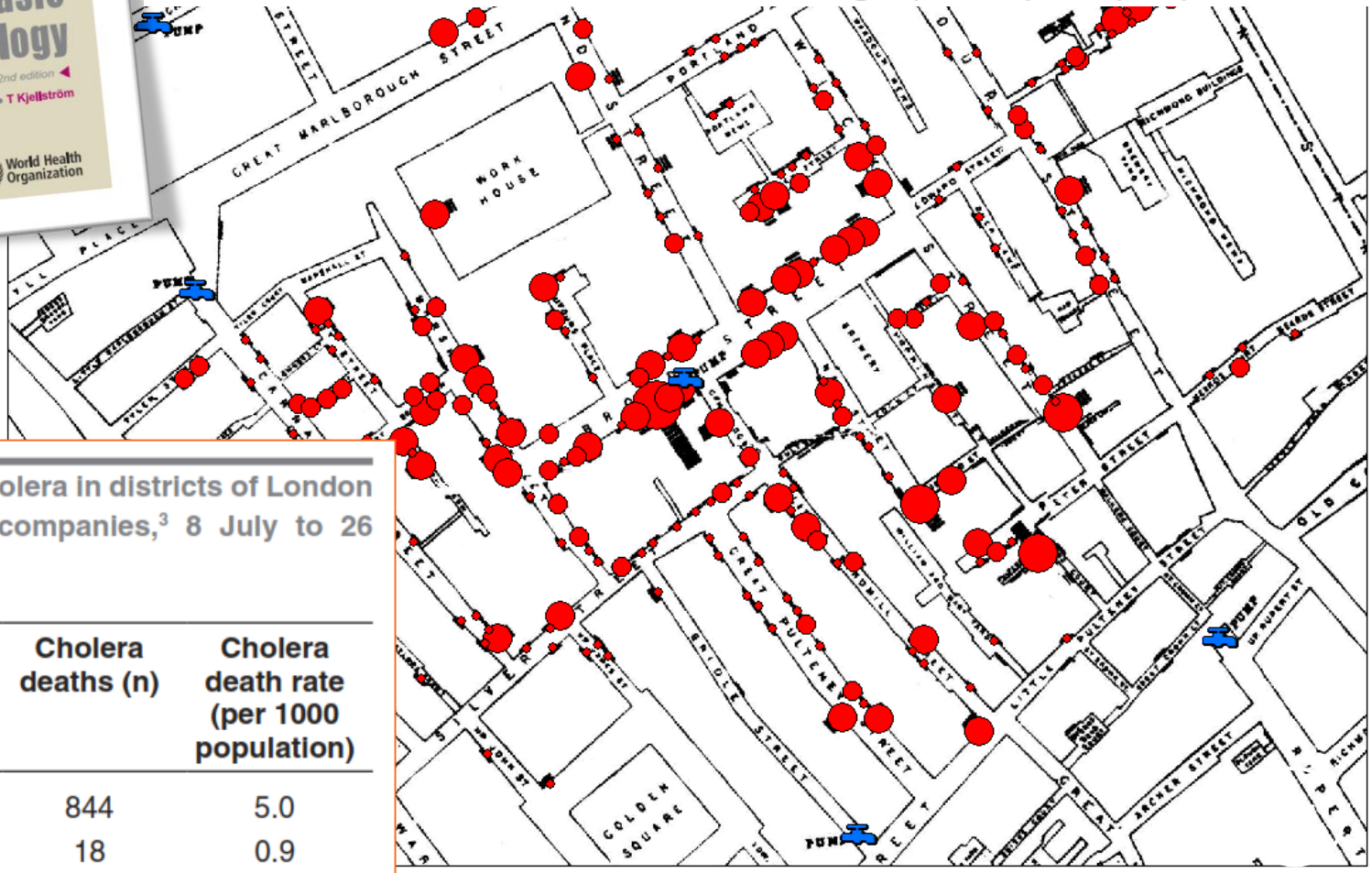
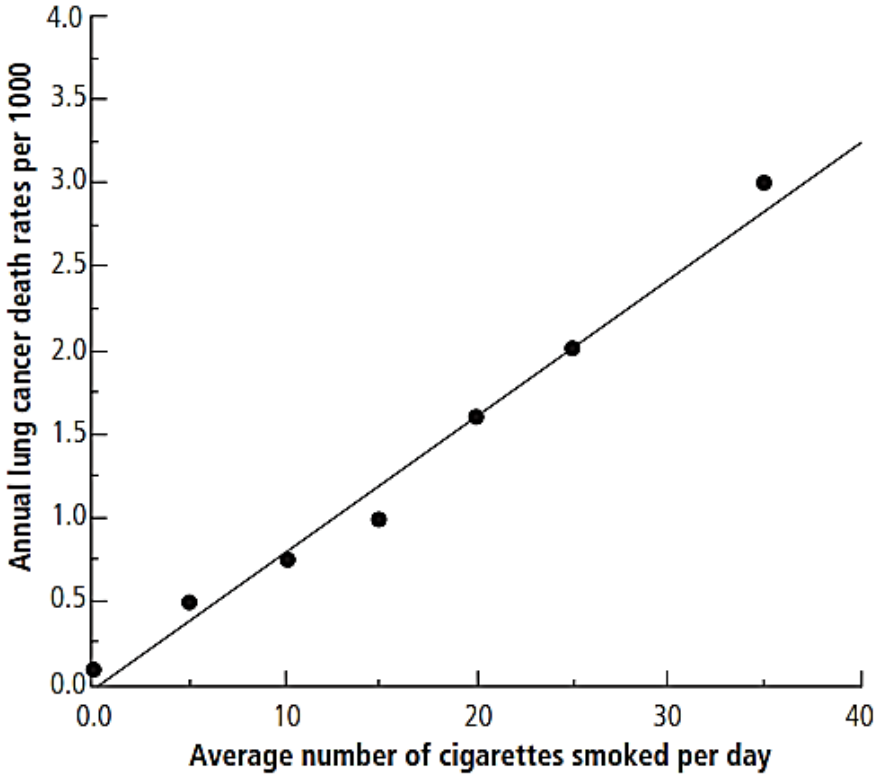


Table 1.1. Deaths from cholera in districts of London supplied by two water companies,[3] 8 July to 26 August 1854

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

RICHARD DOLL AND ANDREW HILL'S STUDY
ON THE RELATIONSHIP BETWEEN SMOKING AND LUNG CANCER

Figure 1.1. Death rates from lung cancer (per 1000) by number of cigarettes smoked,[4] British male doctors, 1951–1961



BASIC CONCEPTS

- Risk
- Risk factor
- Exposed group
- Population at risk
- Rate
- Ratio
- Proportion

RISK

THE PROBABILITY THAT AN EVENT WILL OCCUR - AN INDIVIDUAL WILL BECOME ILL.

Risk Factor

"An aspect of personal behavior or lifestyle, an environmental exposure, or a hereditary characteristic that is associated with an increase in the occurrence of a particular disease, injury, or other health condition."

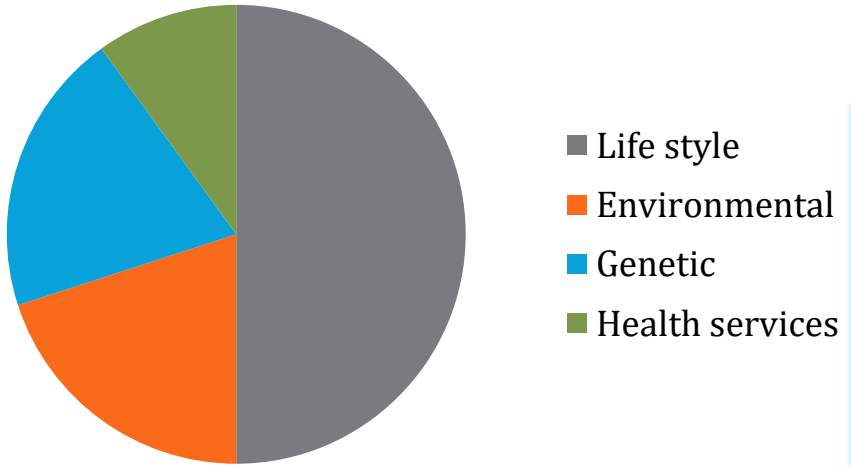
RISK FACTORS ARE OBSERVABLE OR IDENTIFIABLE PRIOR TO THE EVENT THEY PREDICT.

RISK FACTORS CLASSIFICATION

MODIFIABLE / NON-MODIFIABLE
INDIVIDUAL / COMMUNITY

- LIFE STYLE ~ 50%
- ENVIRONMENTAL ~ 20%
- GENETIC ~ 20%
- HEALTH SERVICES ~ 10%

Risk factors contributing for non-communicable diseases



Modifiable Risk Factor

A risk factor that **can** be reduced or controlled by intervention, thereby reducing the probability of disease.

The WHO has prioritized the following four:

- Physical inactivity
- Tobacco use
- Alcohol use
- Unhealthy diets

Noncommunicable Diseases

4 Diseases, 4 Modifiable Shared Risk Factors

	Tobacco Use	Unhealthy diets	Physical Inactivity	Harmful Use of Alcohol
Cardio-vascular	✓	✓	✓	✓
Diabetes	✓	✓	✓	✓
Cancer	✓	✓	✓	✓
Chronic Respiratory	✓			

Noncommunicable Diseases
World Health Organization

World Health Organization

Non-Modifiable Risk Factor

A risk factor that **cannot** be reduced or controlled by intervention, for example:

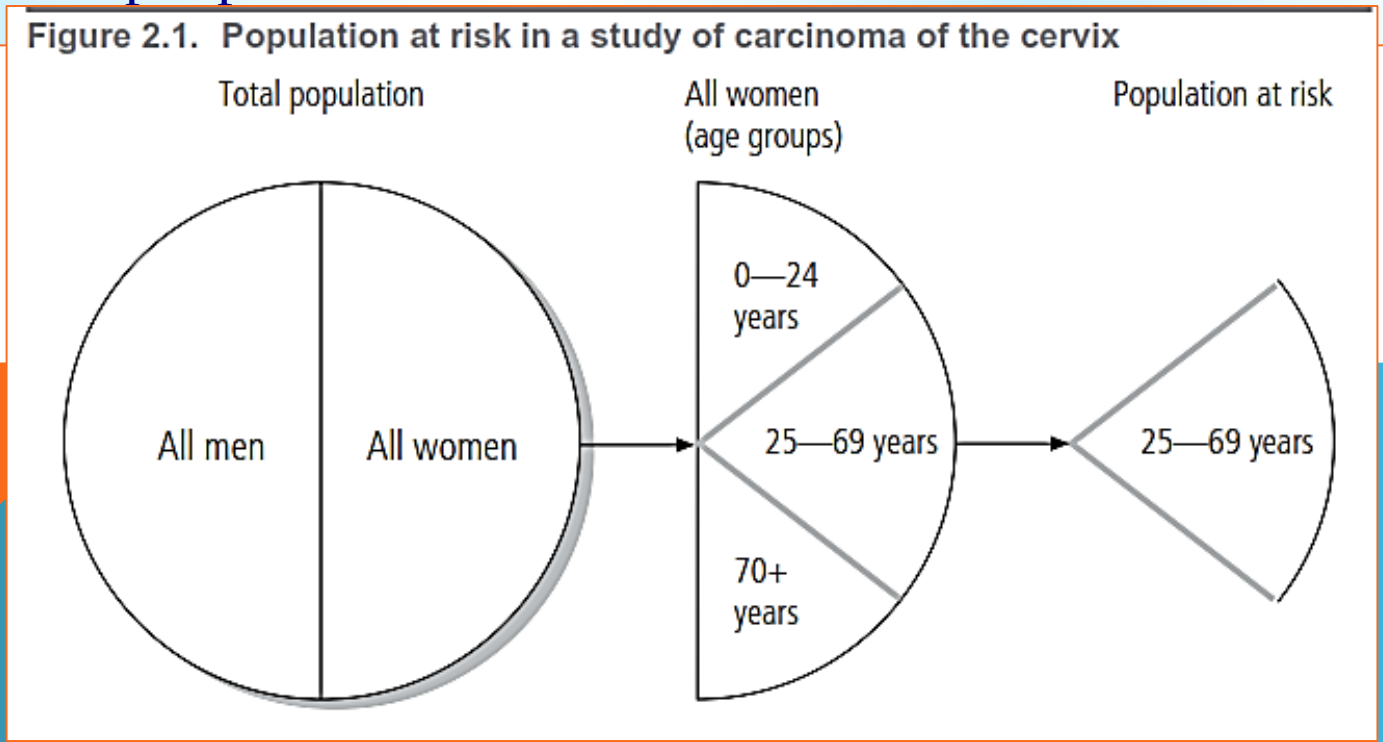
- Age
- Gender
- Race
- Family history (genetics)

EXPOSED GROUP

A GROUP WHOSE MEMBERS HAVE BEEN EXPOSED TO A SUPPOSED CAUSE OF A DISEASE OR HEALTH STATE OF INTEREST, OR POSSESS A CHARACTERISTIC THAT IS A DETERMINANT OF THE HEALTH OUTCOME OF INTEREST.

POPULATION AT RISK

- That part of the population which is susceptible to a disease.
- All those to whom an event could have happened whether it did or not.
- Those who are capable of having or acquiring the disease or condition in question /sometimes it may be necessary to exclude people which are not at risk/.



RATE

A measure of the occurrence of a health event in a population group at a specified time period

$$Rate = \frac{numerator}{denominator}\ x\ multiplier$$

$$Rate = \frac{Number\ of\ cases\ of\ studied\ event}{Population\ at\ risk\ for\ this\ event}\ x\ 10^{n}$$

- Consistency between the numerator and the denominator.
- The numerator should be part of the denominator.

TYPES OF RATES

CRUDE RATES

- **consider the entire population**

SPECIFIC RATES

- **consider differences among subgroups of the population**

ADJUSTED RATES

- **adjust for differences in population composition**

RATIO

- **Relation in size between two random quantities**
- **The numerator is not a component of the denominator**

$$Ratio = \frac{numerator\ (not\ a\ component\ of\ the\ denominator)}{denominator}$$

$$Example: \quad Sex\ Ratio = \frac{females}{males}$$

PROPORTION

- **Relation in magnitude of a part of the whole**
- **The numerator is always included in the denominator**
- **Usually expressed in percentage**

$$Proportion = \frac{PART\ of\ the\ whole\ event}{the\ whole\ event}\ x\ 100\ (\%)$$

MEASURING DISEASE FREQUENCY

PREVALENCE

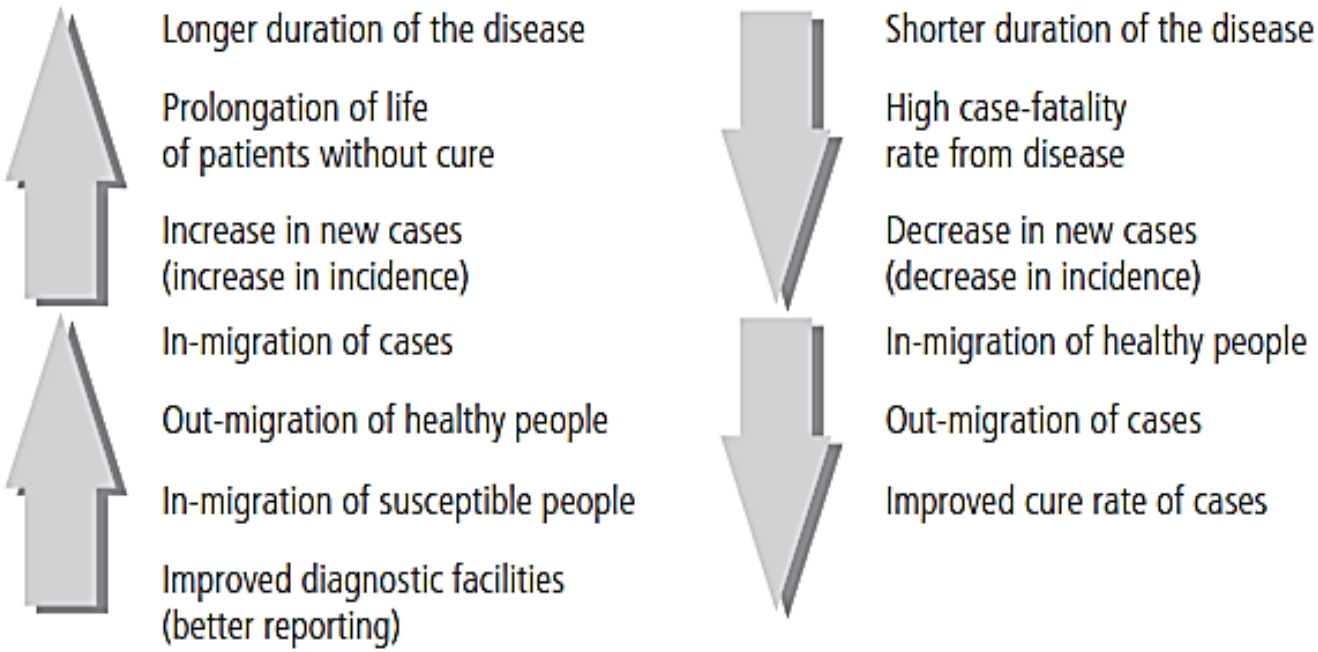
The number of all current cases /old and new/ existing in a defined population at a specified point of time, or over period of time in a given population.

- Point prevalence
- Period prevalence

$$Prevalence = \frac{Number\ of\ existing\ cases\ of\ disease}{Population\ at\ risk}\ x\ 10^{n}$$

$$Prevalence = \frac{Number\ of\ existing\ cases\ of\ disease}{Population\ at\ risk}\ x\ 10^n$$

Figure 2.2. Factors influencing prevalence



INCIDENCE

The number of new cases occurring in a given population during a specified period of time.

$$Incidence = \frac{Number\ of\ new\ cases\ of\ disease}{Person - years}\ x\ 10^n$$

Sum of length of time during which each person in the population is at risk

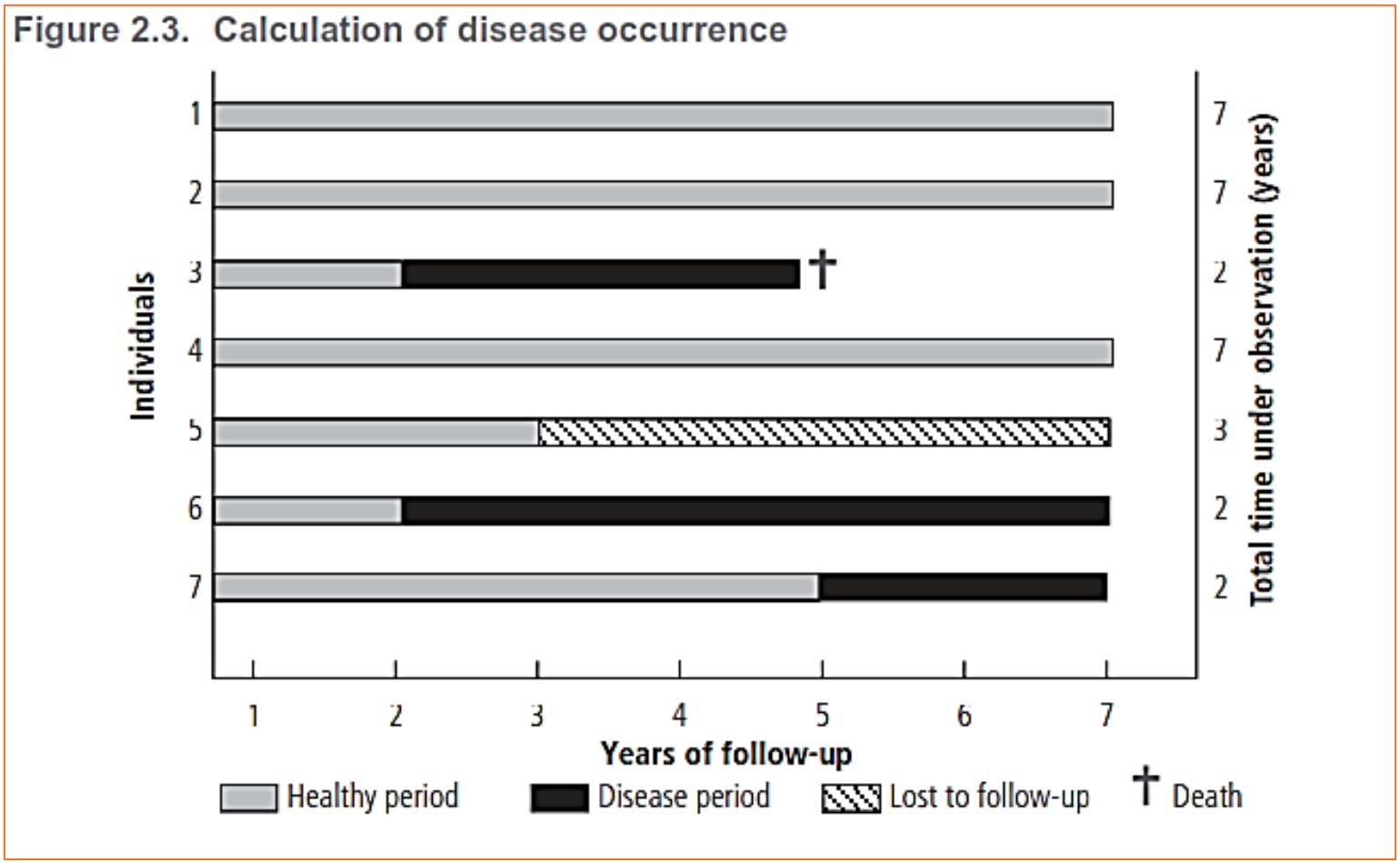
Average size of the study population multiplied by the length of the study period

CUMULATIVE INCIDENCE

Number of new cases of disease occurring over a specified period of time in a population at risk (at the beginning of the interval).

- Simpler measure of the occurrence of a disease or health status.
- The probability or risk of individuals in the population getting the disease during the specified period.

$$Cumulative\ Incidence = \frac{Number\ of\ new\ cases\ of\ disease}{Population\ at\ risk\ at\ the\ begining\ of\ the\ period}\ x\ 10^n$$



I = 3/33 x 100 = 9.1 cases per 100 person-years

CI = 3/7 x 100 = 43 cases per 100 persons

P (at year 4) = 2/6 x 100 = 33 cases per 100 persons

COMPARING DISEASE OCCURENCE

ABSOLUTE COMPARISON	RELATIVE COMPARISON
Indicates on an absolute scale how much greater the frequency of the disease is in one group compared with the other	Indicates how much more likely one group is to develop a disease than another
▪ Risk difference /Excess risk, Attributive risk of exposed/ ▪ Ethiologic /Attributable/ fraction of exposed ▪ Population attributive risk	▪ Relative risk ▪ Odds ratio

RISK DIFFERENCE

- Provides information about the absolute effect of the exposure or the excess risk of disease in those exposed compared with those nonexposed.
- Quantifies the risk of disease in the exposed group that can be considered attributable to the exposure by removing the risk of disease that would have occurred anyway due to the other causes /the risk in the nonexposed/
- The number of cases of the disease among the exposed that could be eliminated if the exposure were eliminated.

$$RD = I_e - I_0$$

ETHIOLOGIC /ATTRIBUTABLE/ FRACTION OF EXPOSED

The proportion of the disease in the specific population that would be eliminated in the absence of exposure.

An useful tool for assessing priorities for public health action.

$$EF = \frac{I_e - Io}{I_e} \; x \; 100$$

POPULATION ATTRIBUTABLE RISK

- Measure of the excess rate of disease in a total study population which is attributable to an exposure.
- Determines the proportion by which the incidence rate of the outcome in the entire population would be reduced if exposure were eliminated.
- Helps to determine which exposures have the most relevance to the health of a community.

$$PAR = \frac{I_p - Iu}{I_p} \; x \; 100$$

RELATIVE RISK

- Estimates the magnitude of an association between exposure and disease.
- Indicates how many times the risk of developing disease by the exposed is greater than the risk of developing the same disease by the nonexposed.
- The larger the relative risk, the stronger the association between cause and effect.

$$RR = \frac{I_e}{I_o}$$

Table 2.4. Relationship between cigarette smoking and incidence rate of stroke in a cohort of 118 539 women[13]

Smoking category	Number of cases of stroke	Person-years of observation (over 8 years)	Stroke incidence rate (per 100 000) person-years)
Never smoked	70	395 594	17.7
Ex-smoker	65	232 712	27.9
Smoker	139	280 141	49.6
Total	274	908 447	30.2

RD = 49,6 - 17,7 = 31,9 per 100 000 person-years
EF = 31,9 / 49,6 x 100 = 64%
PAR = 30,2 - 17,7 / 30,2 x 100 = 41,4%
RR = 49,6 / 17,7 = 2,8

ODDS RATIO

- Estimates the magnitude of an association between risk factor and outcome.
- Substite RR when we are not able to calculate the incidence rate among the exposed and unexposed because we have no data about the population at risk /in case-control studies/.

disease / exposure	yes	no	total
yes	a	b	a + b
no	c	d	c + d
total	a + c	b + d	a + b + c + d

$$OR = \frac{a \; x \; d}{b \; x \; c}$$