Measures of Disease Frequency, Effect and Impact

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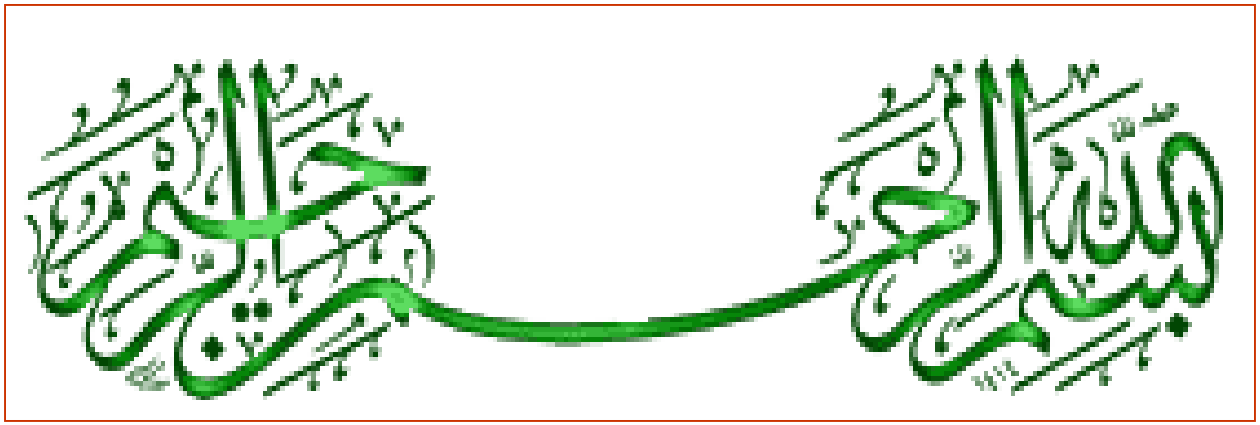
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Learning objectives

- Define & calculate Incidence & Prevalence
  (measures of disease frequency)

- Interpret the relation between incidence and prevalence rates

- List the measures of effect & impact showing
  - relative difference in risks &
  -absolute risk difference
  in ref to those exposed & not exposed to risk factor

Measures of Disease Frequency

- Morbidity rates are indicators of health

- The main measures of disease frequency are:
  - Incidence Rate
  - Attack Rate
  - Prevalence Rate

Types of Fractions Used in Describing Disease Frequency

Proportions

Percentages

Ratios

Rates

Important terms to understand

- Proportion: unit less, % or fraction of a population with an illness or other characteristic [prevalence]
- Rate: How fast the disease is occurring in population with time specification [incidence]
- Ratio: dividing one quantity by another

  e.g. male female, waist hip, MMR

Important terms to understand

- **Exposure (E)**

  risk factor,

  potential health determinant;

  the independent variable

  e.g. Smoking

- **Disease (D)**

  outcome after exposure to the risk factor

  development of disease (death, or disability included)

  the dependent variable

  e.g. Lung cancer

Incidence rate

Cumulative incidence rate

measures the number of **new** cases of a disease that occur in a specified time period in a population at risk

$$Incidence\ rate = \frac{new\ cases\ ocurring\ during\ a\ given\ time\ period}{population\ at\ risk\ during\ the\ same\ time\ period} \times 10^n$$

$$\text{Incidence rate} = \frac{\text{numerator}}{\text{denominator}}$$

The **numerator** should:

-reflect new cases of a disease occurring in a given time period

- not include cases which occurred earlier than the given time.

-come from the population at risk for developing disease

- be a part of the denominator

Example: Incidence

There were 50 cases of Cancer of breast that developed during January to December in 2010 among the 10,000 women above 40 years of age living in city X

~ 50/10,000 is the incidence rate of Ca breast in women above 40 years of age from January 1, 2010 to December 31, 2010 living in City X

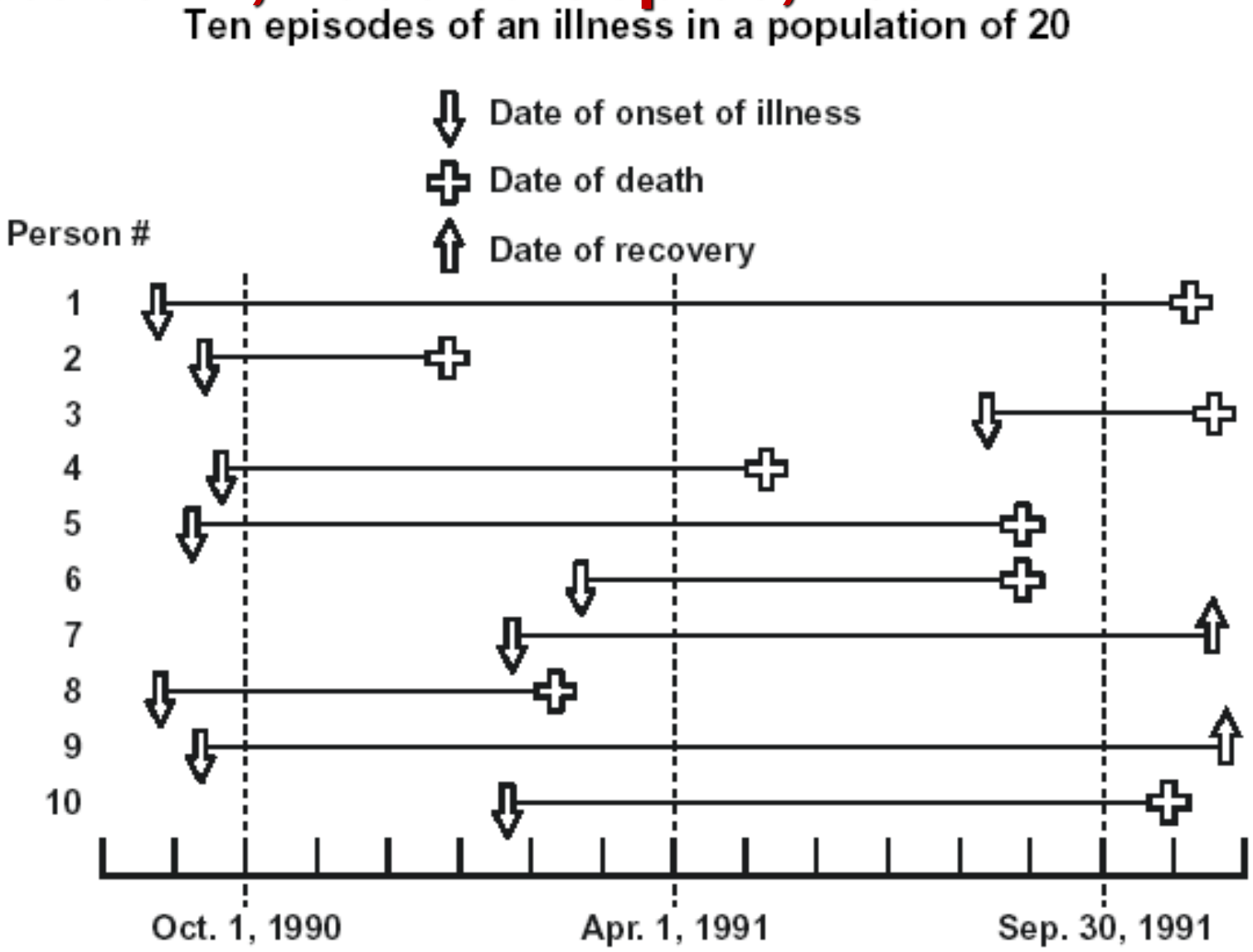
Incidence of Ca Breast was 5/1000 women above the age of 40 yrs in 2010 in City X

Example: Incidence

- The **denominator** should include persons at risk to develop the disease that is being described during the time period covered.
- The denominator may change over time as people develop disease

- ***E.g. if ca breast needs to be studied in 2011 ; all those women who developed Ca breast in 2010 will be excluded from the denominator during 2011***

What is the incidence rate from October 1, 1990 to Sep 30, 1991?



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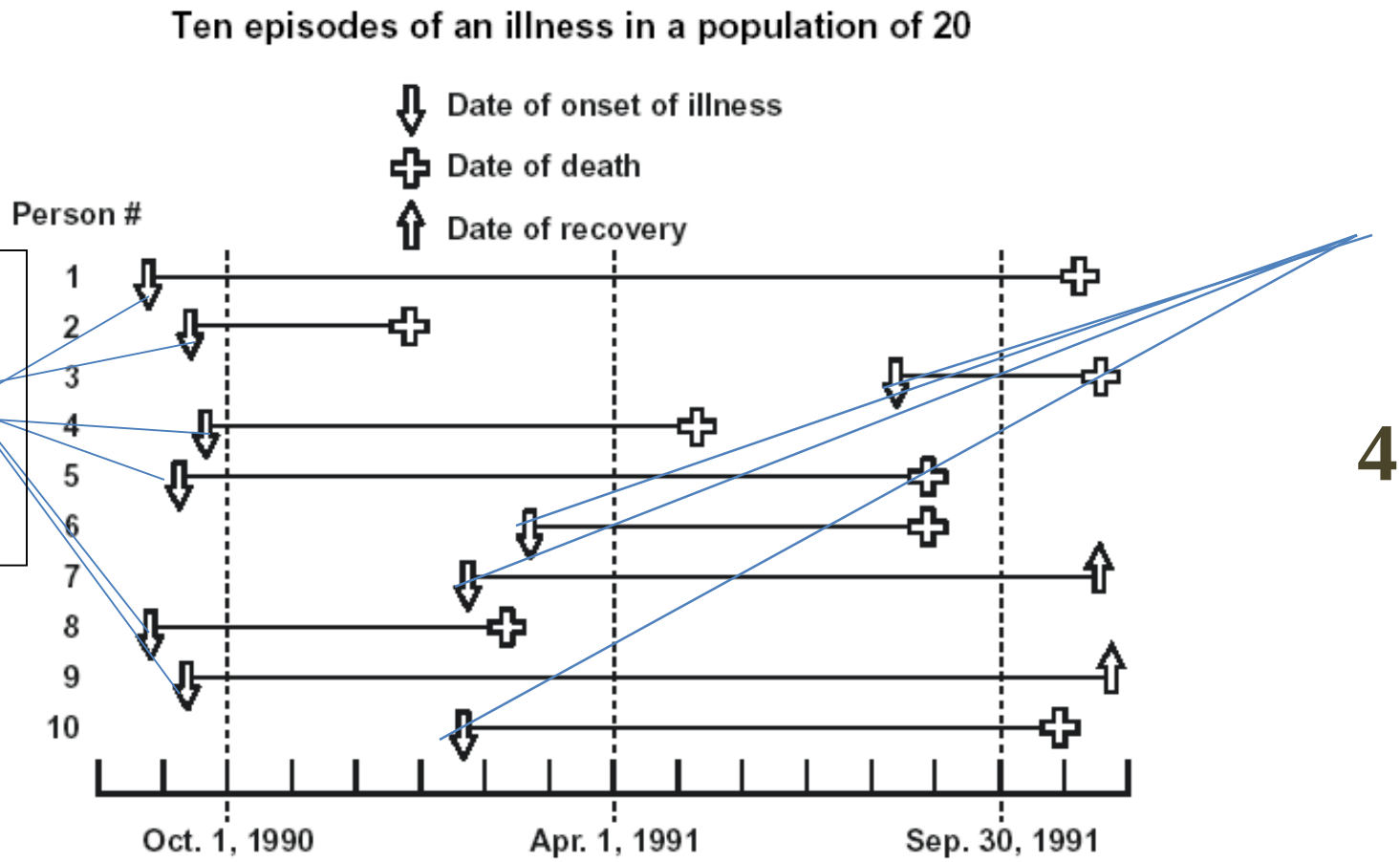

As they have disease; exclude from denominator; not at risk of developing disease

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Factors affecting incidence rate

- **New risk factor**
  - oral contraceptives as exposure and increase in thrombo-embolism in women;
  - food additives and cancer
  - New virus (HIV and AIDS)
- **Changing habits**
  - increased smoking and development of lung cancer
  - fluoridated water and decrease in dental caries

Factors affecting incidence rate

- **Changes in virulence of causative organisms**
  - drug-resistant bacteria (TB)
  - Influenza virus mutation Increase influenza (H1N1)
  - drug resistance to malaria prophylaxis and increase in malaria

❑**Changes from intervention programs**

- vaccination against measles ⇩ incidence of measles
- Polio eradication campaigns ⇩ incidence of polio
- Chemoprophylaxis ⇩ meningitis, Rheumatic diseases

Factors affecting incidence rate

- **Selective migration** of susceptible persons to an endemic area ⇧ incidence
- **Population pattern**
  - Aging ⇧ incidence of Degenerative diseases
- ***Reporting***
  - Increased reporting ⇧ incidence
- ***Screening***
  - Early detection of cases ⇧ incidence
- ***New diagnostic tools***
  - New diagnostic tools ⇧ detection of cases

Attack Rate

An attack rate is a variant of an incidence rate, applied to a narrowly defined population observed for a limited time, such as during an epidemic.

The attack rate is usually expressed as % **percent.**

$$Attack\ rate = \frac{Number\ of\ new\ cases\ among\ the\ population\ \ during\ the\ period}{Population\ at\ risk\ at\ the\ beginning\ \ of\ \ the\ period} \times 100$$

Example

Of 76 persons who attended a picnic, 46 subsequently developed gastroenteritis.

Calculate the attack rate of gastroenteritis

Attendees = 76

ILL = 46

Attack rate = (46 ÷ 76) X 100

= 61%

Prevalence Rate

Divided into two types:

- Point prevalence
- Period prevalence

Prevalence Rate

It is the number of old and new cases occurring over a specific period of time divided by the mid year population

$$Prevalence = \frac{all\ new\ and\ pre\text{-}existing\ cases\ during\ a\ given\ time\ period}{population\ during\ the\ same\ time\ period} \times 10^{n}$$

(when the type of prevalence rate is not specified it is usually point prevalence)

Example

- Question asked:

  Does your child has diarrhea today?

  Yes/No

- e.g. 80 mothers said yes and 1000 were questioned
- What is the point prevalence of diarrhea in children?

Period Prevalence

Proportion of individuals in a specified population who have the disease of interest over a specified period of time. *e.g. annual prevalence, lifetime prevalence rate.*

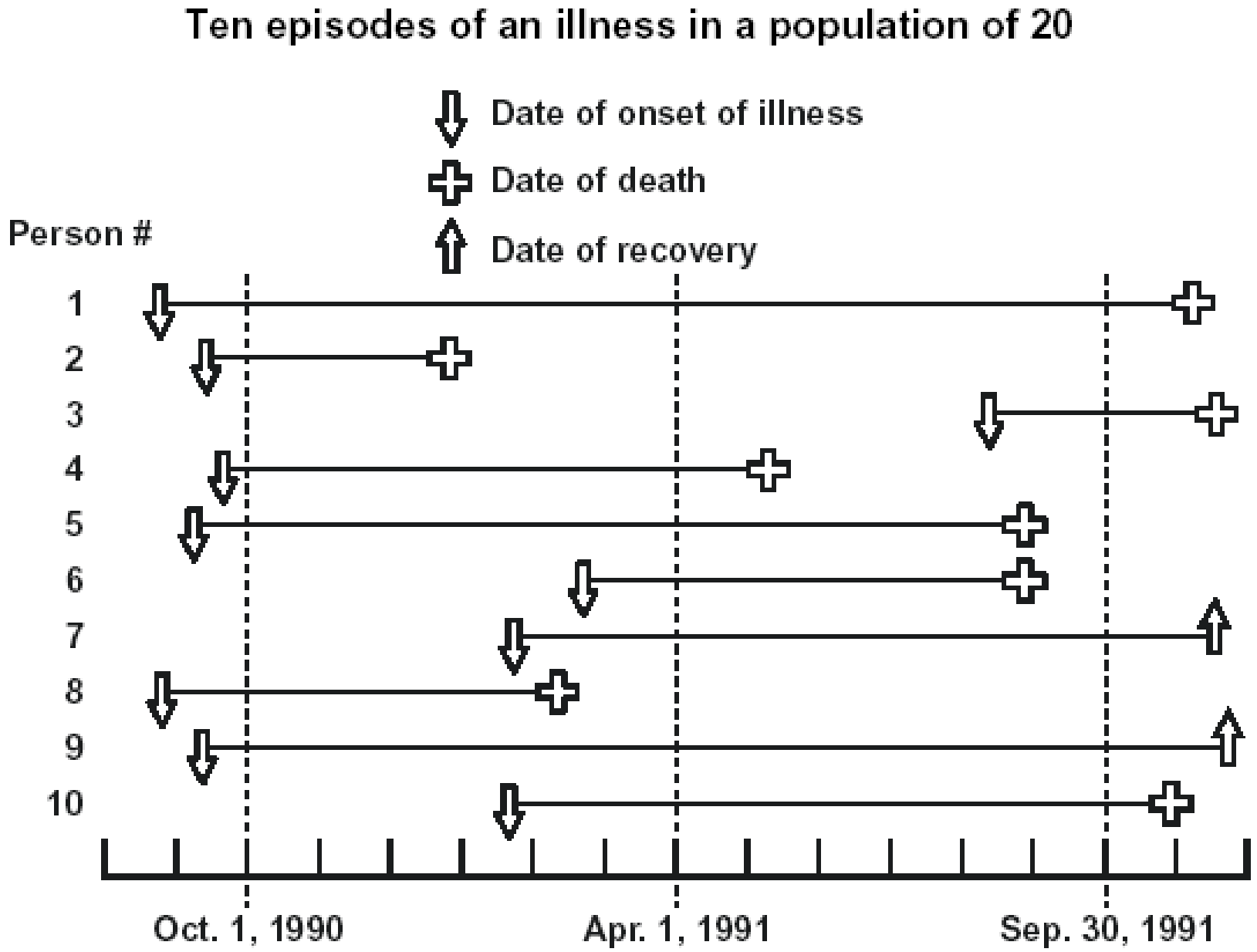
Question asked:

‘Had you ever had asthma?’ Response was either Yes /No

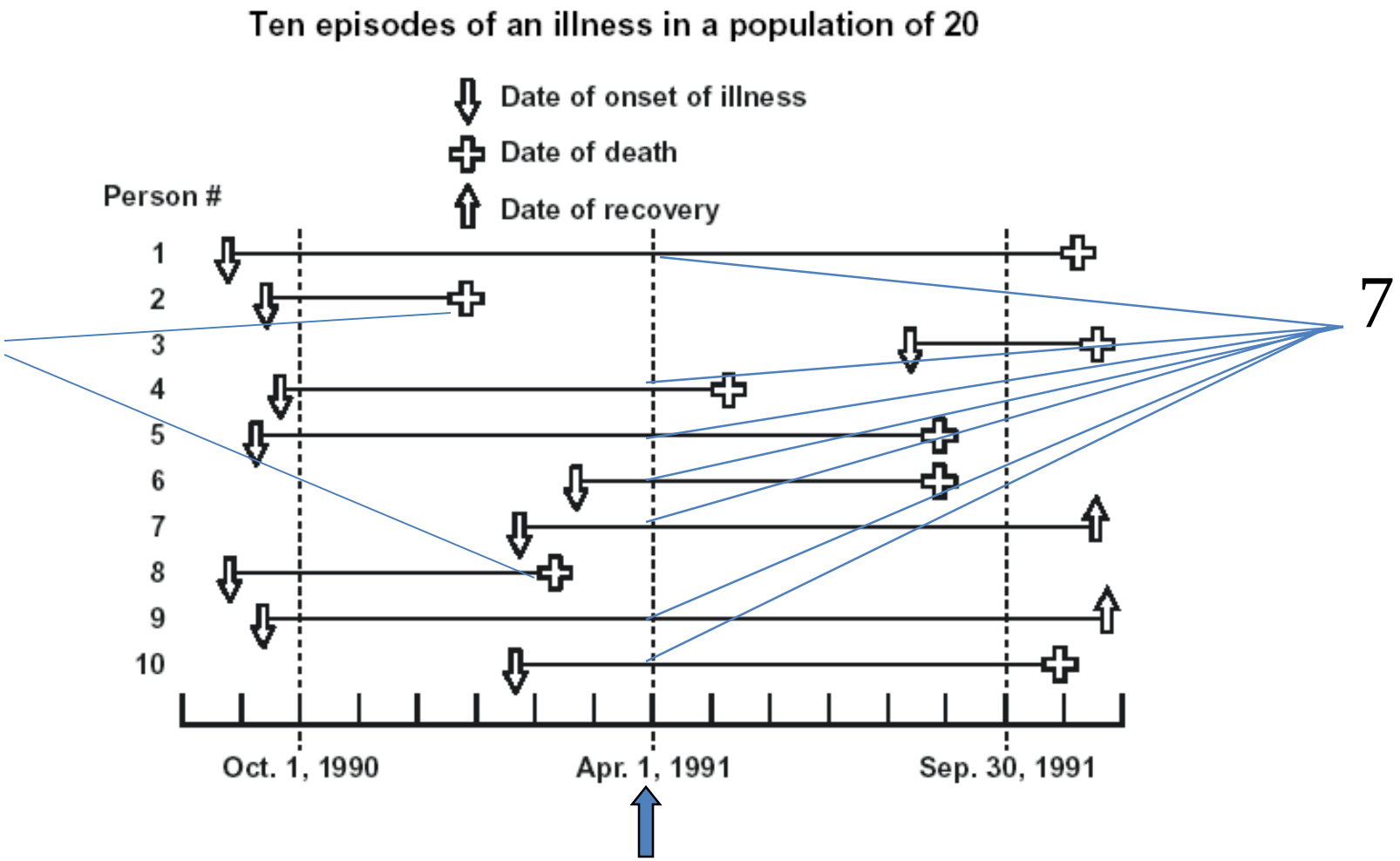
Those who said yes (~100) / All from whom question was asked (~1000) = 10%

This is an example of a lifetime prevalence rate, a period prevalence rate in this population

What is the point prevalence on April 1, 1991?



What is the point prevalence on April 1?



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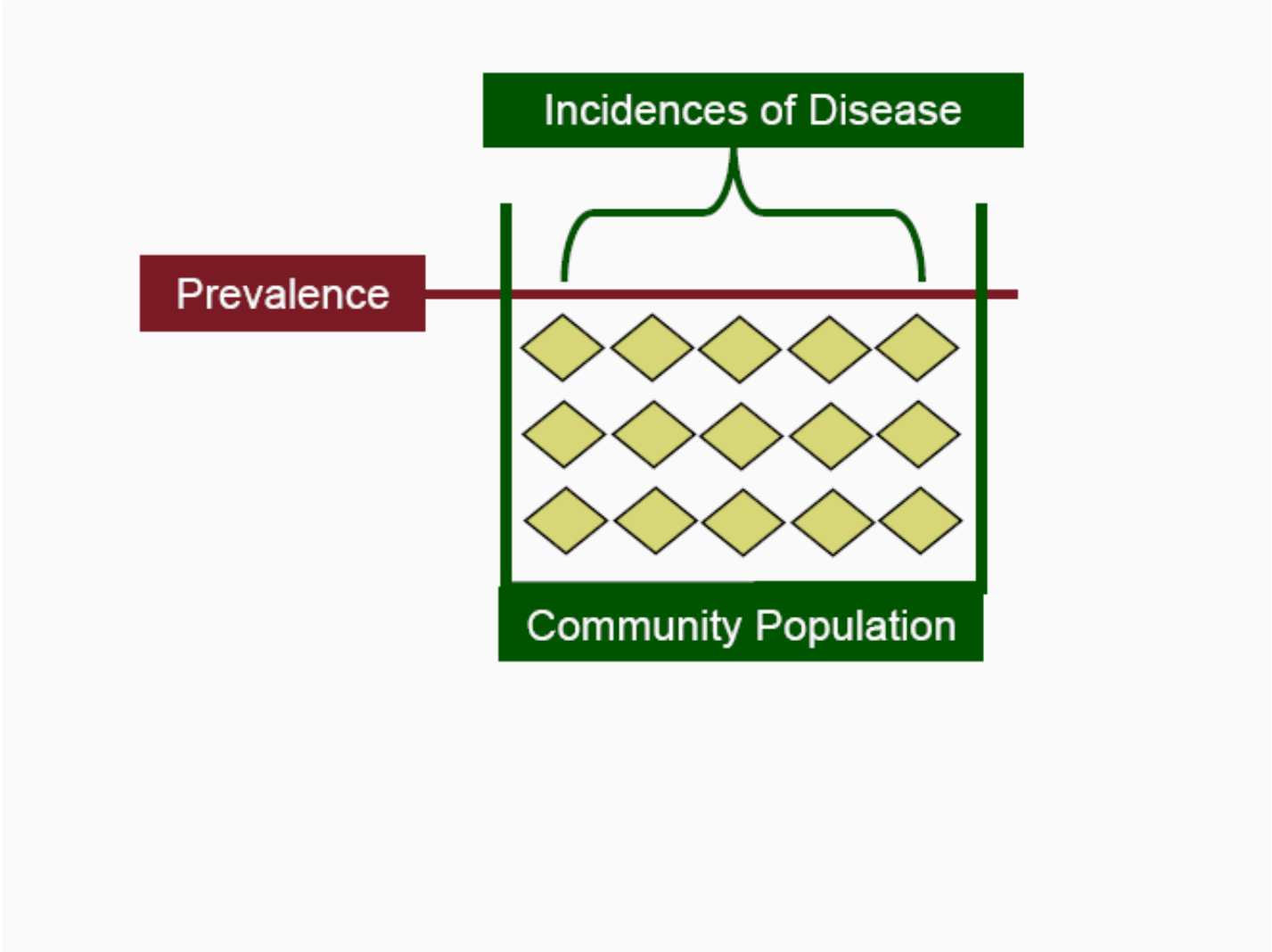
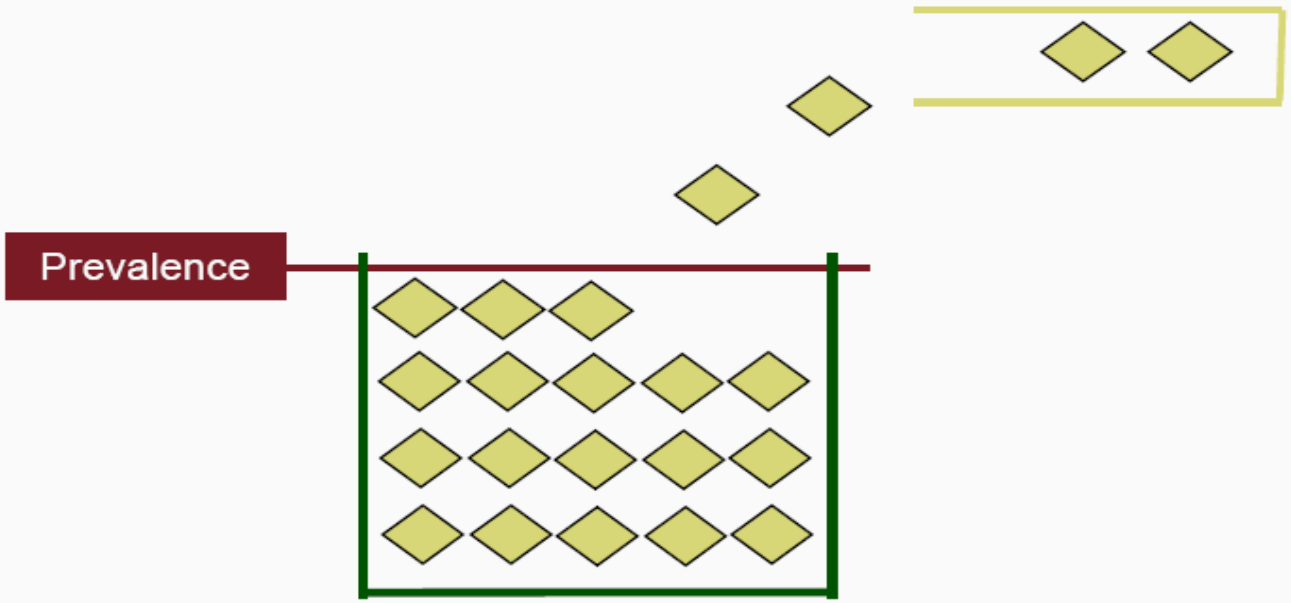
Relation between incidence and prevalence

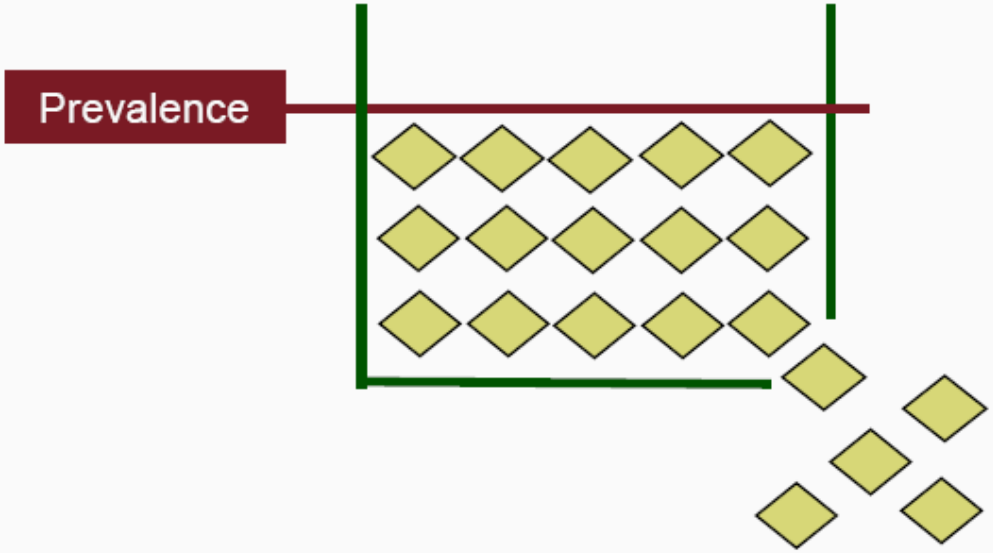


Relation between incidence and prevalence



Prevalence increases as new incidences are added to the population

Relation between incidence and prevalence



Prevalence decreases as incidences are subtracted from the population by death or cure

Relation between incidence and prevalence

Prevalence ~ incidence x duration of disease

- Higher incidence results in higher prevalence

  (with short duration of illness & recovery prevalence may or may not change)

- Longer disease duration leads to higher prevalence

Several factors may affect prevalence rate

- Incidence
- Duration of disease
- Selective Migration
- Disease treatments & outcome

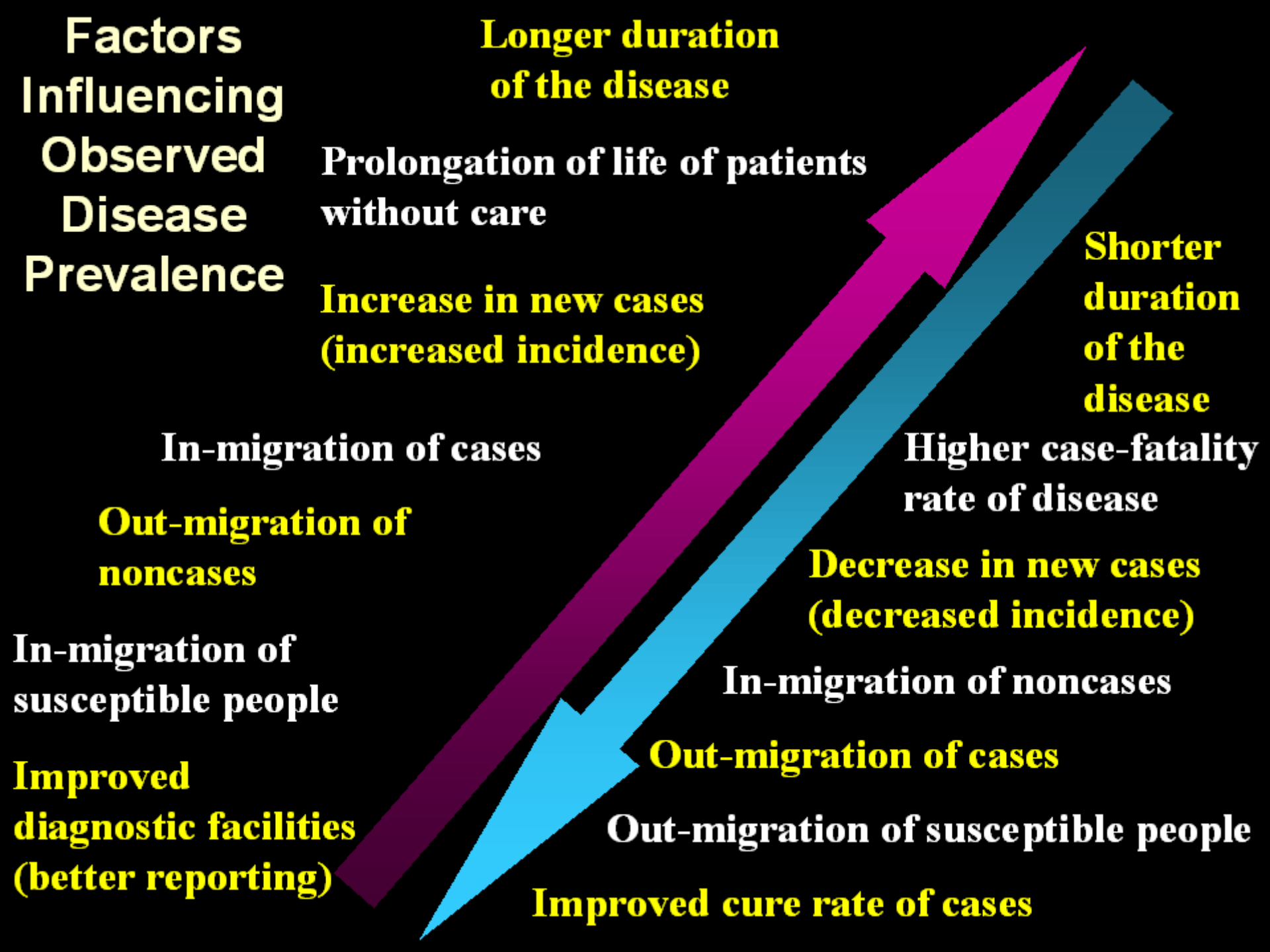
Factors affecting Prevalence:

- **Changes in incidence**

Prevalence rate= Incidence rate x average duration of disease.

High incidence produces high prevalence

- **Changes in disease duration and chronicity**
  - **Longer duration of disease, higher the prevalence rate**
  - **Chronic diseases are accumulating so increase the prevalence**
  - **Acute diseases of a high recovery rate or high case fatality rate decrease prevalence**


Factors Influencing Observed Disease Prevalence
Longer duration of the disease
Prolongation of life of patients without care
Increase in new cases (increased incidence)
In-migration of cases
Out-migration of noncases
In-migration of susceptible people
Improved diagnostic facilities (better reporting)
Shorter duration of the disease
Higher case-fatality rate of disease
Decrease in new cases (decreased incidence)
In-migration of noncases
Out-migration of cases
Out-migration of susceptible people
Improved cure rate of cases

Measures of Impact

- **Measure of potential impact**

Quantifies the potential impact of removing a hazardous exposure as to how much disease development is prevented if the risk factor is removed from population

Assumption of causality need to be satisfied meaning that cause effect elation ship must exist between risk factor and disease outcome

Attributable Risk: Incidence in exposed – Incidence in unexposed

Measure of Impact: Attributable risk

- Absolute comparison is derived by subtraction

- Incidence of lung cancer among smokers =20%
- Incidence of lung cancer among non smokers is 3%

- 17% of lung cancer cases can be prevented if smoking is removed from the population

Measures of Effect

- **Measures of association:**

  Relative comparison derived by division

  Quantifies the relative relationship between an exposure and a disease

  (risk factor & disease development)

- Two types mainly
  - Relative Risk (RR)
  - Odds Ratio (OR)

These will be addressed in detail later with study designs

Measure of Effect: Relative Risk

- Risk in the exposed / Risk in the unexposed
- Incidence in exposed/incidence in unexposed

- Risk is studied after following up population over a time period
- Usually two groups of population are followed
- One group exposed to risk factor (e.g. smokers) and another not exposed to risk factor (e.g. non smokers)

Measure of Effect: Relative Risk

- Is the risk of developing lung cancer twice more in those exposed to smoking compared to those who do not smoke ?

- If yes then Relative risk is 2 calculated from
- = incidence in exposed/incidence in unexposed

Measure of Effect: Odds Ratio

- If it is not possible to follow up in time; disease cases can be inquired about the exposures they had in past; and compared to healthy people (controls) exposures in past
- Diseased cases of coronary heart disease (CHD) were interviewed as to how many were smokers and similarly healthy persons were interviewed for smoking prevalence in past.
- If smoking is associated with CHD then a higher prevalence would be found in CHD cases compared to non cases.

Measure of Effect: Odds Ratio

- Relative comparison would be between two odds
- Odds of exposure in cases / odds of exposure in non cases
- An Odds ratio of 2 would be explained as
- Odds of exposure to cigarette smoking were twice more in CHD cases compared to non cases

Summary

Measures of disease frequency:

Incidence, Attack Rate, & Prevalence

Measures of Association (Effect):

Relative Risk (RR) & Odds Ratio (OR)

Measures of Impact:

Attributable Risk

References

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- -Chapter 3 Measuring the occurrence of Disease I. Morbidity: pages 32-42.
- - Chapter 6 Natural History of Disease : Ways of Expressing Prognosis :pages 96-97