Measures of Morbidity & Mortality

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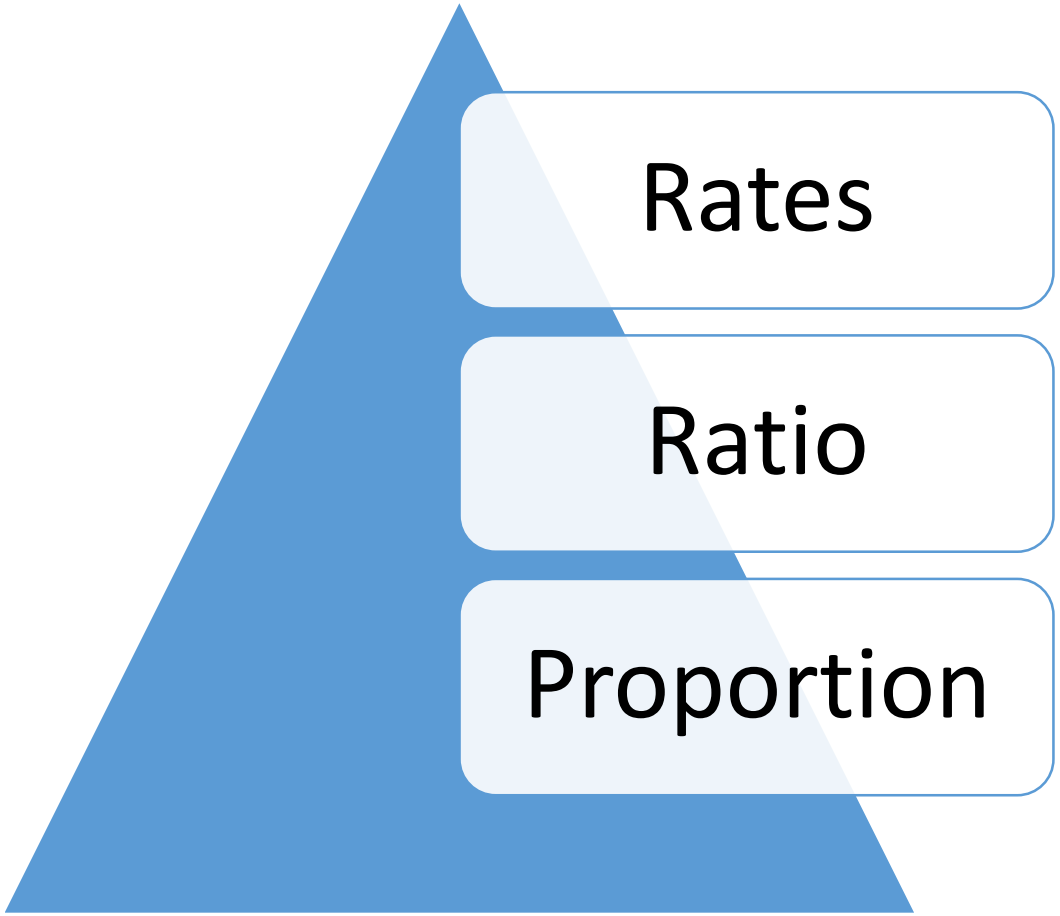
Tools of Measurement

- In epidemiology various measures are used to describe the occurrence of disease within a population.
- Using these measures will allow the comparison of disease frequency between different populations, in the same year (**pattern**) and in the same population along period of time (**trend**).
- The basic tools of measurement in epidemiology are counts (numbers), rates, ratios and proportions.

Components of Epidemiology

- Disease Frequency
- Distribution
- Determinants

Tools of Measurements



Rate

- Measures the occurrence of an event or disease in a given population during a given period (one year). (Birth rate, growth rate, accident rate).
- It is often a proportion, with an added dimension: it measures the occurrence of an event in a population over time. The basic formula for a rate is as follows:

$$Rate = \frac{number\ of\ cases\ or\ events\ occurring\ during\ a\ given\ time\ period}{population\ at\ risk\ during\ the\ same\ time\ period} \times 10^n$$

- Usually expressed per 100 or per 1000 population.
- It has a time dimension, whereas a proportion does not.
- Rate comprises:
  - Death Rate = number of death in one year divided by total mid year population times 1000

Three important aspects of this formula

- The persons in the denominator must reflect the population from which the cases in the numerator arose.
- The counts in the numerator and denominator should cover the same time period.
- In theory, the persons in the denominator must be “at risk” for the event, that is, it should have been possible for them to experience the event.

Ratio

- The value obtained by dividing one quantity by another-X/Y
- Male to Female Ratio.
- A ratio often compares two rates, death rates for women and men at a given age.
- Ratio also express relation of size between the two quantities.
- Numerator is not part of denominator.
- Expresses as X/Y

  Doctor: Population Ratio

  Male: Female Ratio

  WBC: RBC Ratio

Proportion

- A part/share or number considered in comparative relation to a whole.
- The proportion of greenhouse gases in the atmosphere is rising.
- Usually expressed as a percentage %. E.g. proportion of female students; proportion of anemic mothers-60% mothers are anemic.
- This is also relation/magnitude between two quantities, and numerator is always part of denominator.

Measures of Morbidity

Measures of Morbidity

Incidence

"occurrence of new cases"

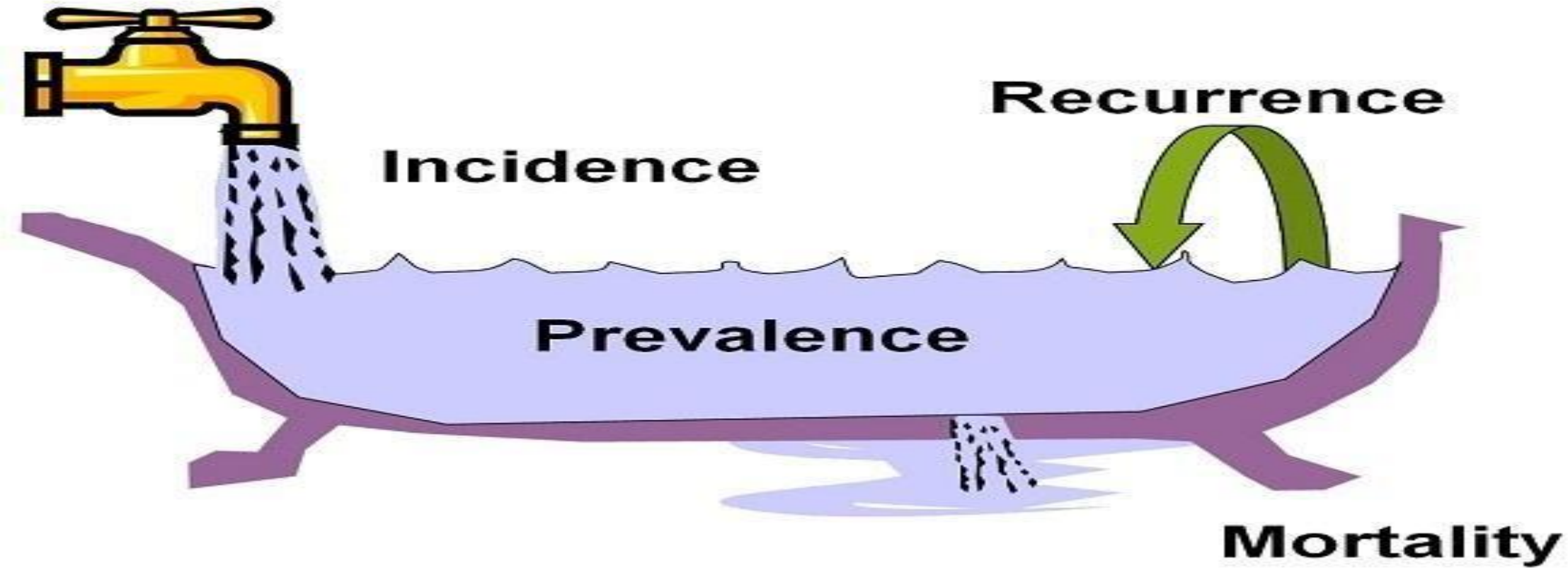
Prevalence

"Existence of all new and old cases"

Prevalence vs. Incidence

- Prevalence: how many people in a population currently have the disease.
- Incidence: how many people are diagnosed each year.

Commonly Used Morbidity Rates



This comic demonstrates the relationship between incidence and prevalence. Prevalence increases as incidence is added to the population being studied.

Types of Prevalence

1. Point prevalence: prevalence at any given point of time; 4% TB cases on 1st of April.
2. Period prevalence: prevalence at a given period of time; period will be one year.

Prevalence

- Prevalence increased by:
  - Longer duration of the disease.
  - Prolongation of life, with treatment.
  - If incidence increases.
  - Immigration of new cases.
  - Better reporting of cases
  - Immigration of healthy people.

Prevalence

- Prevalence decreased by:
  - Shorter duration of diseases.
  - Improved cure rate.
  - Incidence decreases.
  - Emigration of new cases.
  - Under reporting of cases.
  - Immigration of healthy people.

Special Incidences

- **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 a percent, so 10^n equals 100.

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

Attack Rate

Example

Of 75 persons who attended a Mosque picnic, 46 subsequently developed gastroenteritis.

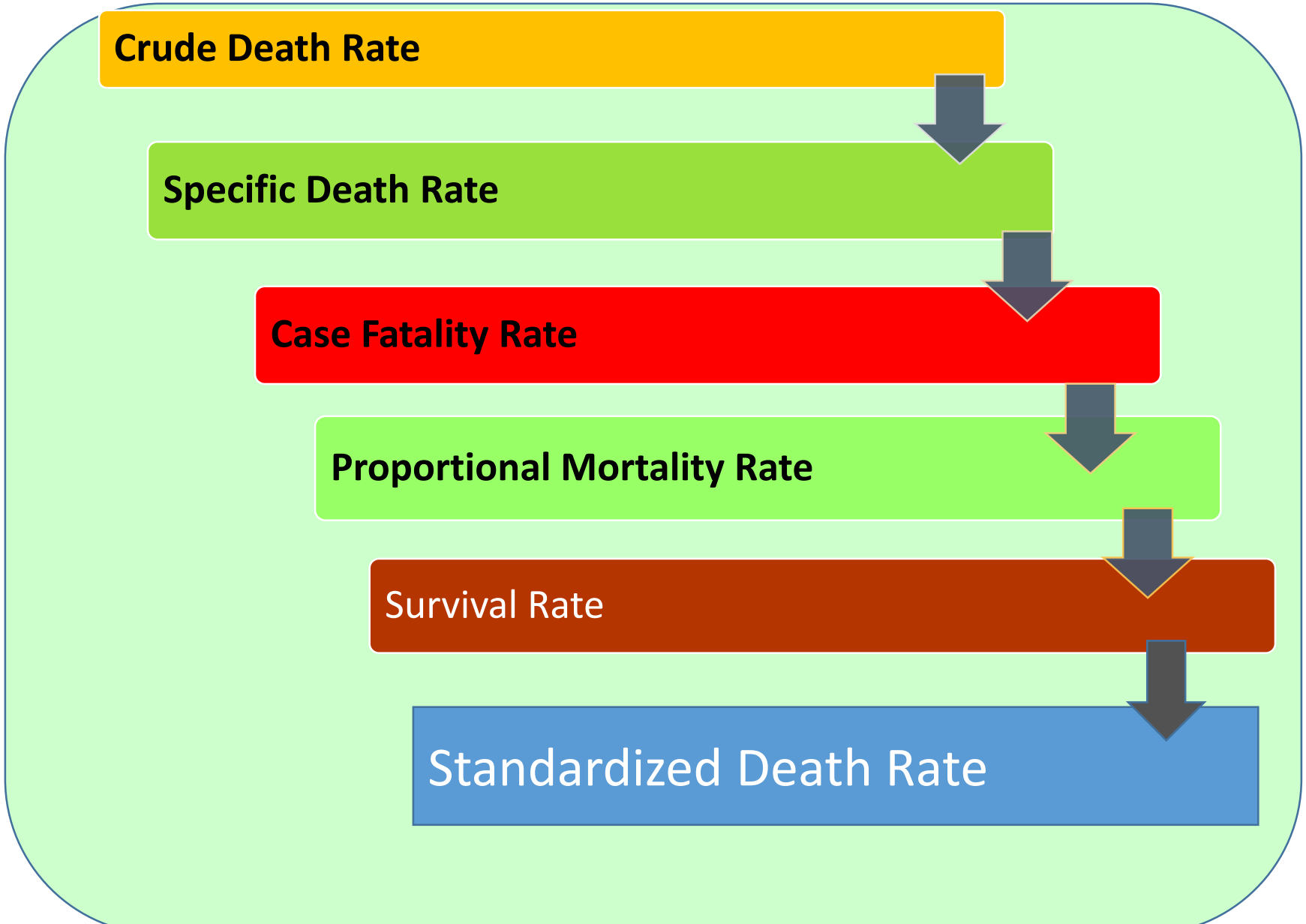
$$Attack\ Rate = \frac{46}{75} \times 100 = 61\%$$

Secondary Attack Rate

- frequency of new cases of a disease among the contacts of known cases.

$$\text{Secondary Attack Rate} = \frac{\text{Number of cases among contacts of primary cases during the period}}{\text{total number of contacts}} \times 10^n$$

Mortality Indicators (death rates):



Crude Death Rate

1. Number of deaths from all causes per 1000 estimated mid year population in one year in a given place.
2. CDR = No deaths during one year/mid year population x 1000

Specific Death Rate

1. Cause specific death rate like; disease death rate, road accident.
2. Age specific –child mortality rate.
3. Sex specific death rate-female.
4. Period specific death rate-death in May

Case Fatality Rate

1. Percentage of particular cases dying during particular disease epidemic.
2. Killing power of disease particularly acute diseases.
3. CFR = No of deaths due cholera/Total No of cholera cases X 100

Proportional Mortality Rate

- Proportion or % of deaths due to particular cause out of total deaths.
- It measures the disease burden.
- Under 5 proportional mortality rate = No of deaths below 5 years / Total No all of deaths X 100

Survival Rate

Percentage of the treated patients remaining alive at the end of 5 years treatment.

Yard stick for assessing the standard of therapy in cancer.

Survival Rate = Pts. Alive at the end of 5 years/Total No of pts treated X 100

Standardized Death Rate (Adjusted Death Rate)

- CDR can not be useful for comparison.
- Death rate need to be standardized for comparisons.
- Standardization can be done by: adjusted death rate age wise, also can be done sex/race wise.

Frequency of measures by type of event described

Condition	Ratios	Proportions	Rates
Morbidity (Disease)	Risk ratio (Relative risk) Rate ratio Odds ratio	Attributable proportion Point prevalence	Incidence rate Attack rate Secondary attack rate Person-time rate Period prevalence
Mortality (Death)	Death-to-case ratio Maternal mortality rate Proportionate mortality ratio Postneonatal mortality rate	Proportionate mortality Case-fatality rate	Crude mortality rate Cause-specific mortality rate Age-specific mortality rate Sex-specific mortality rate Race-specific mortality rate Age-adjusted mortality rate Neonatal mortality rate Infant mortality rate Years of potential life lost rate
Natality (Birth)		Low birth weight ratio	Crude birth rate Crude fertility rate Crude rate of natural increase

Frequently used measures of morbidity

Measure	Numerator (*x*)	Denominator (*y*)	Expressed per Number at Risk(10^n)
Incidence Rate	# new cases of a specified disease reported during a given time interval	average population during time interval	varies: 10^n where n = 2,3,4,5,6
Attack Rate	# new cases of a specified disease reported during an epidemic period	population at start of the epidemic period	varies 10^n where n = 2,3,4,5,6
Secondary Attack Rate	# new cases of a specified disease among contacts of known cases	size of contract population at risk	varies: 10^n where n = 2,3,4,5,6
Point Prevalence	# current cases, new and old, of a specified disease at a given point in time	estimated population at the same point in time	varies: 10^n where n = 2,3,4,5,6
Period Prevalence	# current cases, new and old, of a specified disease identified over a given time interval	estimated population at mid-interval	varies: 10^n where n = 2,3,4,5,6

Frequently used measures of mortality

Measure	Numerator (x)	Denominator (y)	Expressed per number at risk (10^n)
Crude Death Rate	total number of deaths reported during a given time interval	Estimated mid-interval population	1,000 or 100,000
Cause-specific Death Rate	# deaths assigned to a specific cause during a given time interval	Estimated mid-interval population	100,000
Proportional Mortality	# deaths assigned to a specific cause during a given time interval	Total number of deaths from all causes during the same interval	100 or 1,000
Death-to-Case Ratio	# deaths assigned to a specific disease during a given time interval	# new cases of that disease reported during the same time interval	100
Neonatal Mortality Rate	# deaths under 28 days of age during a given time interval	# live births during the same time interval	1,000
Postneonatal Mortality Rate	# deaths from 28 days to, but not including, 1 year of age, during a given time interval	# live births during the same time interval	1,000
Infant Mortality Rate	# deaths under 1 year of age during a given time interval	#l live births reported during the same time interval	1,000
Maternal Mortality Rate	# deaths assigned to pregnancy-related causes during a given time interval	# live births during the same time interval	100,000

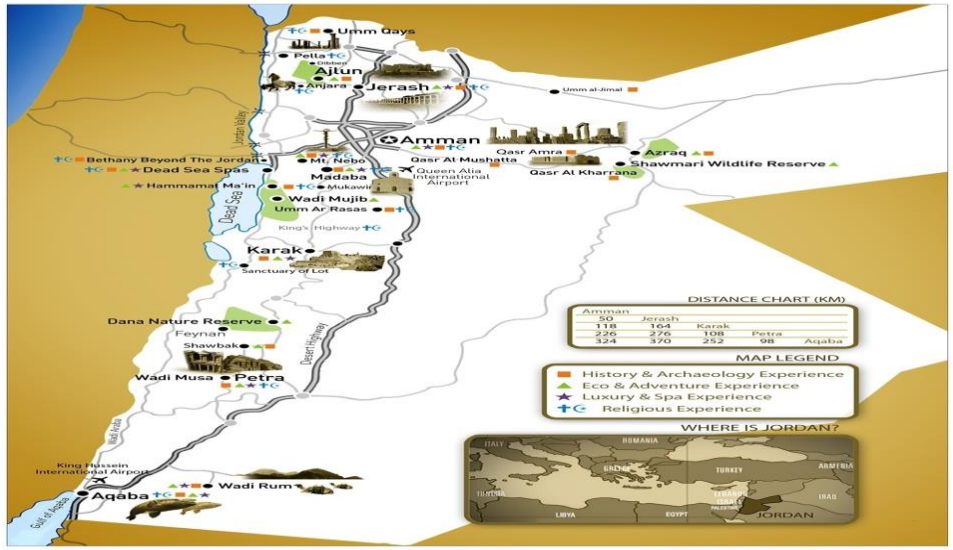
Natality Frequency Measures

Frequently used measures of natality

Measure	Numerator (x)	Denominator (y)	Expressed per Number at Risk (10^n)
Crude Birth Rate	# live births reported during a given time interval	Estimated total population at mid interval	1,000
Crude Fertility Rate	# live births reported during a given time interval	Estimated number of women age 15-44 years mid-interval	1,000
Crude Rate of Natural Increase	# live births minus # deaths during a given time interval	estimated total population at mid-interval	1,000
Low Birth Weight Ratio	# live births under 2,500 grams during a given time interval	# live births reported during the same time interval	100

Testing Whether a Factor Is Associated With Disease

Reference Population



Inference

Sample

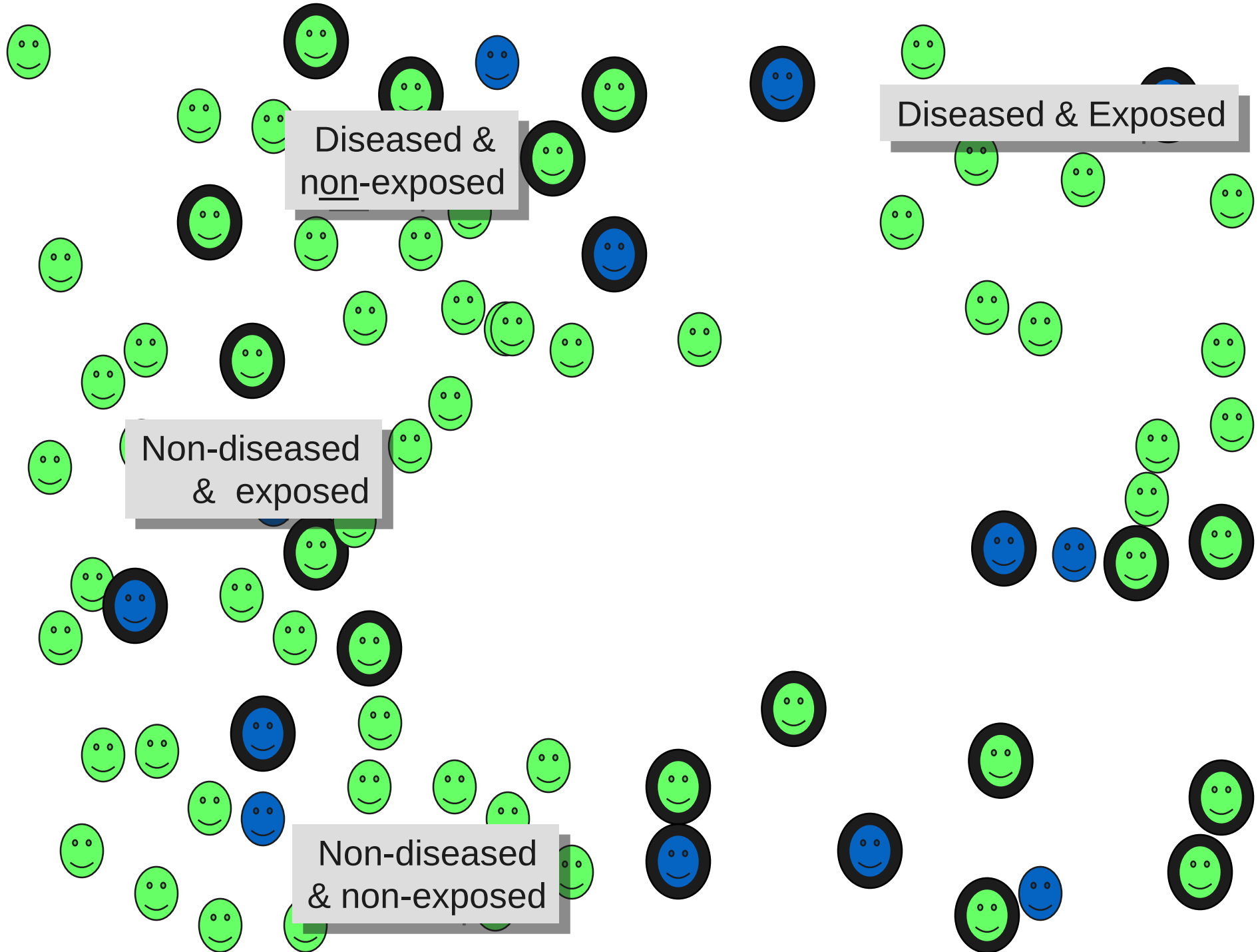
Study population

Are the results valid?

- Chance➢
- Bias➢
- Confounding➢

- Collect data•
- Make comparisons•

Is there an association?


Diseased & non-exposed
Diseased & Exposed
Non-diseased & exposed
Non-diseased & non-exposed

To determine the rates of disease by person, place, & time

- Absolute risk (incidence, prevalence)
  - Incidence = number of new cases of a disease occurring in a specified time period divided by the number of individuals at risk of developing the disease during the same time
  - Prevalence = total number of affected individuals in a population at a specified time period divided by the number of individuals in the population at the time
  - Incidence is most relevant clinically

To Identify the Risk Factors for the Disease

- Relative risk (RR), odds ratio (OR)
  - RR = ratio of incidence of disease in exposed individuals to the incidence of disease in non-exposed individuals (from a cohort/prospective study)
    - If RR > 1, there is a positive association
    - If RR < 1, there is a negative association
  - OR = ratio of the odds that cases were exposed to the odds that the controls were exposed (from a case control/retrospective study) – is an estimate of the RR
    - Interpretation is the same as the RR

To Develop Approaches for Disease Prevention

- Attributable risk (AR)/fraction (AF)
  - AR = the amount of disease incidence that can be attributed to a specific exposure
    - Difference in incidence of disease between exposed and non-exposed individuals
    - Incidence in non-exposed = background risk
    - Amount of risk that can be prevented
  - AF = the proportion of disease incidence that can be attributed to a specific exposure (among those who were exposed)
    - AR divided by incidence in the exposed X 100%

Measures of Association

- A quantitative index of the strength of association between an exposure and a disease
  OR
- It tells us how much excess (or deficit) risk is associated with an exposure
- A statistical relationship between two or more variables

The Risk Approach

- **Epidemiological methods do not allow to study formally the *causes* of diseases.**
- **Allow the study of the characteristics that accompany the variations in the frequency of the occurrence of diseases and thus *formulate hypothesis* on the possible causes of diseases *(risk factors).***
- ***Permit testing of such hypotheses***

A risk factor is a characteristic to which people are exposed and is associated with changes in the frequency of a disease.

Association between exposure & Disease

- Question:

  Is there an excess risk associated with a given exposure?

- Objective:

  To determine whether certain exposure is associated with a given disease

- Methodology:

  Use one of the epidemiologic study designs

  Cohort

  Case-control

MEASURES OF DISEASE ASSOCIATION

The chances of something happening can be expressed as a risk or as an odds:

$$\textbf{RISK} = \frac{\textbf{the chances of something happening}}{\textbf{the chances of } \textit{all} \textbf{ things happening}}$$

$$\textbf{ODDS} = \frac{\textbf{the chances of something happening}}{\textbf{the chances of it } \textit{not} \textbf{ happening}}$$

Thus a risk is a *proportion*, But an odds is a *ratio*.

Was it Clear Enough !