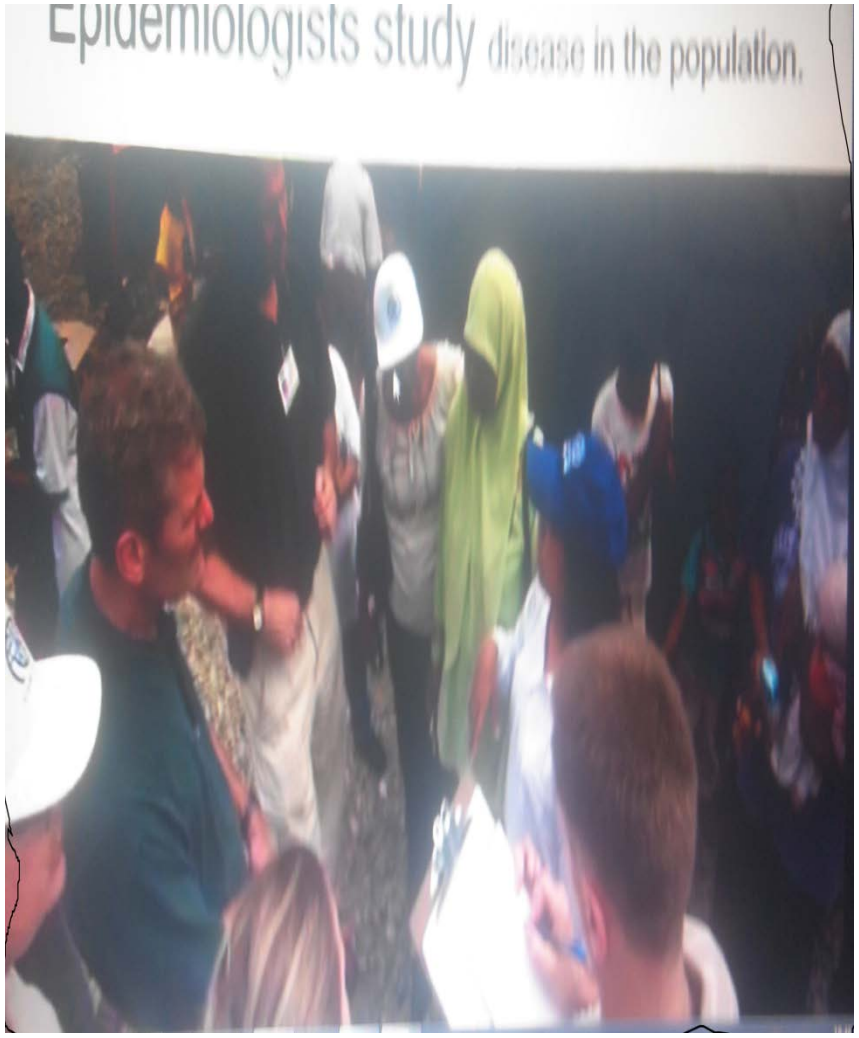
Measurement in Epidemiology

Epidemiological Tools

Background information

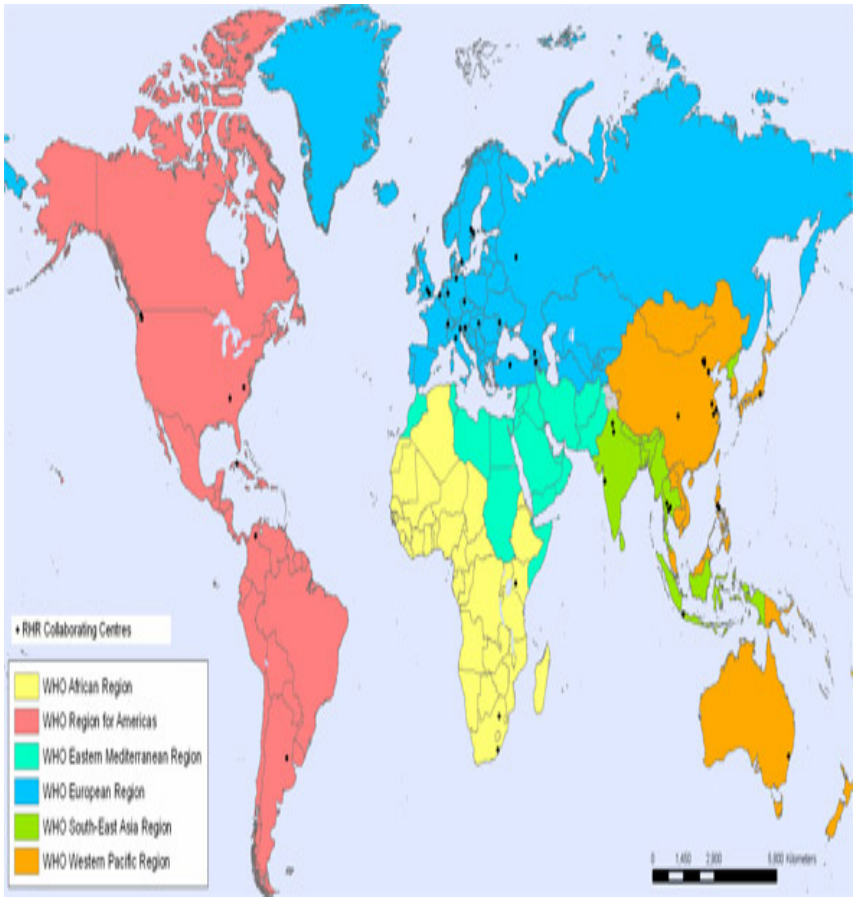
- Epidemiology entails the study **diseases** as well as **health outcome** in **population**
- **Health outcome** include issues related to behaviours, illnesses, disorders, symptoms, risk factors, injuries, **death** e.t.c



Describe frequency distribution of diseases?

- **Measure** the occurrence of one or more diseases
- Define population at risk

- This is necessary to plan interventions or monitor changes within the population



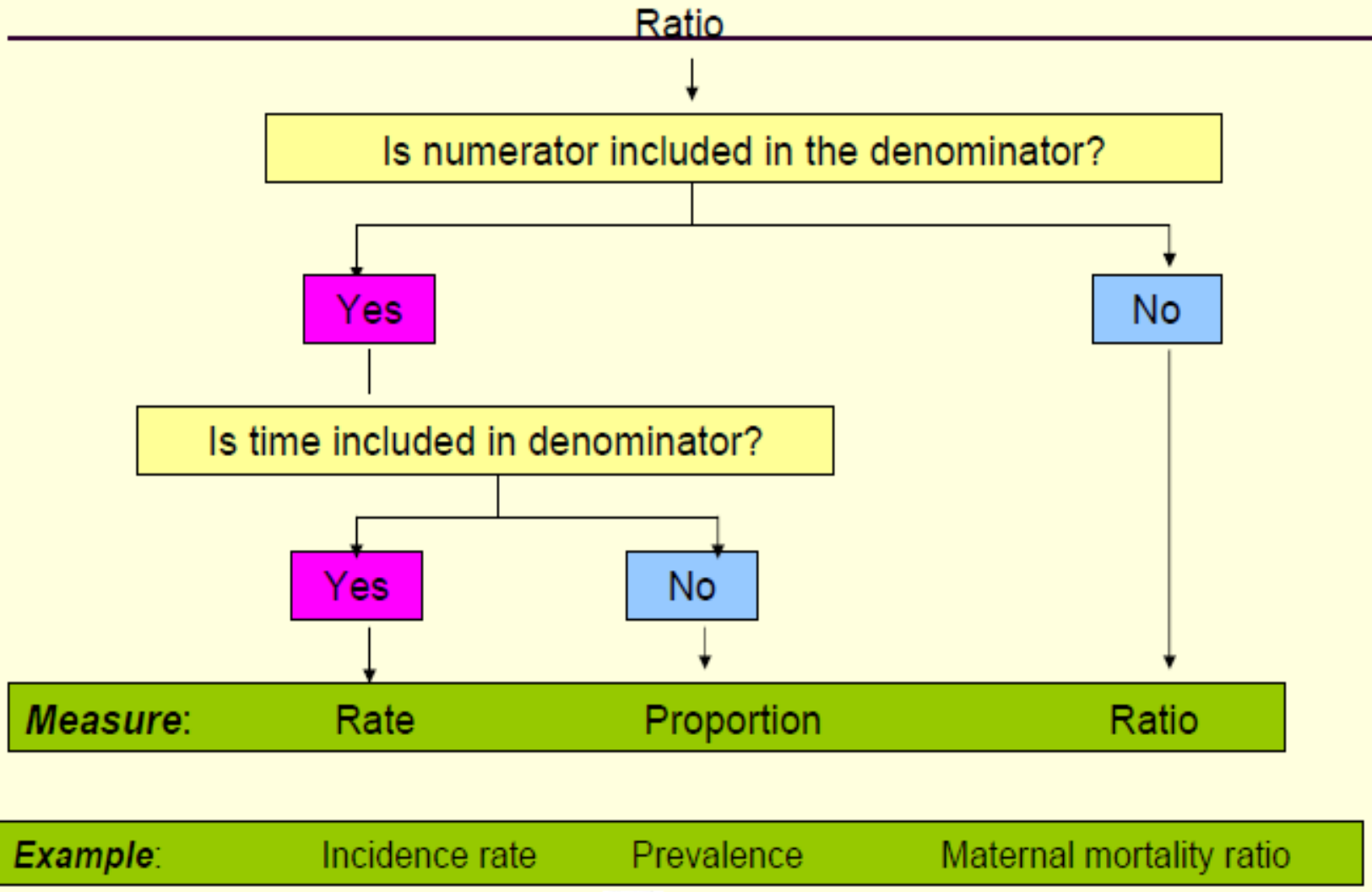
What are the tools used for measurement ?

Estimation of burden in terms of Time, Person and Place?

Overview: Count, Ratio, Proportion, Percentage, Rate

- **Count**: Number of cases or health phenomena
- **Ratio**: A general term that relate events to the source population without implying any specific relationship between the numerator & denominator
- **Proportion**: a type of ratio in which the numerator is part of the denominator
- **Percentage**: Proportion expressed over a base of 100.
- **Rate**: a ratio in which there is a distinct relationship between the numerator & denominator and in which time is an intrinsic part of the denominator. Two distinguishing features of rate: time and a multiplier.

Rates, proportions & ratio: Differences



Measurement of disease frequency

1) Count: Number of cases/ people with diseases

- For example 50,000 people are infected with HIV/AIDS infection in Africa every year

2) Rate: HIV infects 10% of Nigeria population in January, 2009

Relate old and new cases to total population- **Prevalence rate**

Relate **new cases** to population at risk at given time period- **Incidence rate**

Measurement of morbidity

Prevalence and incidence rates

INCIDENCE

- The number of **new cases** occurring in a defined population during a specified period of time

- Incidence= (No. of new case of specified disease during a given time period / population at risk during that period) X 1000

INCIDENCE RATE

- **Refers to:**

a) Only to new cases

b) During a given period

c) In a specified population or population at risk

d) To new spells or episodes of disease arising in a given period of time per 1000 population

Incidence

- Definition: Number of ***new*** events or cases of disease that develop in a population of individuals at risk during a specified time interval
- Three important elements:
  - A numerator- the number of new cases
  - A denominator- the population at risk
  - Time – the period during which the cases accrue
- Types: (i) Cumulative incidence
  (ii) Incidence rate or Incidence density
- Usefulness: Study of disease aetiology

Cumulative Incidence

- Cumulative incidence (CI) is the proportion of people who become diseased during a specified period of time

$$CI = \frac{\text{Number of new cases of a disease during a given period of time}}{\text{Total population at risk}} \times \text{multiplier}$$

- Provides an estimate of probability or risk that an individual will develop a disease during a specified period of time

Incidence rate or Incidence density

- Incidence rate or density (ID) a more precise estimate as a measure of the instantaneous development of disease in a population

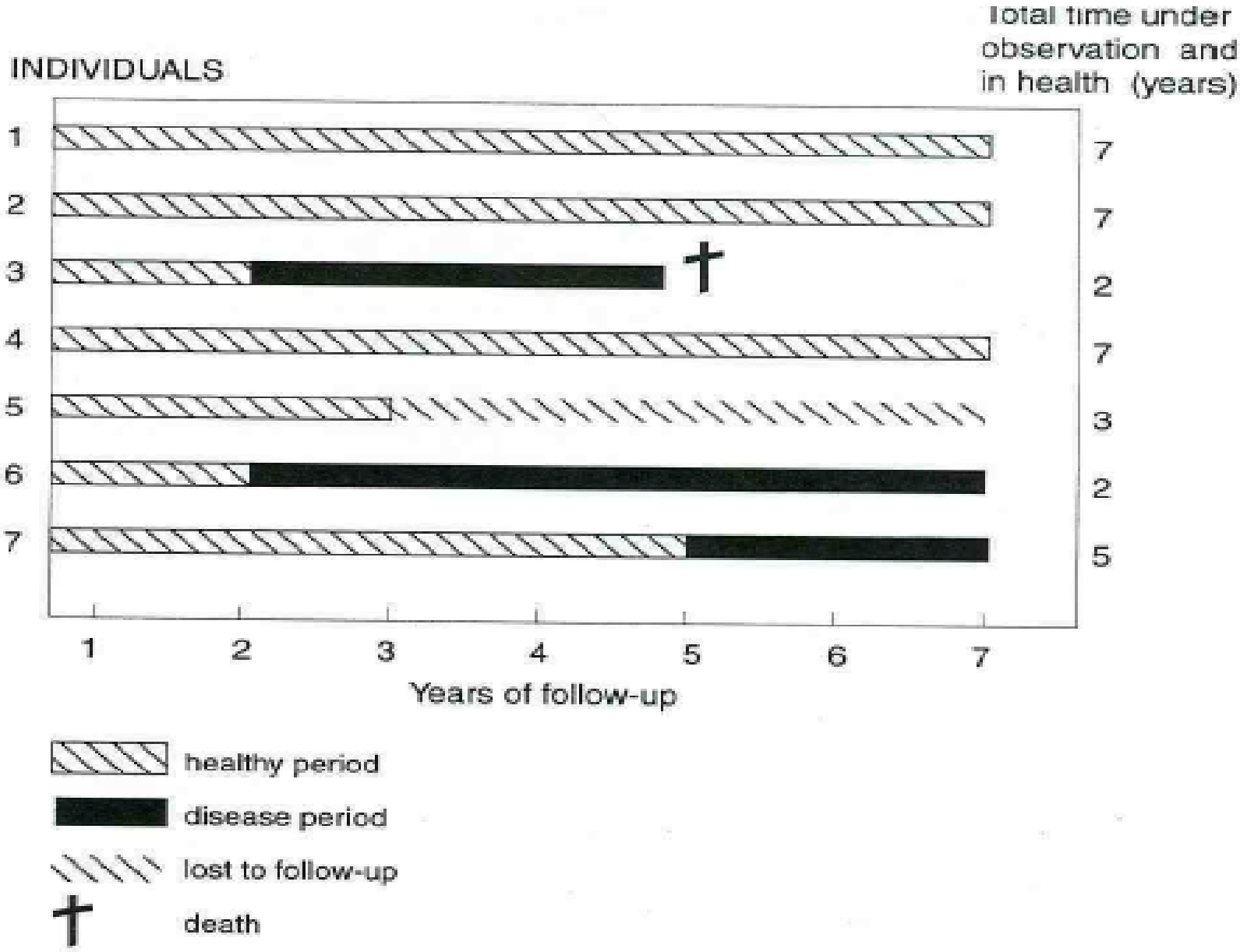
$$ID = \frac{\text{Number of new cases of a disease during given time period}}{\text{Total person-time of observation}} \times \text{Multiplier}$$

- Essential to specify the relevant time unit e.g. case per person-day, person-month, person-year

Person time

- Time in which person is at risk of developing the disease.

- It can be person days, person months or person years


INDIVIDUALS
Total time under observation and in health (years)
1
2
3
4
5
6
7
7
7
2
7
3
2
5
1
2
3
4
5
6
7
Years of follow-up
healthy period
disease period
lost to follow-up
death

Calculate incidence rate

- **EXAMPLE**
- If there had been 500 new cases of an illness in a population of 30,000 in a year the incidence rate or absolute risk will be

- Calculate the answer:

Exercise

- 25 new cases of lung cancer were identified among 10000 smokers in a follow up study of 20 years duration. What is the risk of lung cancer among the smokers in percentage?
- 11,000 people in an area with large nuclear power plant were followed up for 7 years until development of cancer in the blood. 30 cases were identified over the 7 years period. What is the risk of development of blood cancer?

Prevalence

Prevalence

- Definition: Number of ***existing*** cases of a disease or health condition in a population at some designated time
- Relevance/usefulness:
  - Describes health burden of a population
  - Estimates frequency of exposure & probability (risk) that an individual will be ill at a point in time
  - Helpful for allocation of health resources
- Limitation: Not helpful for studies of aetiology (except when condition has an indefinite time of onset)

Prevalence

- Point Prevalence

$$\frac{\text{Number of existing cases of a disease}}{\text{Total population}}$$ at a given point in time

- Period prevalence

$$\frac{\text{Number of existing cases of a disease}}{\text{Average population}}$$ during a time period

*Technically, measures of prevalence are proportion & not really rates

Interview Question	**Type of Measure**
Do you currently have asthma?	Point prevalence
Have you had asthma during the last (*n*) years?	Period Prevalence
Have you ever had asthma?	Cumulative or lifetime incidence

What do you think?

- The prevalence of a congenital anomalies was measured in a follow-up study of all the children born alive in OAUTHC between 2000 and 2005. The numerator of the rate included children whose anomalies were detected at birth or only later in their lives, or (in some cases) only when they died. The denominator consisted of all the children studied. Is this a point or period prevalence rate?

Exercise

- During flu season, there are 20 sick children and 80 healthy children taking a course in statistics. What is the prevalence of flu among the children?

Relationship between incidence and prevalence

- Incidence & Prevalence:
  - Prevalence $\simeq$ ID x average duration of disease

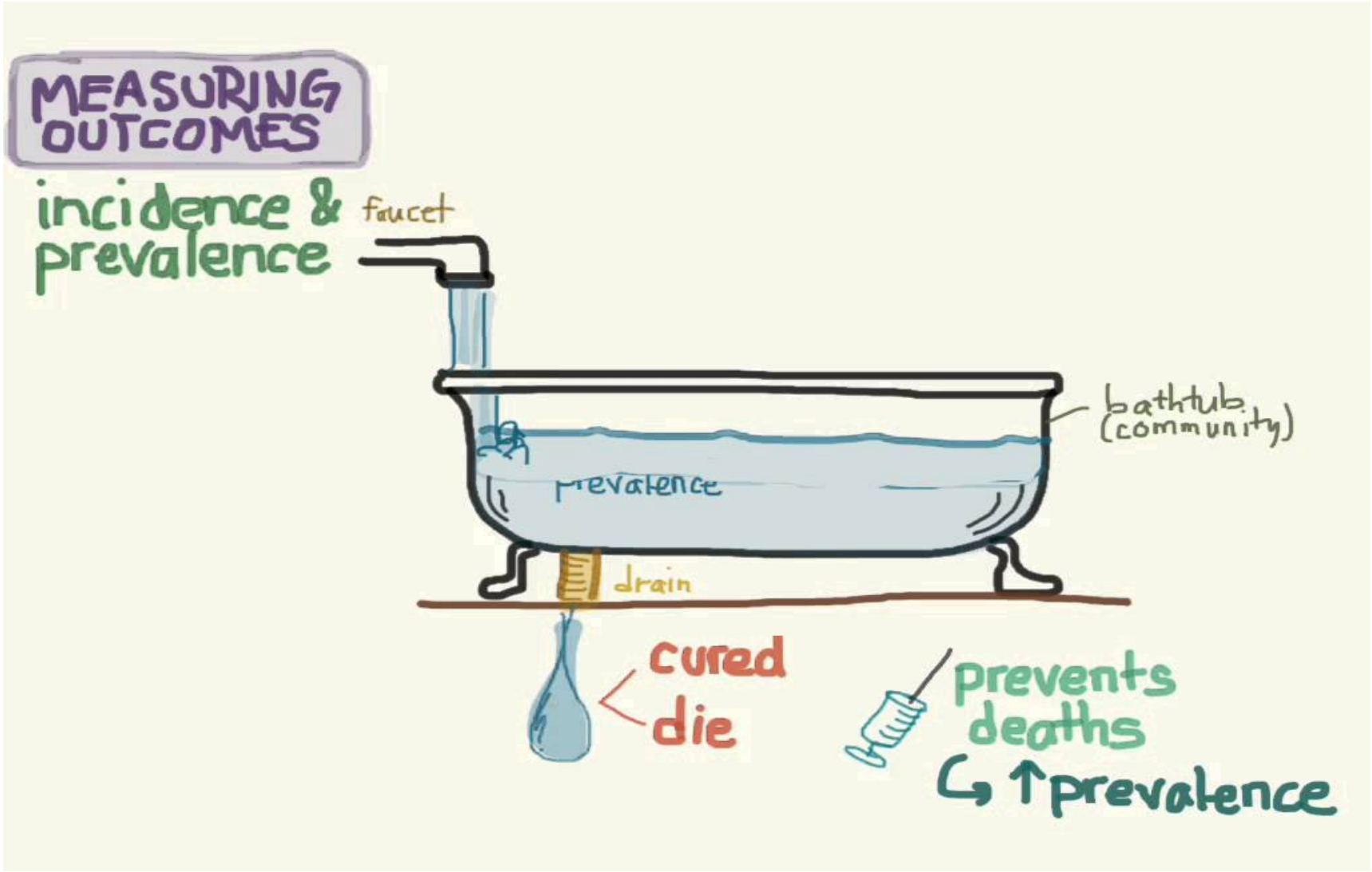
    When:

    (a) Incidence rate has been constant over time

    (b) Duration of the disease is constant

    (c) Prevalence of the disease is low (< 0.1)

Relation between incidence and prevalence



Factors influencing prevalence of diseases

Increased by:

- Longer duration of disease
- Prolongation of the life of patients without cure
- Increase in new cases
- In-migration of cases
- Out-migration of healthy people
- Improved diagnostic facilities
- Better reporting

- Decreased by:
- Shorter duration of disease
- High case-fatality rate from disease
- Decrease in new cases
- In-migration of healthy people
- Out-migration of cases
- Improved cure rate of cases

Measurement of mortalities

Deaths

The Rates: Crude, Specific & Adjustment

Mortality- Death

Rates

$$\frac{\text{Numbers of events (deaths, disease, e.t.c. in a specified period}}{\text{Population at risk of experiencing the event during that period}} \times 10^n$$

Categories of mortality rate

- **Crude Death Rate (CDR)**
- **-Specific Death Rates**
- **-Case Fatality Rates (CFR)**
- **-Proportional Mortality Rates**

CRUDE DEATH RATE

(CDR) =

$$\frac{\text{No. of deaths in one year in a specified area}}{\text{Mid year population of the specified area during the same year}}$$

X 1000

CRUDE DEATH RATE (CDR)

Affected by

-Health of the population,

-Composition of the population

CDR lacks comparability

To COMPARE the mortality of two different populations- need to calculate the **'Standard Mortality Rate'** for both populations

Specific Death Rates

(a)Cause Specific Death Rates e.g. TB death rate, death rate due to accidents etc.

(b)Group specific death rates e.g. Age specific death rate, sex specific death rate, race specific DR, rural-urban DR etc.

Cause Specific Death Rates

X 1000

$$(\textit{cause specific death rate}) = \frac{\text{No. of deaths due to a cause in a calendar year}}{\text{Mid year population in the same calendar year}}$$

Group Specific Death rates

- Age specific death rate:

Age Sp. DR =

$$\frac{\text{no. of deaths in the specific age group in the defined population}}{\text{Mid year population of the same age group in the same year}}$$

CASE FATALITY RATE

- Measures the 'killing power' of a disease

$$\text{CFR} = \frac{\text{total no. of deaths due to a particular disease}}{\text{total no. of cases due to the same disease}} \times 100$$

- More relevant to acute diseases

PROPORTIONAL MORTALITY RATE

- "the **ratio of deaths** due to a specific cause, in a specific age, sex, group or sub-area, to the total deaths
- E.g. PMR due to a specific cause (or an age group) will be:
-

$$\frac{no.\ of\ deaths\ due\ to\ the\ cause\ (or\ in\ a\ particular\ group)\ in\ one\ year}{no.\ of\ deaths\ due\ to\ ALL\ causes\ in\ the\ same\ year}$$

Questions and answers

Exercise: Crude death rate

- Calculate the crude death rate- Total mid year population is 10000, number of death in a year is 20

Questions

- Efili is a community in Delta State having 100,000 people in 2001, 50 of which are infected with malaria out of which 25 died of the infection
- What is the mortality rate of malaria in 2001?

- What is the case fatality rate of malaria in 2001?

Exercises on measurement

- In New York City, 200 out of 14,000 people as at December 1st had cold. What is the **prevalence of cold** in the population?
- 11,000 people in an area with large nuclear power plant were followed up for 7 years until development of cancer in the blood. 30 cases were identified over the 7 years period. What is the **absolute risk** of development of blood cancer?

Exercises on measurement

- A Researcher recruited 10,000 residents living near a nuclear power plant and follow the residents up for 5 years until development of cancer of the blood. Over the 5 years study period, 25 cases of cancer of the blood were identified and 5 deaths recorded. What is the **absolute risk** of developing cancer of the blood:
- What is the **case fatality** rate?

ATTACK RATE

- ATTACK RATE- An attack rate is an incidence rate (usually expressed as a per cent), used only when the population is exposed to risk for a limited period of time such as during an epidemic
- It relates the number of cases in the population at risk and reflects the extent of the epidemic

ATTACK RATE

- (No. of new cases of a specified disease during a specified time interval /Total population at risk during the same interval) X100
- E.g. calculation of attack rate in case of acute food poisoning
- A food borne attack rate tells us the proportion of all people who ate a certain food who became ill

Secondary attack rate

- It is defined as as "the number of exposed persons developing the disease within the range of the incubation period, following exposure to the primary case"
- SAR= (No. of exposed persons developing the disease within the range of incubation period/ total no. of exposed/ susceptible contacts) X100