Measuring Health and Disease

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Objectives

- Define **prevalence** and **incidence**.
- Distinguish between disease incidence expressed as a **risk** versus a **rate**
- Define **odds**
- Describe measures of effect

What is epidemiology?

- Measurement of occurrence of disease or health status of a population and their determinants in relation to time.
- **Criteria for disease/case definition**
  - Set of diagnostic criteria to distinguish individuals with disease (cases) and those without.
  - May be based on specific symptoms, signs, medical history or test results
- **Population at risk**
  - individuals who are able to develop the disease or condition of interest
- **Time frame**
  - Specific point in time
  - Interval of time

Prevalence

- Two main measures of prevalence
  - **Point prevalence**
  - **Period prevalence**

Point prevalence

- This is the proportion of population at risk who have a disease of interest at a particular point in time.
  - $$\frac{\textit{number of existing cases at a specific point in time}}{\textit{Total population at risk}}$$
- Persons in the numerator are also included in the denominator
- Gives a snap shot of the population
- It is a measure of disease burden.
- It is a proportion and therefore can be expressed as a percentage

Period Prevalence

- The proportion of the population at risk that had a particular disease with a certain period of time
  - $$\frac{\textit{number of existing cases in time period}}{\textit{Total population at risk in that same period}}$$

- The numerator includes cases present at the start, as well as incident cases which arose during the period of interest.
- **Period prevalence** measures the frequency of all events (old and new) for a prescribed period of time.

Example: Scenario

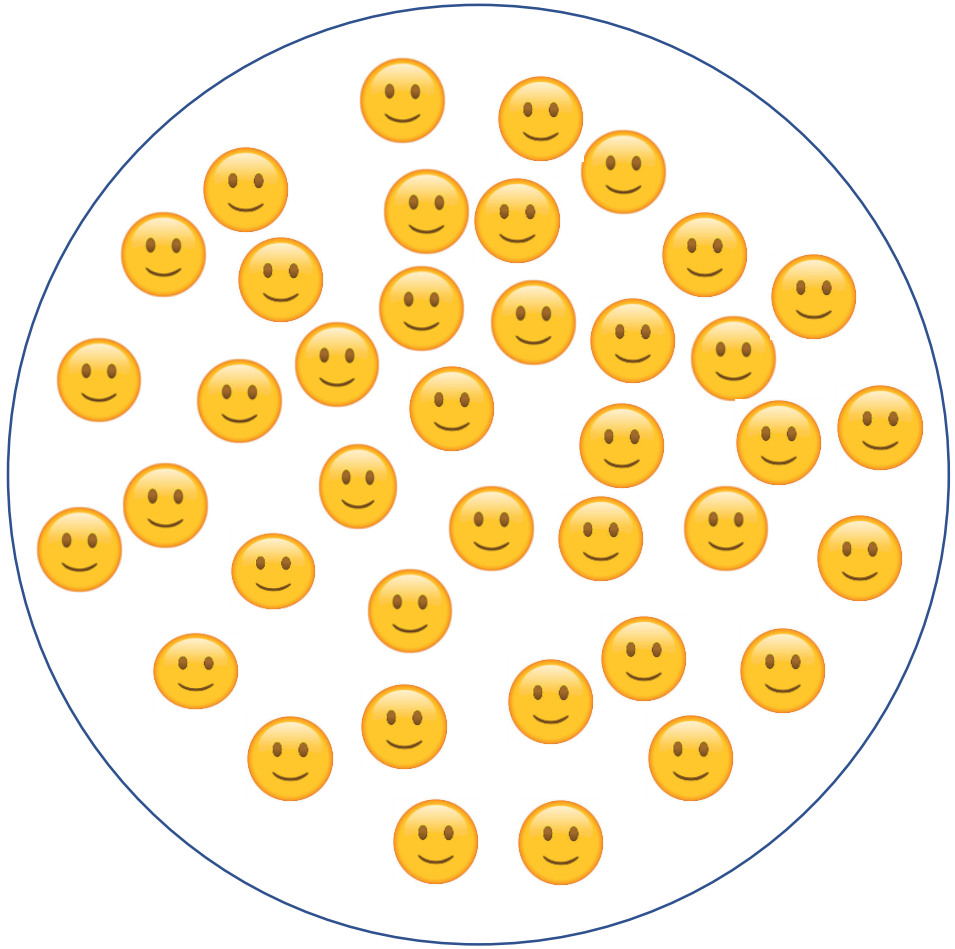
- A population of 150 school children were screened for a condition.
- They were followed up for one year
- 25 children had condition of interest at beginning of study
- Another 15 cases developed during year of follow-up

Point prevalence:25/150 = 0.17 = 17%

Period prevalence: (25 +15)/ 150 = 0.27 = 27%

Incidence

- The measure of occurrence of **new cases** of disease in a defined **population at risk**, in specified period of time.
- This is a proportion and can be expressed as a %



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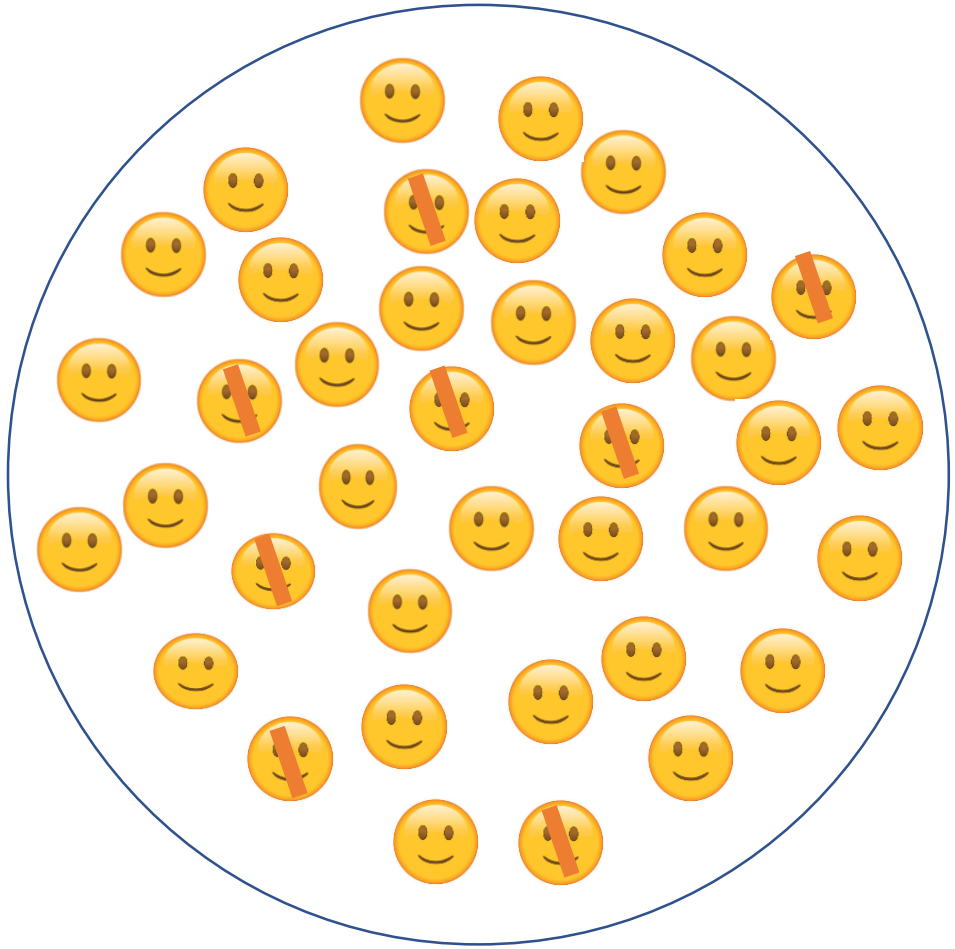
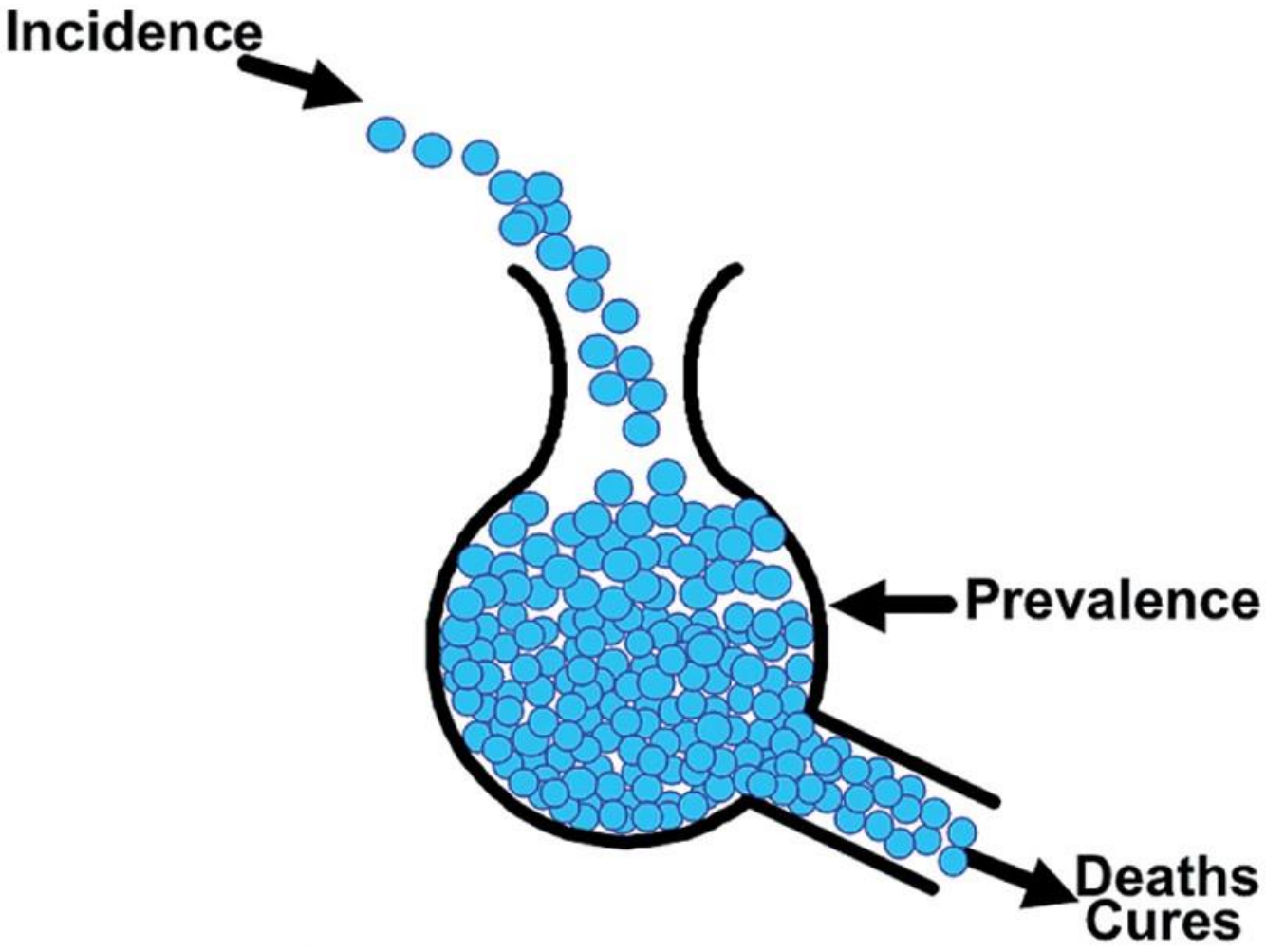


Prevalence vs Incidence



- **Prevalence** can be seen as describing a pool of disease in a population
- **Incidence** is the input flow of new cases into the pool.
- Deaths and cures reflect the output flow from the pool

Factors influencing prevalence

- **Number of new cases**
  - Increased new cases (improved detection, immigration of patients), increases prevalence
  - Decreased new cases (improved cure rate or emigration of patients), decreases prevalence
- **Duration of illness**
  - Short duration, prevalence will be reduced
  - Long duration results in increased prevalence

Uses of prevalence data

- Assessing health care needs of a population
- Planning health services after understanding burden of disease

Measuring incidence

- 2 main measures of incidence
  - **Risk**
  - **Rate**

Incidence Risk

- Reflects the **absolute risk** of developing disease within a given population

  - $$\frac{\textit{number of new cases from population at risk}}{\textit{Disease free population at the start of the follow-up}}$$

- Neither the denominator nor numerator includes people who already have the disease
  - No prevalent cases included

- Also known as **cumulative incidence**, **incidence proportion**

Incidence Rate

- Measures the pace at which new cases of disease occur in a population at risk.
  - $$\frac{\textit{number of new cases from population at risk}}{\textit{sum of disease free time of each person in the population at risk}}$$

- The total time the population was at risk of developing disease is also known as **person-time**
- Person time can be measured with whatever scale that makes the most sense i.e., person-days, person-weeks, person-months, person-years (PY)
- Incidence rate is also known as **incidence density**, **hazard rate**, **person-time rate**

Incidence Rate

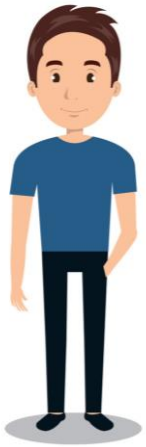
- Typically individuals are followed up until one of 3 **endpoints** occurs
  - Diagnosis of disease of interest
  - End of study
  - Loss to follow-up
- Loss to follow-up may occur due to
  - Migration out of the population
  - Death
  - Refusal to continue to participate in the study
  - These individuals may be described as **“censored”**

Example…**total person-time**

Example…**total person-time**

5 years

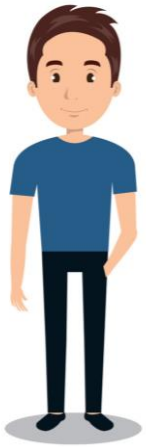
Example…**total person-time**

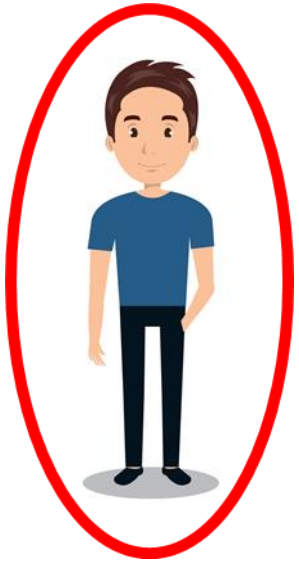


5 years

3 years

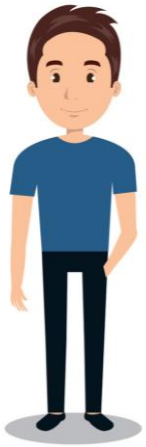
Example…**total person-time**





5 years **3 years** **4.5 years**

Example…**total person-time**



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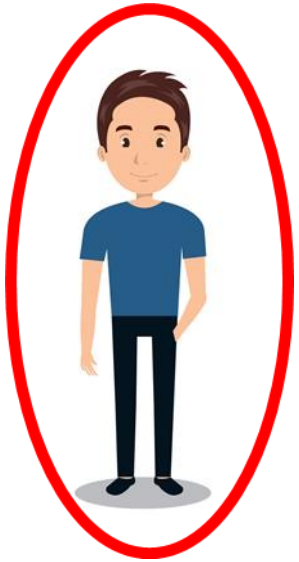
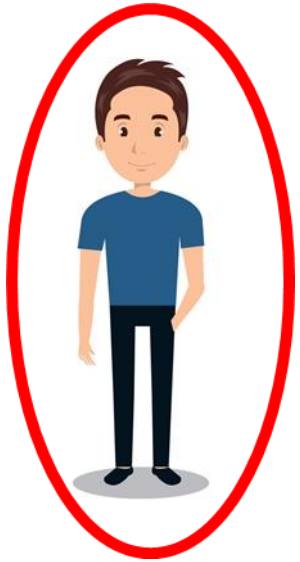
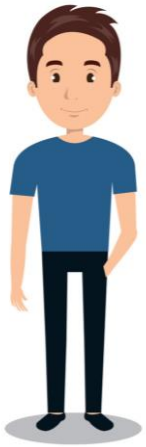


4.5 years



1+3 years

Example…**total person-time**



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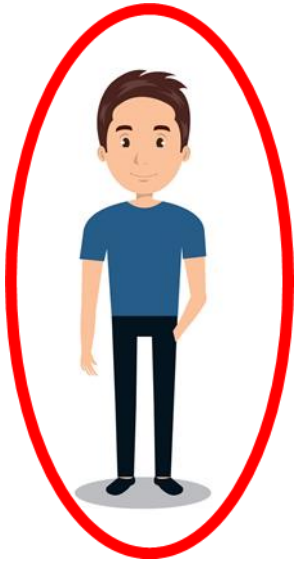
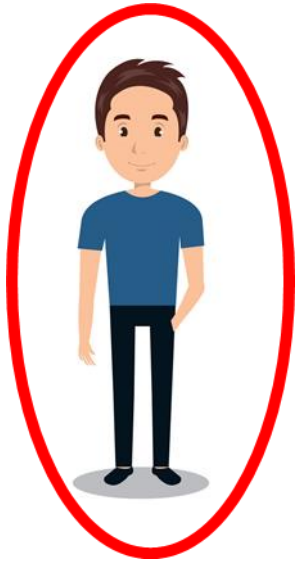


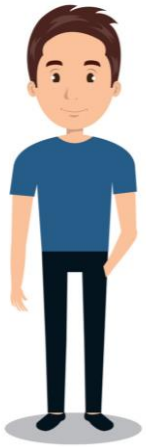
4.5 years

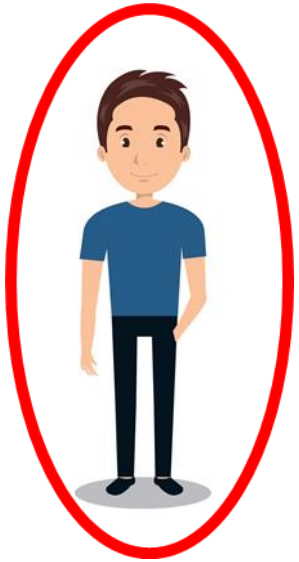


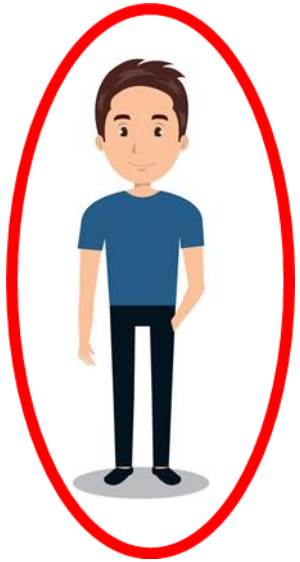
1+3 years

1 years

Example…**total person-time**



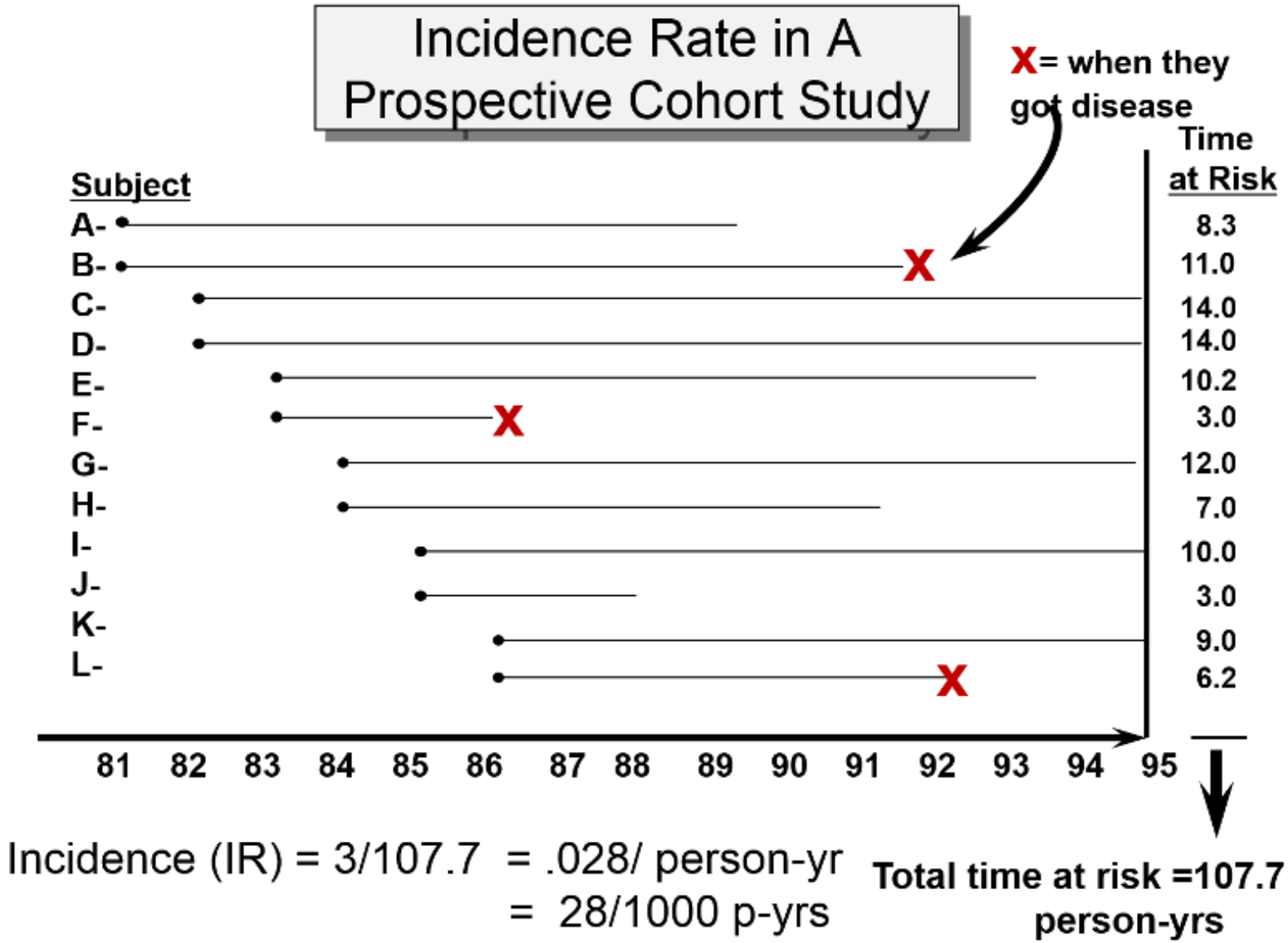




5 years **3 years** **4.5 years** **1+3 years** **1 years**

Total person-time: 5 + 3 + 4.5 + 1+ 3 +1 = 17.5 years

A graphic representation of incidence



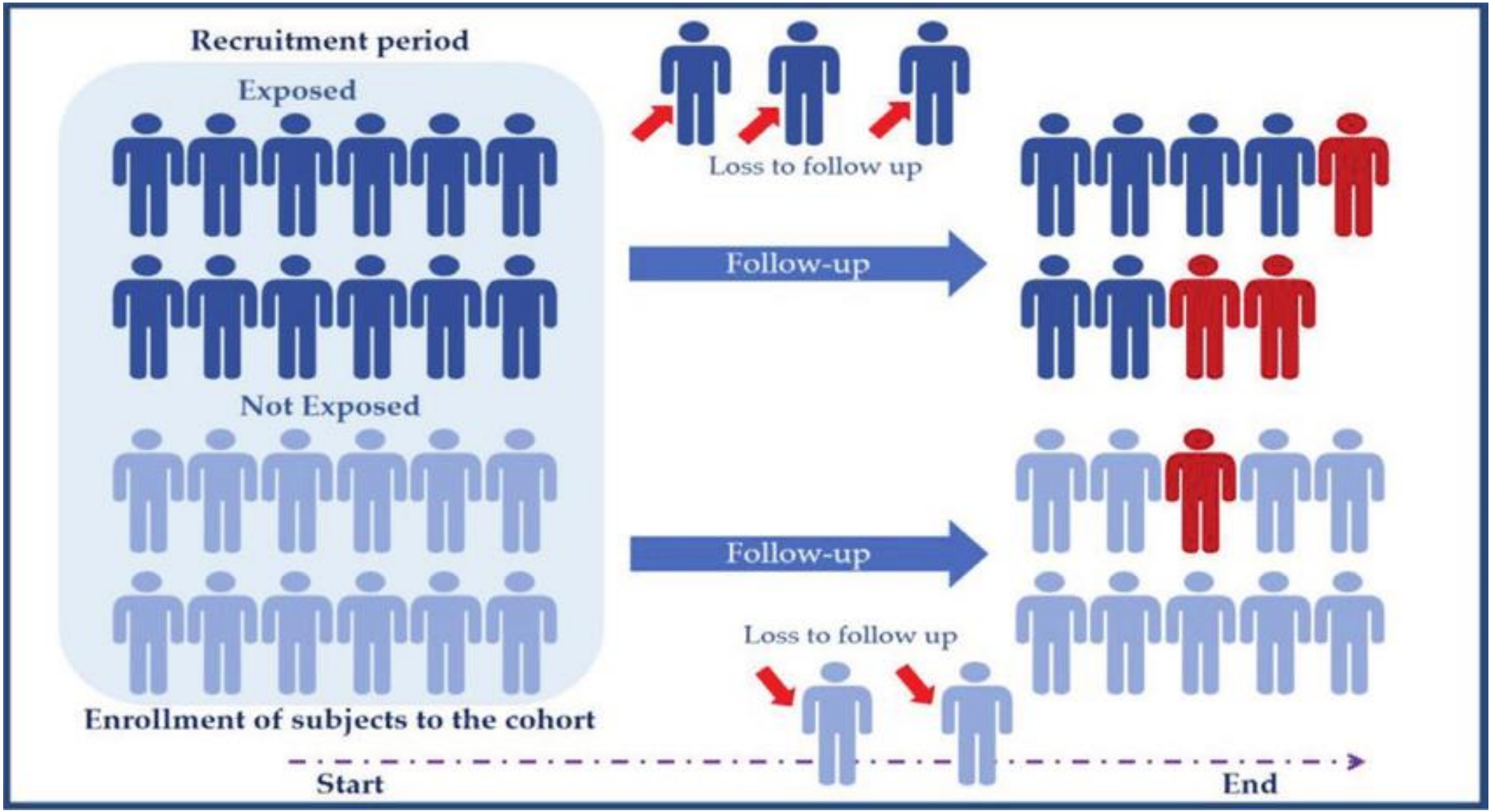
Types of cohorts

Closed

- After start of follow-up, no new persons can be added in the study
- Can directly calculate
  - Incidence risk
  - Incidence rate
  - odds

Open

- May gain members over time (birth or immigration)
- May also lose members through emigration
- Can directly calculate incidence rate using person-time of follow-up


Recruitment period
Exposed
Not Exposed
Enrollment of subjects to the cohort
Loss to follow up
Follow-up
Follow-up
Loss to follow up
Start
End

Uses of incidence data

- Useful in describing trends in disease
- Allows evaluation of impact of primary prevention programs

Odds

- The **odds** of becoming a case is a measure of the number of cases in a defined population and time period, divided by the number of people who *did not* become a case in the same time period.
  - $$\frac{\textit{number of cases}}{\textit{number of non-cases}}$$
- The odds of becoming a case is rarely used as a measure of occurrence.
- However, it is an important measure of *effect*, known as **odds ratio**,

Example

- In a population of 100 school children, 20 children had at least one episode of diarrhoea during a one year study period. The odds of developing diarrhoea in the school during the study period was:
  - $$odds = \frac{number\ of\ cases}{number\ of\ non\text{-}cases}$$

$$\frac{20}{(100-20)} = 0.25 = 25\%$$

Measures of effect

- Important for assessing for an **association** between a suspected factor and the outcome of interest e.g. disease.
- The factor suspected to be associated with an event is referred to an **exposure**.
- An exposure could be anything from
  - a harmful substance to
  - a specific behaviour or
  - a personal characteristic.

Measures of effect

- **Compare** the occurrence of the outcome in a group of people that has been 'exposed' to the factor, with the occurrence in a group of people that has not been 'exposed'.
- The measures are expressed as a **ratio** to get the **relative** measure of effect of the exposure on disease
- Alternatively, the **difference** of the two measures of occurrence gives the **absolute** measure of effect of the exposure

Relative measures of effect

- estimate the magnitude of an association between exposure and disease
- Different types of relative measures can be calculated, known as measures of **relative risk**:
- $Risk\ ratio = \dfrac{Risk\ in\ the\ exposed\ group}{Risk\ in\ the\ unexposed\ group}$
- $odds\ ratio = \dfrac{odds\ of\ disease\ in\ the\ exposed\ group}{odds\ of\ disease\ in\ the\ unexposed\ group}$
- $Rate\ ratio = \dfrac{Incidence\ rate\ in\ the\ exposed\ group}{Incidence\ rate\ in\ the\ unexposed\ group}$

Example….

	Exposed	Unexposed
Number initially at risk	**2000**	**8000**
Deaths during the period	**15**	**30**
Person-years at risk	**3985**	**15970**

$$Risk\ ratio = \frac{15/2000}{30/8000} = 2$$

$$odds\ ratio = \frac{15/(2000-15)}{30/(8000-30)} = 2.0076$$

$$Rate\ ratio = \frac{15/3985}{30/15970} = 2.0038$$

Interpreting measures of effect

- A value of 1 indicates the risk in exposed and unexposed is **identical**, thus **no association** observed between exposure and disease
- A value >1 indicates a **positive association** or an **increased risk** among those exposed
- A value <1 indicates an **inverse association** or a **decreased risk** among those exposed i.e. exposures appears protective

Thank you