Measures of Disease Frequency

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Objectives

1. Calculate the following measures of disease frequency: incidence proportion (risk), incidence rate, and prevalence.

2. Interpret the following measures of disease frequency: incidence proportion (risk), incidence rate, and prevalence.

Risk = Probability

- **Risks account for differences in population size**
- **Risk of an event = Relative frequency of an event**

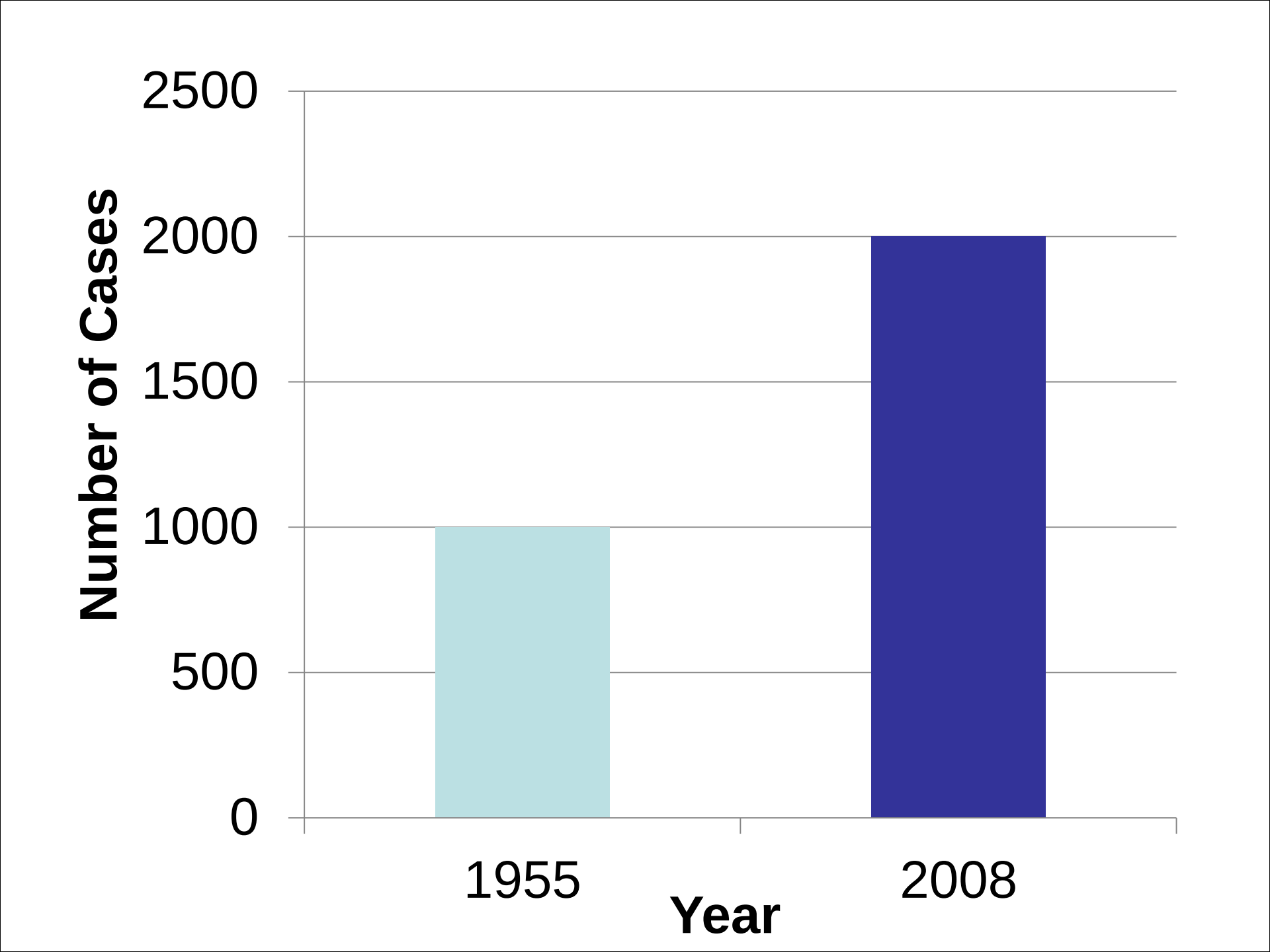
Example

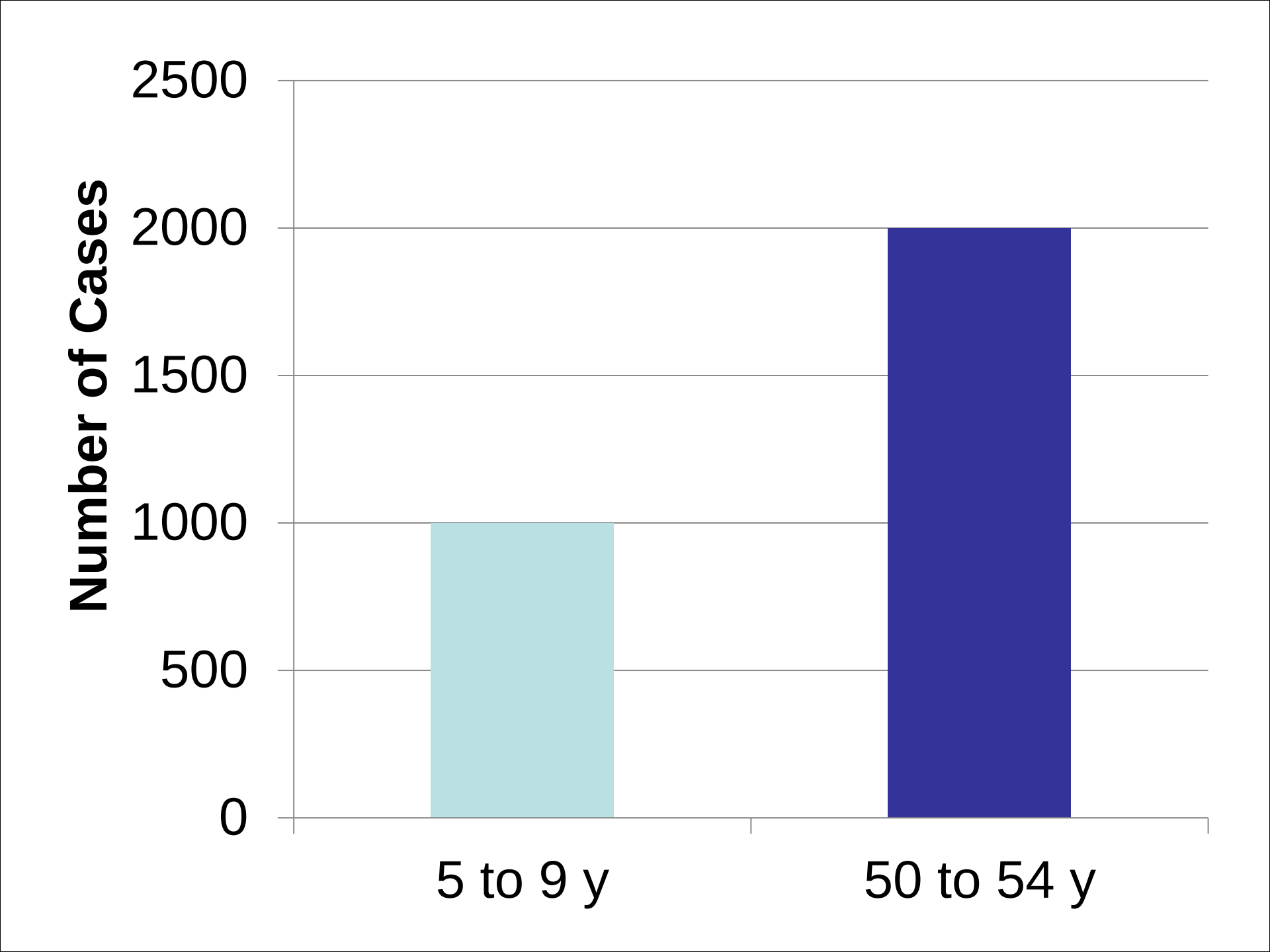
- **Shuffled deck of cards**
- **52 cards**
- **4 kings**
- **4 / 52 = 0.077 or 7.7%**

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

Synonyms for Risk

- **Cumulative incidence**
- **Incidence proportion**


2500
2000
1500
1000
500
0
Number of Cases
1955
2008
Year


Number of Cases
2500
2000
1500
1000
500
0
5 to 9 y
50 to 54 y

More on risk (incidence proportion)

- **You need to know the time period!**
- **5 cases per 100,000 per year?**
- **5 cases per 100,000 per day?**

More on risk

- **"The only way to interpret a risk is to know the length of the time period over which the risk applies."** **Rothman, 2012**

- **Without a time period, the risk is meaningless**

Proportion

$$\frac{X}{X + Y}$$

A proportion is a type of ratio in which the numerator appears in the denominator.

Incidence Rate

- **Not a proportion so range is 0 to +∞**
- **The momentary rate at which cases are occurring within a population**

Incidence Rate

- **Appropriate when there are varying periods of follow up**

- **Synonym: incidence density**

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

Incidence Rate, Unlike Incidence Risk, Can Be Greater than 1

$$100 \ \frac{\text{cases}}{\text{person - year}}$$

$$10{,}000 \ \frac{\text{cases}}{\text{person - century}}$$

$$0.27 \ \frac{\text{cases}}{\text{person - day}}$$

Calculating Incidence Rates in the Exposed (or Treated) and in the Unexposed (or Untreated)

	Had outcome	Didn't have outcome	
Exposed	A	—	PT_e
Unexposed	C	—	PT_{ne}

Note: PT_e & PT_{ne} are person-time in the exposed and unexposed groups, respectively.

Relative Rate (Incidence Density Ratio)

$$= \frac{\frac{A}{PT_e}}{\frac{C}{PT_{ne}}}$$

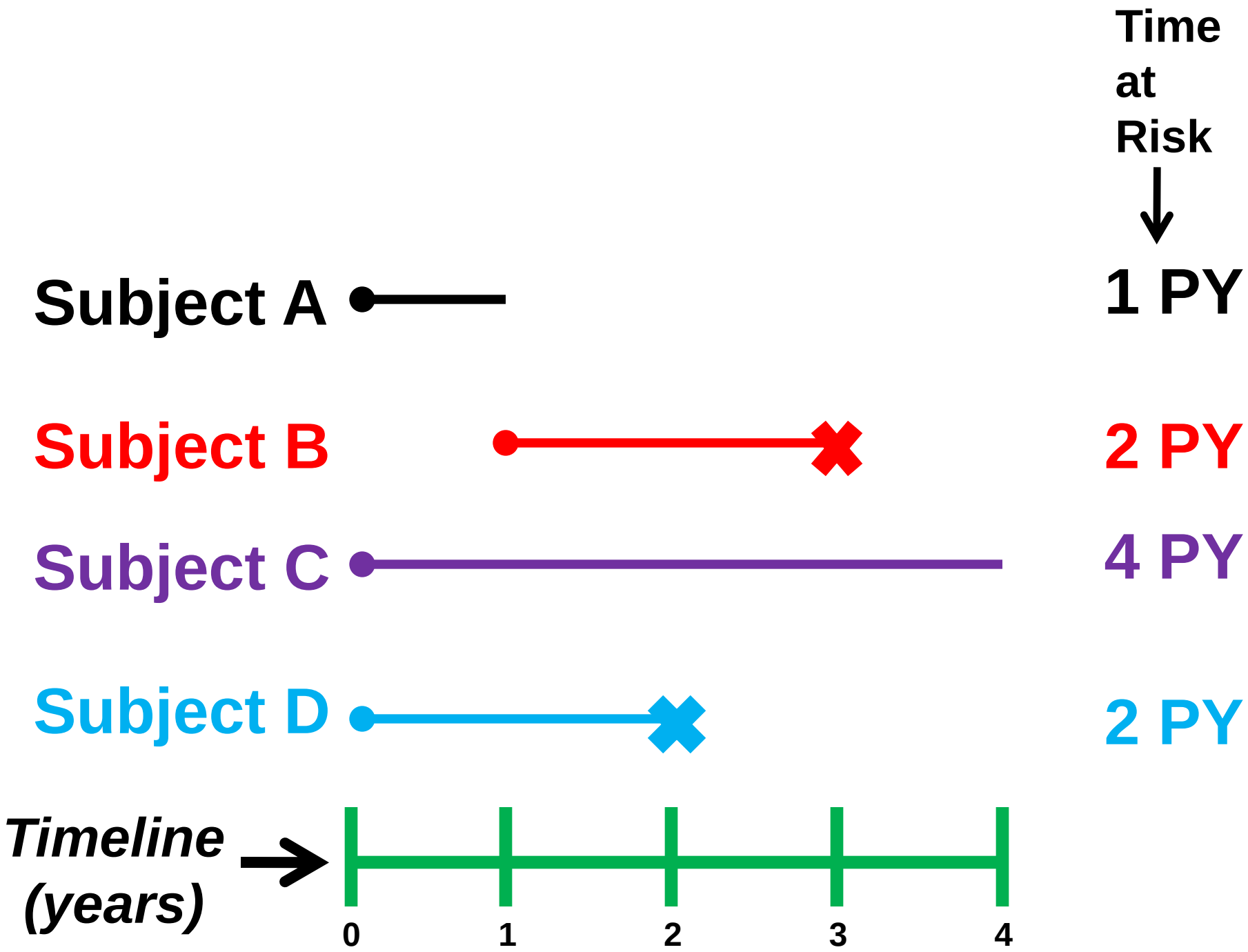
Calculation of Incidence Density:

Four subjects who enrolled in a four-year study at different times and were followed for varying lengths.

● = Start of follow-up

— = Time followed

✖ = Development of outcome


Time at Risk
Subject A
1 PY
Subject B
2 PY
Subject C
4 PY
Subject D
2 PY
Timeline (years)
0
1
2
3
4

Calculation of Incidence Density (ID)

- **Subject A dropped out of the four-year study before the study was completed. He did not have the outcome of interest when he dropped out.**

- **He was censored after one year of follow up. Subject C also censored.**

Calculation of Incidence Density (ID)

1 PY + 2 PY + 4 PY + 2 PY =

9 person-years of follow-up

ID = 2 cases divided by 9 person-years

ID = 0.222 / person-year or

2.22 / 10 person-years

Comparison of Incidence Proportion (Risk) and Incidence Rate

Property	Incidence Proportion	Incidence Rate
Smallest value	0	0
Greatest value	1	Infinity
Units (dimensionality)	None	1/Time

Adapted from Rothman's intro text (1st edition, 2002)

Prevalence

- **Quantifies the proportion of individuals in a population who have the disease at a specific instant**

- **Is a proportion**

Hennekens & Buring, 1987

Prevalence

- While cumulative incidence provides an estimate of the risk that a person will develop a disease during a particular period of time, prevalence provides an estimate of the risk that a person will be ill at a point in time.

$$\text{Prevalence} = \frac{\text{Number of existing cases of a disease}}{\text{Total population}}$$

Cited References

Hennekens CH, Buring JE. Epidemiology in medicine. Boston: Little, Brown and Company, 1987.

Rothman KJ. Epidemiology an introduction. New York: Oxford University Press, 2002.