Measures of Disease Frequency, Impact and Effects

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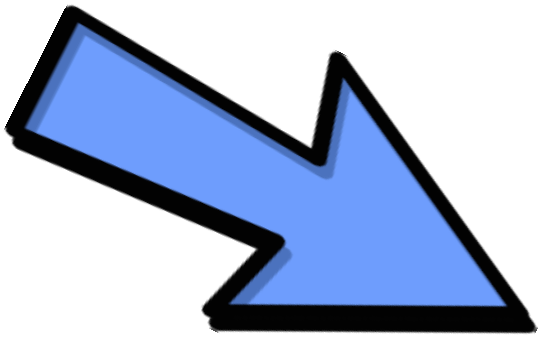
Learning Objectives

By the end of this session, the students will be able to:

- Understand the concept of the common epidemiological measures of disease frequency and effect.
- Identify the appropriate use of these measures
- Interpret the measures of disease frequency, impact and effect

Table 1.1. Questions relevant for epidemiological enquiry

Disease definition	What characteristics or combination of characteristics best discriminate disease from non-disease?
Disease occurrence	What is the rate of development of new cases in a population? What is the proportion of current disease within a population? What are the influences of age, sex, time and geography on the above?
Disease causation	What are the risk factors for disease development and what are their relative strengths with respect to an individual and a population?
Disease outcome	What is the outcome following disease onset and what are the risk factors, including their relative strengths, for a poor outcome?
Disease management	What is the relative effectiveness of proposed therapeutic interventions? (Included within this are health service research questions related to the relative effectiveness of proposed health service delivery options.)
Disease prevention	What is the relative effectiveness of proposed preventive strategies including screening?

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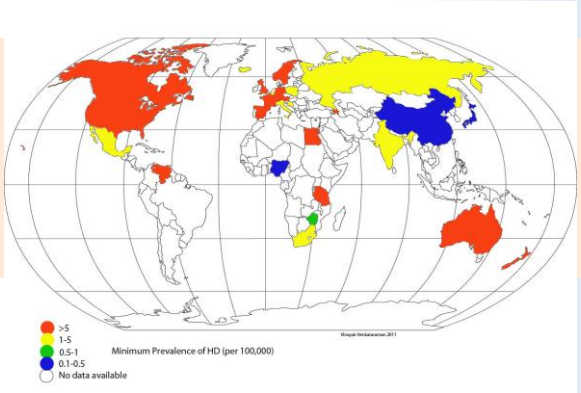
Measures for Disease Occurrence



- **Proportions:**
  - Prevalence
  - Incidence proportion
- **Rates:**
  - Incidence rates
- **Ratio:**
  - odds for a certain disease

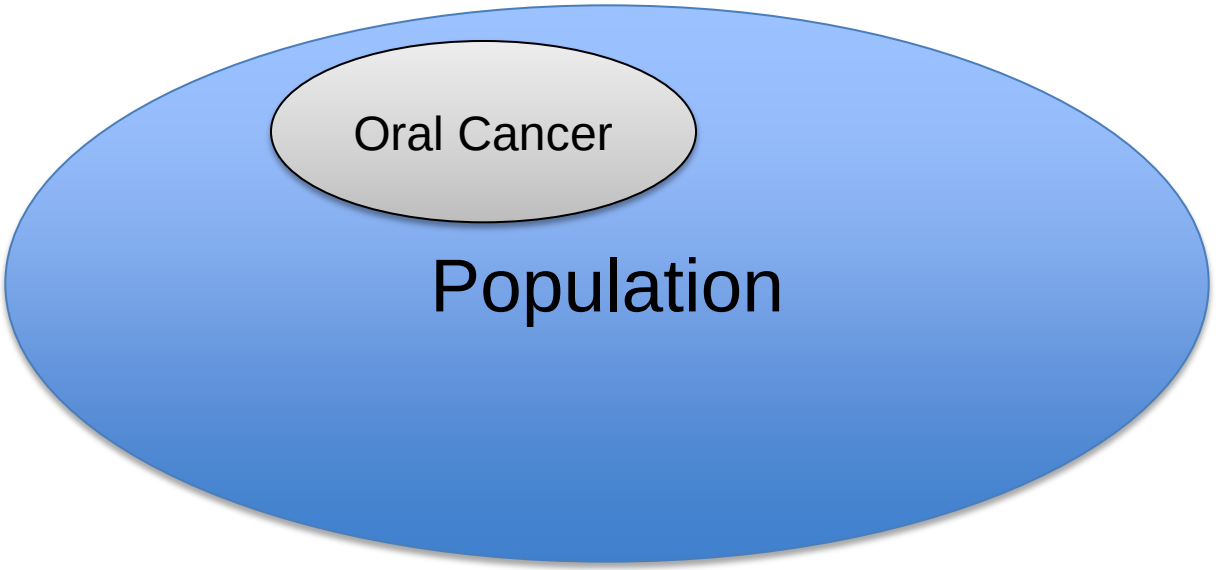
Proportion, Rate and Ratio

- **Proportions**
  - They are dimensionless (do not have a unit of measure, because the unit of measure in the denominator is the same as the numerator)
  - Always lies between 0 and 1
- **Rates**
  - Denominator is measured in time units
  - Can exceed 1 if no. of new cases > person-time spent at risk
- **Ratio**
  - Compares between two measures (two rates, odds or proportions)
  - What is counted in numerator isn't always in the denominator

Measures of Disease Frequency

Prevalence

- The amount of a disease in a population at a given point in time.



Point Prevalence

The proportion of the **population** that has the disease at a **specific point** in time

Point Prevalence

$$= \frac{\text{Number of } \textbf{current} \text{ cases at a specific point in time}}{\text{Total population at that same point in time}}$$

"Current cases" means new and pre-existing cases (all the cases that were there at that point in time)

Period Prevalence

- The proportion of the **population** that has the disease during **a specified period** of time

Period Prevalence

$$= \frac{\text{Number of } \textbf{current} \text{ cases during a specific period of time}}{\text{Average or mid-interval population}}$$

Prevalence (Example)

	Asthma	No Asthma	Total
Non-smokers	40	360	400
smokers	30	170	200
Total	70	530	600

What is the prevalence of asthma among
(1) Smokers and
(2) Non-smokers?

Prevalence of asthma among smokers = 30/200 = 15%
Prevalence of asthma among non-smokers = 40/400 = 10%

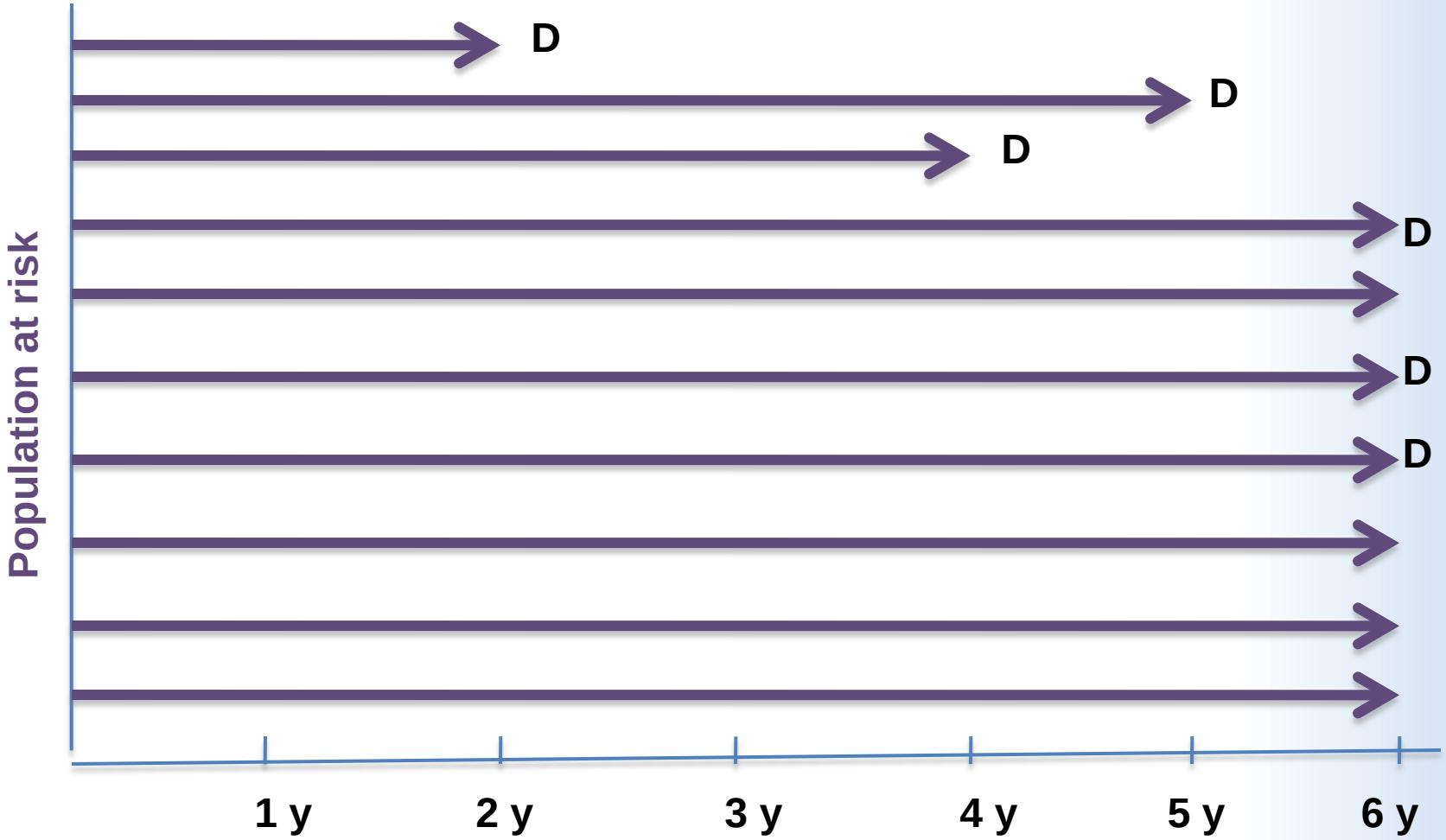
Incidence Proportion

Incidence Proportion =

$$\frac{\textit{Number of new cases}}{\textit{total population at risk at the beginning of the study}}$$

- **The population at risk** is a well-defined population that is **free** of the disease at the beginning of the study and has certain characteristics that put them at risk for developing the disease

Follow-up in Study



# of people at risk at baseline?

# of cases developed during the 6 year follow-up period?

Total person-time at risk?

Incidence Rate

Incidence Rate=

$$\frac{\textit{Number of new cases}}{\textit{the total person time at risk over the study period of time}}$$

- Here we are taking into consideration the **time** that each person spent being at risk before developing the disease
- By contrast the incidence proportion only considers the total population at risk without also incorporating time in the equation

Rate vs. Risk

A study followed 3,000 males ages 45 years and older for 5 years to assess the development of MI.

During the study period, 150 men developed MI, who accumulated a total person-time of 14,625 person-years.

What is the *incidence proportion* after 5 years?

What is the *incidence rate* after 5 years (rate)?

Prevalence vs. Incidence

- Prevalence → Cross-sectional study (Survey)
- Incidence → Cohort study

Comparisons between Prevalence and Incidence

Prevalence

- One point in time; easy to measure
- Proportion or %
- Numerator: count of people with disease
- Denominator: count of total population at risk
- No time component

Incidence

- Involves time; difficult to measure
- Measured as either *rate* or *proportion*
- Numerator: count of people who develop disease during follow-up
- Denominator:
  - (prop.) People at risk and disease free
  - (rate) Person-time at risk.

Measures of Effect (Associations)

Measures of Effect (Associations)

- Risk
- Odds
- Risk Ratio
- Odds Ratio
- Relative Risk Reduction and Absolute Risk Reduction
- Number needed to Treat and Number needed to Harm

2X2 Table

		Outcome		Total
		Yes	No	
Exposure	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	N

Odds

- The ratio of the probability of occurrence of an event to that of non-occurrence
- Odds in Exposed = a/b
- Odds in unexposed, “Baseline odds” = c/d

		Outcome		Total
		Yes	No	
Exposure	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	N

Odds Ratio (OR)

	Outcome	Outcome	Total
Exposure	Yes	No	
Yes	a	b	a + b
No	c	d	c + d
Total	a + c	b + d	N

$$\text{Odds ratio} = \frac{a/b}{c/d} = \frac{ad}{cb}$$

Odds Ratio

	Ear Infection	Ear Infection	Total
Swimming	Yes	No	
Yes	40	60	100
No	5	95	100
Total	45	155	200

Odds of getting infection for swimmers: 40/60 = 0.67

Odds of getting infection for non-swimmers: 5/95 = 0.052

$$\text{Odds ratio} = \frac{0.67}{0.052} = 12.7$$

Risk

- Probability that an event will occur
  - Risk in Exposed = a / (a+b)
  - Risk in unexposed, “Baseline risk” = c / (c+d)

		Outcome		Total
		Yes	No	
Exposure	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	N

Relative Risk (RR) = Risk Ratio

		Outcome		Total
		Yes	No	
Exposure	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	N

$$\text{Relative Risk} = \frac{a/(a+b)}{c/(c+d)}$$

Relative Risk

Interpretation:

How many **times** more likely it is that someone who is exposed to something will develop a certain disease compared to someone who is not exposed.

- 1 → no difference between the groups
- <1 → reduced the risk (protective)
- >1 → increase the risk

Relative Risk

	Ear Infection	Ear Infection	Total
Swimming	Yes	No	
Yes	40	60	100
No	5	95	100
Total	45	155	200

Risk of getting infection for swimmers: 40/100 = 0.4

Risk of getting infection for non-swimmers: 5/100 = 0.05

$$\text{Relative Risk} = \frac{0.4}{0.05} = 8$$

Relative Risk

RR doesn't tell you the magnitude of benefit of treatment.

It only tells there is increase or decrease risk in experiment group compared to control group.

Number Needed to Treat (NNT)

- Number of persons who would have to receive an intervention (treatment) for 1 to benefit.

- NNT= 1/AR

Measures of Impact

Measures of Impact

- Measures of association providing information about absolute effects of exposure

- Reflect apparent contribution of an exposure to the frequency of disease

Attributable Risk (AR)

- Quantifies disease burden in **exposed group** attributable to exposure (describe the impact of an exposure on a population of interest)

- **Provides answers to**
  - What is the risk attributed to the exposure?
  - What is the excess risk due to the exposure?

Attributable Risk (AR)

- The interpretation of this measure assumes a reasonable degree of certainty that the exposure itself is likely causing the observed difference in the outcome.

- Results obtained from a large RCT OR observational study supported by established biological evidence

Attributable Risk (AR)

- It is also called the absolute risk reduction.

- Calculated as risk difference (RD)

  =Risk (exposed) – risk (unexposed)

- It maintain the same unit as the risk value.

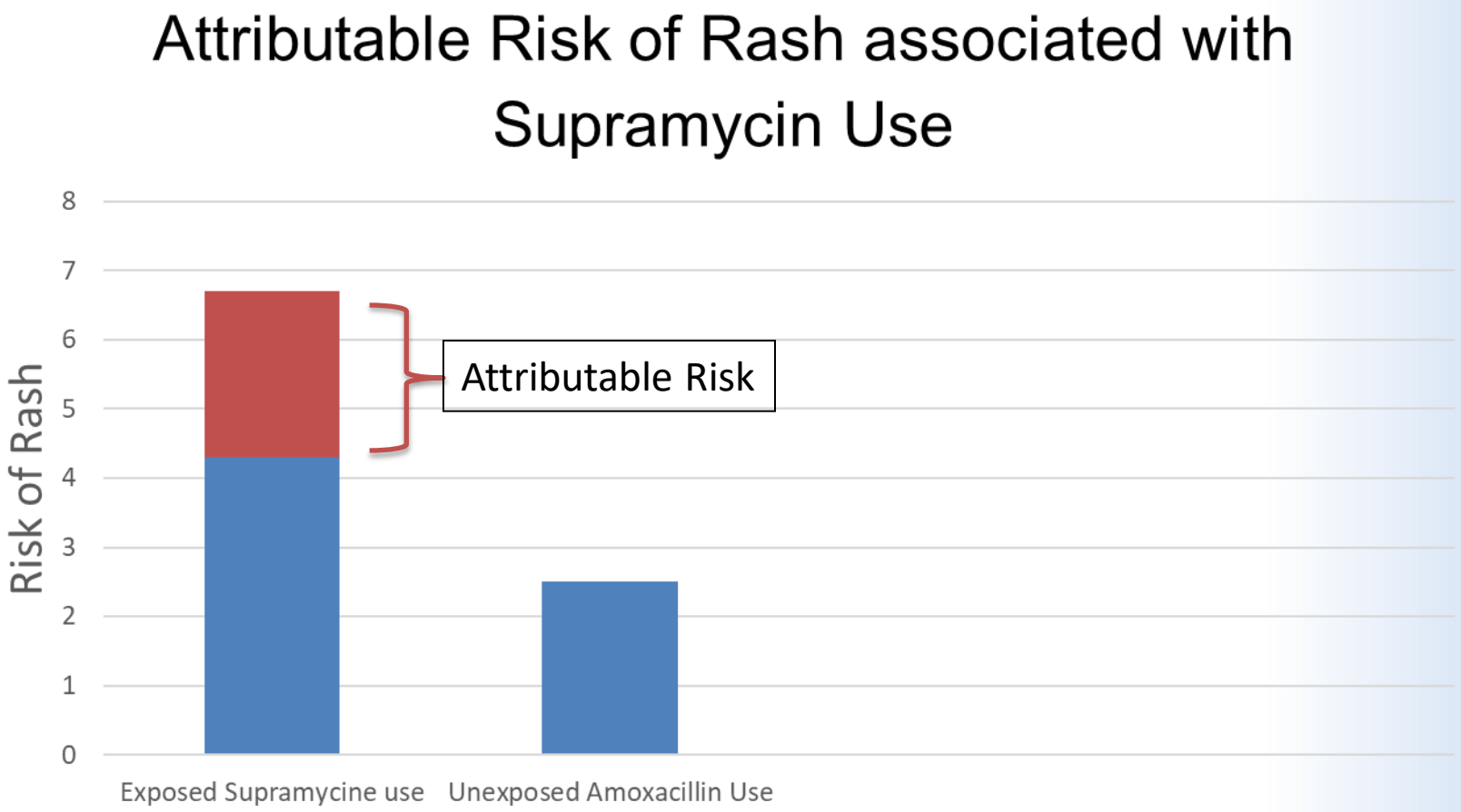
Attributable Risk (Example)

Attributable Risk for Supramycin use in development of rash

	Rash	No rash	Total
Supramycin use	10	90	100
Amoxicillin use	20	380	400
Total	30	470	500

AR = ?

Attributable Risk (Example)



Summary

- Measures of Disease Frequency
  - Prevalence
  - Incidence
- Measures of Effect (Associations)
  - Risk
  - Odds
  - Risk Ratio
  - Odds Ratio
  - Number needed to Treat
- Measures of Impact
  - Attributable Risk (AR)
  - Population Attributable Risk


Thank
you!!