04

MEASURES OF DISEASE FREQUENCY, IMPACT AND EFFECTS

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ACKNOWLEDGMENTS

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TABLE OF **CONTENTS**

LECTURE **OBJECTIVES**

By the end of this lecture, I am 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

In this course we use quantitative data more than qualitative data.
Quantitative data are translated into interpretable words that answer the research question.

Table 1.1. Questions relevant for epidemiological enquiry

Disease definition Usually used by experts.	What characteristics or combination of characteristics best discriminate disease from non-disease?
Disease occurrence Easiest way to assess a condition in a certain population or community. It's a complete research by itself.	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? Aids in allocation of suitable healthcare services.
Disease causation (A factor directly causing disease) Applies for infectious diseases only.	What are the risk factors for disease development and what are their relative strengths with respect to an individual and a population? Other disease have multiple risk factors in play rather than 1.
Disease outcome Prognosis	What is the outcome following disease onset and what are the risk factors, including their relative strengths, for a poor outcome?
Disease management Requires a long time limit. You can take it retrospectively if you didn't have the time, and check the medication effect.	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?

MEASURES OF DISEASE OCCURRENCE

1 Proportions

- Prevalence & Incidence Proportions
- The numerator is part of the denominator (percentage).
- Always lies between 0 and 1 Rates.
- Dimensionless (do not have a unit of measure, the unit of measure in the denominator is the same as the numerator.

2 Rates

- Incidence Rates.
- Denominator is measured in time units.
- Can exceed (1) if number of new cases > person-time spent at Risk Ratio.

3 Ratio

- Odds for a certain disease.
- Compares between two measures (two rates, odds or proportions).
- What is counted in numerator isn't always in the denominator.
- Denominator not related to numerator.

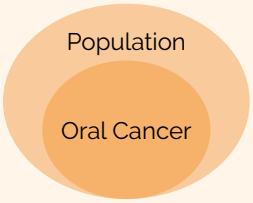
MEASURES OF DISEASE FREQUENCY

Prevalence

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

Number of cases in the entire population.

Example: During five months, 300 patients attended the clinic (denominator), and 40 of them had oral cancer (numerator).



Point Prevalence

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

Small duration of time (Days, Weeks, Months). Three months maximum. But if it's a disease that has rapid progression, then you can't measure prevalence; it has to be a chronic disease, less likely to be cured.

$$= \frac{\textbf{Number Of Current Cases At A Specific Point In Time}}{\textbf{Total Population At That Same Point In Time}}$$

Current Cases are new, and pre-existing cases. (All cases that were there at that point of time).

Period Prevalence

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

Example: During the year 2017.

$$= \frac{\textbf{Number Of Current Cases During A Specific Period Of Time}}{\textbf{Average Or Mid-interval Population}}$$

Point VS. Period Prevalence

	Point Prevalence	Period Prevalence
Difference (Denominator)	Sample size	The population changes during the period, these are added and divided by number of times changed
Common	Same Numerator	
Used by	Research done by 3rd year students	Ministry of Health

Prevalence Example

	Asthma	Non-asthma	Total
Non-smokers	40	360	400
Smokers	30	170	200
Total	70	530	600

What Is The Prevalence Of Asthma Among: (A) Smokers (B) Non-smokers?

- Prevalence of asthma among smokers = 30/200 = 15%
- Prevalence of asthma among non-smokers = 40/400 = 10%
- Prevalence of asthma= 70/600 = 8.56%

Incidence Proportion

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.

$$= \frac{\textbf{Number Of New Cases}}{\textbf{Total Population At Risk At The Beginning Of The Study}}$$

When you start the study without the outcome of interest, You can know when it will appear, and you can measure the incidence (cohort and RCT you can measure incidence). But if you started the study with the outcome, you CANNOT measure it like in (case-control). You can know when the disease appeared by following up the patients.

Incidence Rate

No Person-Time calculation in the exam

The time each person spent being at risk before developing the disease. By contrast, the incidence proportion only considers the total population at risk, without incorporating time in the equation. This is why incidence rate is more accurate.

$$= \frac{\textbf{Number Of New Cases}}{\textbf{Total Person-Time At Risk Over The Study Period Of Time}}$$

Rate VS. Risk

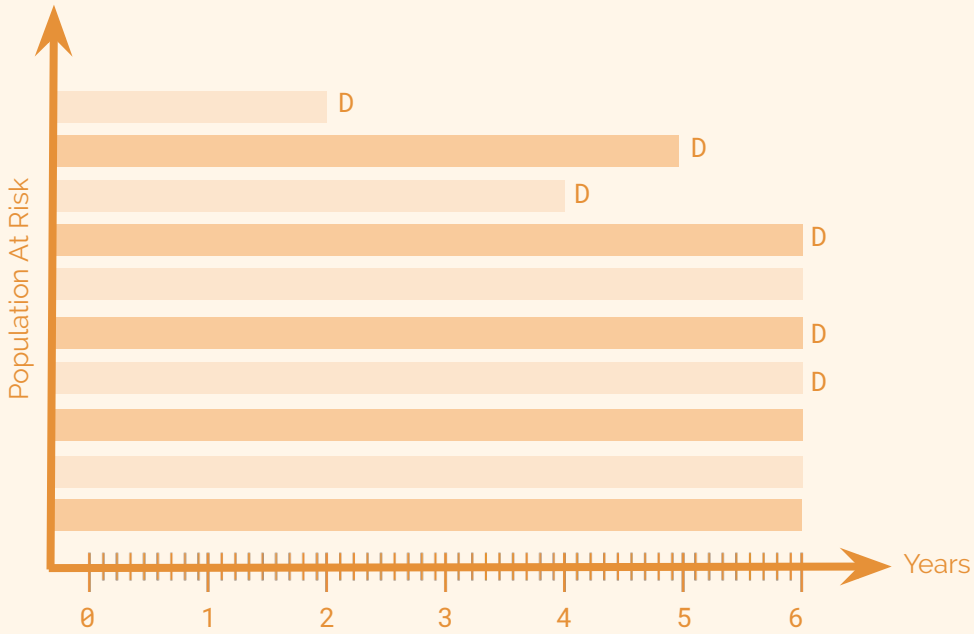
Example: A study followed 3,000 males ages 45 years and older for 5 years to assess the development of MI. During the study period, 150 men developed MI, who accumulated a total person-time of 14,625 person-years (Accumulated years of follow-up).

What is the incidence proportion after 5 years? 150/3000

What is the incidence rate after 5 years (rate)? 150/14625

Follow-Up In Study

Important.



- **What is the # of people at risk at the baseline?** 10 (All of them)
- **What is the # of cases developed during the 6-year follow-up period?** 6
- **What is the total person-time at risk?** 6/10 = 60%
- Person-time always means incidence rate
- Denominator in incidence rate = Denominator is the sum of follow up years of each participant (2+5+4+6+6+6+6+6+6+6)/10).
- Statistical program calculates it because sample size is too large for human calculation
- Incidence of disease at 2 years= 1/10
- Incidence of disease at 4 year 1/9
- We excluded the patient that was diseased in year 2 because he/she is not at risk
- Incidence rate at 6 years= 3/7

Prevalence VS. Incidence

	Prevalence	Incidence
Study	Cross-Sectional (Survey)	Cohort
Difficulty	One point in time; easy to measure	Involves time; difficult to measure
Time	No time component	Person-time at risk (Rate)
Measurement	Proportion or Percentage	Rate or Proportion
Numerator	Count of people with disease	Count of people who develop disease (during follow-up)
Denominator	Count of total population at risk	**Proportion:** People at risk and disease free **Rate:** Person-time at risk.

MEASURES OF EFFECT [ASSOCIATION]

They Are

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

Here, we have two factors, and we want to see the relation between them, and how each one affects the other

2x2 Table

		Outcome		
		Yes	No	Total
Exposure	Yes	**A**	**B**	A+B
	No	**C**	**D**	C+D
	Total	A+C	B+D	N

Easiest method to develop risk and odds ratio.

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

Odds Ratio

Measure of association in case-control studies.

It considers the number of control, rather than the total number we use in risk.

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

Risk

The probability that an event will occur.

- **Risk in Exposed** = a / (a+b)
- **Risk in unexposed (Baseline risk)** = c / (c+d)

Relative Risk (Risk Ratio)

How many times is it likely that someone exposed to something will develop a disease, compared to unexposed.

Interpretation: 1 = No difference, >1 Increase the risk, <1 Reduce the risk (Protective).

- **Risk Ratio (RR)** = $\frac{a / (a+b)}{c / (c+d)}$

Used in cohort studies that are looking for association between two factors.

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.

Odd and Risk don't give you exact number, just tells you whether it increases or decreases so if you want to get the exact number use Attributable Risk.

Example

Important. You may be asked to draw the table.

		Outcome		
		Yes	No	Total
Exposure	Yes	**A**	**B**	A+B
	No	**C**	**D**	C+D
	Total	A+C	B+D	N

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

What are the odds of getting infection for swimmers? 40/60 = 0.67

What are the odds of getting infection for non-swimmers? 5/95 = 0.052

What is the odds ratio? $\frac{0.067}{0.052}$ = 12.7

Interpretation: The odds of ear infection in swimmers is **12.7** times more common than in non swimmers.

What is the risk of getting infection for swimmers? 40/100 = 0.4

What is the risk of getting infection for non-swimmers? 5/100 = 0.05

What is the relative risk $\frac{0.4}{0.05}$ = 8

Interpretation: Swimming increases ear infection by **8** times.

Number Needed To Treat

No NNT calculation in the exam

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

Used in Randomized Control trials.

Example: How many people do I have to administer Aspirin in order to prevent one case of MI?

- **NNT** = 1/AR

MEASURES OF IMPACT

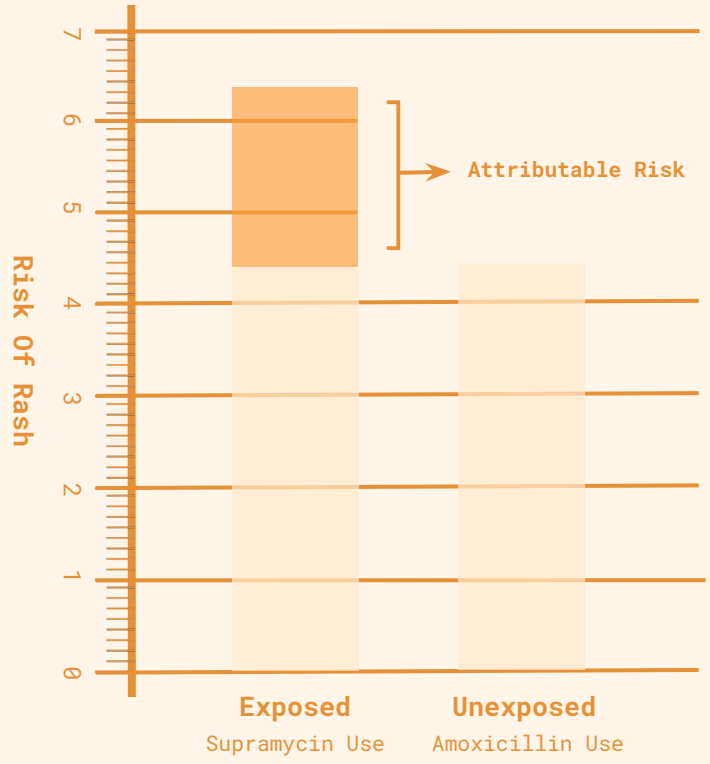
They Are

- Measures of association providing information about absolute effects of exposure
- Reflect apparent contribution of an exposure to the frequency of disease
  1. Attributable Risk **Level:** Study
  2. Population Attributable Risk **Level:** Population

Attributable Risk

- Quantifies the disease burden in an exposed group, attributable to exposure (Describes the impact of exposure on a population of interest).
- **Provides answers to:**
  1. What is the risk attributed to the exposure?
  2. What is the excess risk due to the exposure?
- 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.
- Calculated as **Risk Difference (RD) = Risk (Exposed) – risk (Unexposed).**
- Maintains the same unit as the risk value.
- It is also called the **Absolute Risk Reduction.**

Example



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

What is the Attributable Risk for Supramycin use in development of rash?

AR = (10/100) - (20/400) = 0.05

RECOMMENDED READ