Epidemiology: Measures of Disease Occurrence and Effect

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Outlines

- Introduction
- Measures of Disease Frequency
- Measures of Effect

Learning outcomes

- Understand and differentiate numerator vs denominator
- Understand and differentiate ratio, proportion and rate
- Understand and differentiate measures of disease occurrence
- Understand and differentiate measures of effect

Introduction

Terms

- Numerator
  - "case"
  - Dividend
- Denominator
  - "population at risk"
  - Population size
  - Divisor

$$\frac{\text{numerator}}{\text{denominator}}$$

Terms

- Ratio

$$\frac{a}{b}$$

- e.g. Odds

- Proportion

$$\frac{a}{a+b}$$

- e.g. Prevalence, Risk
- Range: 0 to 1
- Usually in %

- Rate

$$\frac{a}{\text{time observed}}$$

- Incidence rate
- Usually per thousands population

Measures of Occurrence

Prevalence

- Quantifies cases (new + existing) at a point / period of time
- Cross-sectional study
- Measures:
  - Point prevalence
  - Period prevalence

Point Prevalence

$$P = \frac{C}{N}$$

C = # cases at time point
N = Population size at time point

Period Prevalence

$$PP = \frac{C + I}{N}$$

C = # existing cases at the beginning of a time period
I = # new cases during the time period
N = Population size for the time period

Example

Prevalence of diabetes among adults in Malaysia 18.3% (NHMS 2019)

Incidence

- Quantifies new cases that develop over a period of time
- Cohort study – requires follow-up to keep track of new cases
- Measures:
  - Risk (a.k.a. cumulative incidence)
  - Incidence rate (a.k.a incidence density)

Risk

$$R = \frac{I}{N}$$

C = # new cases during follow-up
N = # persons at risk
(disease-free subjects at the start of follow-up)

Incidence rate

$$IR = \frac{I}{PT}$$

I = # new cases during follow-up
N = Person-time (person-years, -months of exposure)
(total time disease-free persons are followed-up)

Incidence rate

$$IR = \frac{I}{N}$$

I = # new cases in one year
N = Mid-term population for the year

Example

7-day incidence rate of COVID-19 in Malaysia was 26.6 per 100,000 population (Jayaraj et al., 2021)

Prevalence vs Incidence

Table 1. Summary of characteristics of measures of disease frequency

	Prevalence	Incidence	
Represents	Existing cases at a time point	New cases over a period	
Use	– Reflects disease burden – Can be used for planning of health care facilities	– Assessment of disease aetiology – Identification of risk factors	
		Risk	Incidence rate
Synonyms	Prevalence proportion	Cumulative incidence Incidence proportion	Incidence density Hazard
Range	0–1 (0–100%)	0–1 (0–100%)	0 to infinity
Interpretation	Proportion	Probability	Reciprocal of waiting time

*Table 1 in Noordzij et al. (2010)

Measures of Effect

Relative

- Relative risk
  - Risk ratio
  - Incidence rate ratio
- Odds ratio

Relative risk

		Lung cancer		Marginal total
		Yes	No	
Exposure	Smoker	125	125	250
	Non- smoker	125	375	500

Risk of lung CA for smoker = 125/250 = 0.5
Risk of lung CA for non-smoker = 125/500 = 0.25
Risk ratio = 0.5/0.25 = 2

Odds ratio

		Exposure		*
		Smoker	Non-smoker	
Lung cancer	Yes	125	125	*
	No	125	375	*

Odds of being smoker in lung CA = 125/125 = 1
Odds of being smoker in no lung CA = 125/375 = 0.333
Odds ratio = 1/0.333 = 3

Odds ratio

		Lung cancer		*
		Yes	No	
Exposure	Smoker	125	125	*
	Non- smoker	125	375	*

- Odds of lung CA in smoker = 125/125 = 1
- Odds of lung CA in non-smoker = 125/375 = 0.333
- Odds ratio = 1/0.333 = 3!!! Same as previous table.
- Uniqueness of odds ratio.

Absolute

- Risk difference (Attributable risk)

Risk (exposed) – Risk (unexposed)

- Rate difference (Attributable rate)

Rate (exposed) – Rate (unexposed)

Risk difference & NNT

		Lung cancer		Marginal total
		Yes	No	
Exposure	Smoker	125	125	250
	Non- smoker	125	375	500

Risk of lung CA for smoker = 125/250 = 0.5
Risk of lung CA for non-smoker = 125/500 = 0.25
Risk difference = 0.5 – 0.25 = 0.25

References

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