Research
442

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Interpreting Measures of Frequency, Association and Impact

Tutorial No. 4

Objectives:

~ This lecture was presented by **Dr. Kholood Altassan**
~ It is included in the **Midterm Exam**
~ We highly recommended reading the **Ayah** in the first page

Slides

Color code

Original text
Dr. Notes
Important
Golden note
Extra

Editing file

Measures of Disease Frequency

- Can be measured either as a **count or a proportion, rate, or ratio.**
- Counts alone are often insufficient without looking at them in relation to the population.

سُورَةُ الرُّومِ

وَإِذَا مَسَّ ٱلنَّاسَ ضُرٌّ دَعَوْا۟ رَبَّهُم مُّنِيبِينَ إِلَيْهِ ثُمَّ إِذَآ أَذَاقَهُم
مِّنْهُ رَحْمَةً إِذَا فَرِيقٌ مِّنْهُم بِرَبِّهِمْ يُشْرِكُونَ ﴿٣٣﴾

Types of measures of disease <u>frequency:</u>

1) Prevalence:

- Captures the frequency of disease (or specific characteristic, outcome or behavior) **at a specific point in time.**
- It is a **static** measure.
- Prevalence is a **proportion or ratio** of the **count** of prevalent cases over the total population at the specified point in time.

$$\text{Prevalence} = \frac{\text{Number of prevalent cases}}{\text{Total population}}$$

- Can also be presented as a rate (e.g per 100,000 people (ppl), percentage)
- Can be calculated from cross-sectional studies both descriptive and analytic.
- Descriptive cross-sectional studies are often referred to as prevalence studies.

<u>Examples: Prevalence of vaping and smoking among medical students at KSU:</u>

	Those who vape only	Those who smoke only	Those who smoke and vape	Those who do not vape or smoke	Total
Male	103	69	26	16	214
Female	23	4	3	78	108
Total	126	73	29	94	322

- Calculate the prevalence of only vaping among female medical students:
  (23/108) x 100 = 21.2%
- Calculate the prevalence of smoking among all medical students: smoking generally
  [(73 + 29)/322] x 100 = 31.7%
- Calculate the prevalence of non-smoking and vaping (don't vape) among medical students:
  (94/322) x 100 = 29.2%

2) Incidence rate:

- Captures new cases of a disease (or a specific characteristic, outcome or behavior) as they develop **over time.**
- It is a **dynamic** measure.
- The incidence rate is the ratio of people who develop the outcome of interest to the total number of people in the study (generally calculated as per 100,000).

$$\textbf{IR disease} = \frac{a+c}{a+b+c+d}$$

	Develop disease	Did not develop disease	Total	Incidence rate
Exposed	a	b	a+b	IR in exposed = a/ a + b
Unexposed	c	d	c+d	IR in unexposed = c/ c + d

Example: Influenza in Saudi in 2020:

2019		2020	
Influenza confirmed	Population	Influenza confirmed	Population
70,000	34,270,000	450	34,810,000

- Incidence rate of influenza in 2019:
  70,000/34,270,000 = 204 per 100,000 ppl
- Incidence rate of influenza in 2020:
  450/34,810,000 = 1.3 per 100,000 ppl

3) Mortality rate:

- The same as the incidence rate **but the outcome of interest is death.**
- **Disease-specific mortality rate:** the incidence of death among those with a specific disease over the total population.
- **Age-specific mortality rate:** the incidence of death among those in a specific age group over the total population.

	Died	Did not die	Total	Mortality rate
Specified group (disease, age, gender, etc)	a	b	a+b	MR in group = a / a +b + c+ d
Not in the group	c	d	c+d	

Example: COVID-19 mortality in different countries:

Country	Total population	Confirmed cases	Deaths from COVID-19	Mortality rate (per 100,000)
Peru	32,970,000	3,571,516	213,013	646 per 100,000
US	329,500,000	82,613,620	999,842	303 per 100,000
Tunisia	11,820,000	1,041,197	28,575	242 per 100,000
Italy	59,550,000	17,071,649	165,346	278 per 100,000
SA	34,810,000	759,856	9,118	26 per 100,000

Just focus on the total population and the deaths

Measures of Disease Frequency, *cont.*

4) Case-fatality:

- Used to calculate the incidence of death **among those with** a specific disease, **exposure**, or complication.
- Generally calculated as a percentage.

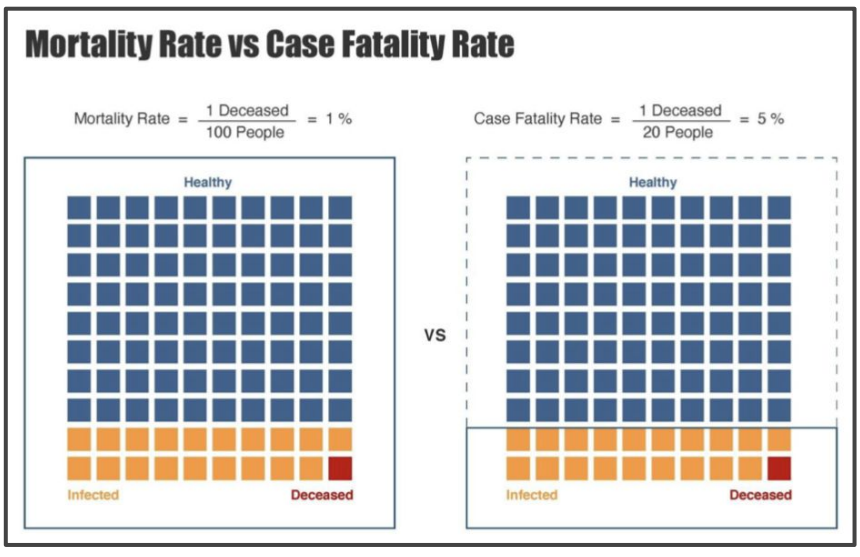
	Died	Did not die	Total	Case-fatality
With exposure or disease	a	b	a+b	= a / a +b x 100

Example: COVID-19 mortality in different countries:

Country	Total population	Confirmed cases	Deaths from COVID-19	Case-fatality
Peru	32,970,000	3,571,516	213,013	6%
US	329,500,000	82,613,620	999,842	
Tunisia	11,820,000	1,041,197	28,575	
Italy	59,550,000	17,071,649	165,346	
SA	34,810,000	759,856	9,118	1.2%

Mortality rate =
Deaths/ population

Case-fatality =
Deaths / confirmed cases



Measures of Association

1) Odds Ratio (OR)

- The odds ratio (OR) is a measure of association calculated from **case-control studies.**
- It is a measure of the odds of exposure in the diseased compared to the odds of exposure in those without disease, and is calculated as: OR = ad/bc
- OR interpretations: OR > 1, OR = 1, OR < 1

$$\text{Odds Ratio} = \frac{\text{Odds of exposure among cases}}{\text{Odds of exposure among controls}} = \frac{ad}{bc}$$

	Cases	Controls
Exposed	a	b
Unexposed	c	d

Interpretation:

	OR = 1	OR < 1	OR > 1
Interpretation	Odds of **exposure** are equal among cases and controls	Odds of **exposure** for cases are less than the odds of exposure for controls	Odds of **exposure** for cases are greater than the odds of exposure for controls
Exposure as a risk factor?	Particular exposure is probably not a risk factor	Exposure possibly reduces disease risk (Protective)	Exposure possibly increases disease risk (Risk factor)

Example: Asbestos and lung cancer:

	Case of lung cancer	Control	Total
Exposed to asbestos	600	250	850
Not exposed to asbestos	400	750	1150
Total	1000	1000	200

$$\text{OR} = \frac{\text{Odds of exposure among cases (a/c)}}{\text{Odds of exposure among controls(b/d)}}$$

= ad / bc

= 600*750 / 400*250 = 4.5

Examples: Adenocarcinoma of the vagina

	Have VA	Do not have VA
Exposed to DES	7	0
Not exposed to DES	1	32

- Rare disease
- A cluster of cases recorded between 1966 and 1969 among individuals born a New England hospital between 1946 and 1951.
- Exposure of pregnant mothers to diethylstilbestrol was suspected.
- Conducted a case-control study with 8 cases and matched control at a 4:1 ratio.

Measures of Association, *ont.*

2) Prevalence Odds Ratio (POR)

- The prevalence odds ratio (POR) is a measure of association calculated from **cross-sectional analytic** studies.
- It is a measure of the odds of exposure in those with the outcome of interest compared to the odds of exposure in those without the outcome.
- OR interpretations: POR > 1, POR = 1, POR < 1

$$\text{POR} = \frac{\text{Odds of exposure among those with outcome}}{\text{Odds of exposure among those without outcome}} = \frac{ad}{bc}$$

	W/ outcome	W/O outcome
Exposed	a	b
Unexposed	c	d

3) Relative Risk (RR)

- Risk is a **measure of association** that can be calculated from **cohort studies and experimental studies.**
- Calculation of risk is based on calculating an incidence rate so you can only calculate risk if you have the incidence.
- Relative risk (RR) is the ratio of developing the outcome in the exposed group compared to developing the outcome in the unexposed group.

$$\text{RR} = \frac{\text{Incidence of outcome among exposed}}{\text{Incidence of outcome among unexposed}} = \frac{a/a+b}{c/c+d}$$

4) Attributable Risk (AR)

- Attributable risk (AR) is how much of the risk of developing the outcome can be attributed to the exposure.

$$AR = \frac{\text{Incidence of outcome among exposed - incidence among unexposed}}{\text{Incidence of outcome among exposed}}$$

$$= \frac{(a/a+b) - (c/c+d)}{a/a+b}$$

Exposure: vaping
Outcome: pulmonary illness

Example: Cohort study of vaping and pulmonary illness followed for 1 year.

	Pulmonary Illness	No Pulmonary Illness	Total
Vaping	42	27,000	27,042
No vaping	7	63,000	63,007
Total	49	90,000	90,049

Differentiating between the interpretation of a relative risk and an OR:
RR = 1.2 means exposed people are 20% **more likely to develop the disease**, OR = 1.2 means that the **odds of having been exposed** is 20% higher in people who have the disease.

Dr. Khlood: Attributable risk (AR) and attributable risk ratio (ARR) are similar but I prefer using attributable risk ratio because I like the interpretation of it (as a percentage) more. For attributable risk refer back to Dr. Afnans' lecture. The ARR can also more easily be interpreted as a percentage by multiplying by 100.

- IR among exposed = 42/27,042 = 1.5/1000 person-year
- IR among unexposed = 7/63,007 = 0.1/1000 person-year
- RR = 1.5/0.1 = 15
- AR = 1.5 – 0.1/1.5*100 = 93%

Interpretation:

What does a relative risk of 15 mean?

- The risk of developing pulmonary illness is 15 times higher among those who vaped compared to those who did not.

What does an attributable risk of 93% mean?

- 93% of pulmonary illness among subjects may be attributed to vaping

القادة:

نواف التركي عبدالله الشهري وهى المتحمي

ريان الغنامي

الأعضاء:

عبدالله التركي
محمد الزير
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ناصر الغيث
سعد السهلي
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وعد ابو نخاع
ثراء الهويش
في الدوسري
منار الزهراني

رزان المهنا

MCQ:

Q1: The incidence rate is calculated by dividing the number of new cases of a disease by:

A. The total population
B. The prevalence of the disease
C. The mortality rate

Q2: Which measure of disease frequency provides information about the severity of a disease by measuring the proportion of diagnosed cases that result in death?

A. Prevalence
B. Incidence
C. Mortality rate
D. Case fatality rate

MCQ:

Q3: The odds ratio is commonly used when the outcome of interest is:

A. Rare
B. Common
C. Continuous
D. Binary

Q4: Which measure of disease frequency is most appropriate for studying the impact of a new treatment on reducing the occurrence of a disease?

A. Prevalence
B. Incidence
C. Mortality rate
D. Case fatality rate