Practical 2: Epidemiologic Measures II

Objectives

At the end of Practical 1 students should be able to:

- Understand the distinction between prevalence and incidence
- Understand the need for denominators when measuring disease frequency
- Calculate and interpret different measures of disease frequency (prevalence, prevalence odds, risk/incidence, incidence odds, rate)

At the end of Practical 2 students should be able to:

- **Calculate and interpret different measures of disease frequency (prevalence, prevalence odds, risk/incidence, incidence odds, rate).**
- **Calculate and interpret ratios and difference figures.**

This practical returns to some of the questions you worked on in Practical 1.

Question 1 **(continuing from Q2 in Practical 1)**

1. John Snow is considered one of the founders of modern epidemiology. He investigated several major outbreaks of cholera in London in the 1800s and provided evidence that access to a particular water source was associated with cholera deaths.

   In 1854, John Snow compared cholera deaths across areas of London supplied by different water providers (1). His findings are below.

Local water provider	Population	Cholera deaths from 8 July to 26 Aug 1854	Incidence risk per 100,000 people
Southwark and Vauxhall Company (S&V)	167,654	844	503.4
Lambeth Company	19,133	18	94.1
Total	186,787	862	461.5

a. Calculate and interpret the incidence risk ratio (IRR) for cholera deaths by water provider

IRR= (18/19133) / (844/167,654) = 0.19. Relative to people who are provided water by S&V Company, people who are provided water by Lambeth company had 0.19 times the incidence risk (had 81% lower risk) of cholera death between 8 July and 26 August 1854.

Also acceptable is: IRR = (844/167654) / (18/19133) = 5.35 between 8 July and 26 August 1854. Relative to residents of Lambeth-served areas, residents of S&V-served areas had 5.3 times the incidence risk of cholera death between 8 July and 26 August 1854.

b. Calculate and interpret the incidence risk difference. Report this as deaths per 100,000 population.

Residents of S&V-supplied areas experienced 503.4 deaths per 100,000 population from 8 July to 26 August 1854, and – assuming causality - 409.3 of these cholera deaths could have been averted if those residents had been supplied water from the Lambeth Company.

Note: The risk difference is the excess risk in those who have the exposure (not in the population in general).

c. What proportion (or percentage) of cholera deaths among people who had been supplied water by the S&V Company would be eliminated if these residents had been supplied by from the Lambeth Company instead? What is this measure called?

This measure is called the attributable risk percent (AR%).

$$AR\% = \frac{503.4 - 94.1}{503.4} = \frac{409.3}{503.4} = 0.813 = 81.3\%$$

(Alternative formula) $AR\% = \frac{RR-1}{RR} = \frac{5.35-1}{5.35} = 0.813 = 81.3\%$

Residents of S&V-supplied areas experienced 503.4 deaths per 100,000 population from 8 July to 26 August 1854, and - assuming causality - 81.3% of these cholera deaths could have been eliminated if those residents had been supplied water from the Lambeth Company.

d. Comment on the ‘exposure’ definition. Is this meaningful? What are its limitations?

We don’t really know if the people in these areas are (or to what extent) actually drinking water from the named supplier.

In contemporary surveys, a question similar to “Primary source of drinking water” would likely be used – for example, to distinguish drinking water from a water source which may be the greatest used by volume but which is mainly for other purposes

(e.g. for washing or agriculture) personal preferences (e.g. taste or perceived safety) or accessibility (e.g. the 'closest' water source), although this definition may still have limitations (e.g. different water sources in different climatic seasons, often this data is recorded for a household but may not be accurate for all household members).

e. Asides from their water supplier, comment on how the residents of two neighbourhoods might be different in an urban area of a setting which your group is familiar with.

No 'correct' answer here. What are the implications when you are comparing two groups of people who differ in multiple ways, and not only by their area of residence? We will formally explore this concept in teaching week 5 (confounding and causality).

More about John Snow:

Watch Dr Ros Stanwell-Smith discussing John Snow here: http://www.londonlive.co.uk/news/2018-07-20/pump-reinstated-in-soho-to-remember-great-scientist,

Read more in the award-winning book "Ghost Map" by Steven Johnson, available in the LSHTM library: https://lshtm.primo.exlibrisgroup.com/permalink/44HYG_INST/1g4gmr9/alma991000315279703736

Read more here: https://www.lshtm.ac.uk/newsevents/news/2019/john-snow-memorial-pump-marking-historic-cholera-outbreak-reinstalled-its ;

Learn more about John Snow at the John Snow pub in Soho, where you can see a replica of the famous hand pump outside: 39 Broadwick St, London W1F 9QJ.

Watch the John Snow Society's annual Pumphandle Lecture, held every September at LSHTM: https://www.lshtm.ac.uk/newsevents/events/series/annual-lectures, followed by a visit to the John Snow pub.

Question 2

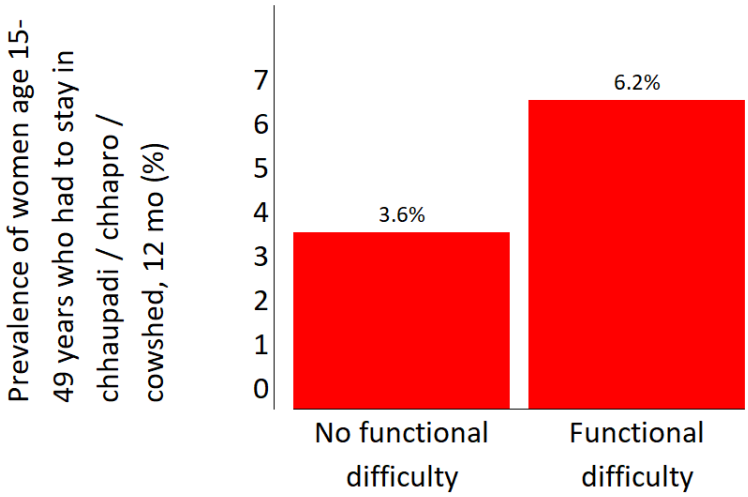
2. In 2019, the Government of Nepal and UNICEF completed the sixth round of the nationally representative Multiple Indicator Cluster Survey (MICS). The questionnaire for women aged 15-49 included measures on social practices relating to menstruation.

   Chhaupadi is a practice observed in Nepal whereby women, girls and people who are menstruating are required to spend their nights in a separate house. Often these houses are unprotected huts, which creates a risk of substantial harm, including death.

1_Nepal MICS Table
Nepal MICS 2019 Fir

Click on the icon above to download the table (also available on Moodle)

a. Use the figures from the table to complete the following bar graph, and to calculate a prevalence ratio.



$$Prevalence\ ratio = \frac{Prev\ of\ chhaupadi\ among\ women\ with\ functional\ difficulty}{Prev\ of\ chhaupadi\ among\ women\ without\ functional\ difficulty} = \frac{0.062}{0.036} = 1.72$$

Alternatively, $Prevalence\ ratio = \frac{0.036}{0.062} = 0.58$

b. How do you interpret the prevalence ratio?

In 2019, women aged 15-49 years who had functional difficulty had 1.72 times the prevalence of staying in a chhaupadi/chhapro/cowshed during menstruation, relative to women who did not have functional difficulty.

Or, in 2019, women aged 15-49 years who had functional difficulty had 72% higher prevalence of staying in a chhaupadi/chhapro/cowshed during menstruation, relative to women who did not have functional difficulty.

Alternatively, in 2019, women aged 15-49 years who did not have functional difficulty had 0.58 times the prevalence (42% lower prevalence) of staying in chhaupadi/chhapro/cowshed due to menstruation, relative to women who did have functional difficulty.

c. (Optional) Why do you think these two measures (i.e. functional ability and sleep exclusion) appear to be associated?

From the available data, we cannot confirm a true answer to this question. However, we can generate some hypotheses for future investigation.

- One potential scenario is that women with functional difficulty are more likely to be subject to discriminatory and exclusionary practices such as chhaupadi.
- Conversely, it could be that women who are required to stay in chhaupadi are more likely to get injured and become disabled.
- Assuming both measures are self-reported in an interview (i.e. not verified), it could also be that women who have functional difficulty are more likely to disclose experience of chhaupadi, and vice versa.
- There could be other factors which are associated with both disability and chhaupadi (e.g. age) and these should be considered before making any conclusions about causal relationships. You will explore this idea further in the session about Confounding and Causation.

Question 3

3. In 2013, epidemiologists conducted a study of alcohol use in Sehore, a rural district of Madhya Pradesh state in India(3). They enrolled a random sample of 3220 adults from the district and reported the following:

Characteristic	Total n	n who drink alcohol	Prevalence of alcohol use	Prevalence ratio	Prevalence odds of alcohol use	Prevalence odds ratio
Age (years)						
18-29	905	139	0.154	1.0 [Ref]	0.181	1.0 [Ref]
30-49	1501	193	0.129	0.84	0.148	0.82
>=50	814	100	0.123	0.80	0.140	0.77
Gender						
Female	1444	9	0.006	1.0 [Ref]	0.006	1.0 [Ref]
Male	1776	423	0.238	39.7	0.312	52.0

a. Calculate (to 2 decimal places) prevalence ratios for each characteristic. For each characteristic, use the first row as the reference group (i.e. Female, 18-29 years). Interpret the two prevalence ratios for age.

See table. In 2013 in Madhya Pradesh, relative to adults aged 18-29 years, adults aged 30-49 had 0.84 times the prevalence (i.e. had 16% lower prevalence) of being an alcohol user. Relative to adults aged 18-29 years, adults aged >=50 had 0.80 times the prevalence (i.e. had 20% lower prevalence) of being an alcohol user. Relative to females, men had 39.7 times the prevalence of being an alcohol user.

b. Repeat part a, using the prevalence odds instead of prevalence.

See table. In 2013 in Madhya Pradesh, relative to adults aged 18-29 years, adults aged 30-49 had 0.82 times the prevalence odds (i.e. had 18% lower prevalence odds) of being an alcohol user. Relative to adults aged 18-29 years, adults aged >=50 had 0.77 times the prevalence odds (i.e. had 23% lower prevalence odds) of being an alcohol user. Relative to females, men had 52.0 times the prevalence odds of being an alcohol user.

Question 4

4. Sonkin et al (4) analysed the child mortality rate in UK for different modes of transport in 1985 and in 2003. Their findings are tabulated below.

Mode of transport	Mortality rate during use of transport (per 100 million passenger-miles): 1985	Mortality rate during use of transport (per 100 million passenger-miles): 2003
In car	0.4	0.1
On foot	10.8	2.7
On cycle	8.4	5.5

a. Compare the mortality rate for 'On Foot' in 1985 vs 'On Foot' in 2003. Which is of greater public health relevance: the mortality rate ratio or the mortality rate difference? Why?

Rate ratio = 10.8/2.7 = 4.0. Those who travelled on foot in 1985 had 4 times the rate of death relative to those who travelled on foot in 2003.

Alternatively: Rate ratio = 2.7/10.8 = 0.25. Those who travelled on foot in 2003 had 0.25 times the rate of death (75% lower rate of death) relative to those who travelled on foot in 1985.

Rate difference = 10.8 – 2.7 = 8.1 deaths / 100 million passenger-miles.

Arguably, the RD is more relevant. The rate difference gives us an "impact" perspective. Even if pedestrian deaths were quite rare in 1985, there has been a massive reduction in the mortality rate over time. One can ask what has made walking so much safer in this time.

b. Compare the mortality rate for 'On Cycle' in 2003 vs 'In Car' in 2003. Which is of greater public health relevance: the mortality rate ratio or the mortality rate difference? Why?

Rate ratio = 5.5 / 0.1 = 55. Those who travelled by cycle in 2003 had 55 times the rate of death relative to those who travelled in a car in 2003.

Rate ratio = 0.1 / 5.5 = 0.018. Those who travelled by car in 2003 had 0.018 the rate of death (98.2% lower rate) relative to those who travelled on cycle in 2003.

Rate difference = 5.5 – 0.1 = 5.4 deaths per 100 million passenger-miles. There were 5.5 deaths per 100 million passenger-miles on cycle in 2003, and – assuming causality - 5.4 of these cycling deaths could have been averted by being in a car.

Again, the RD is arguably more relevant. It is rather inflammatory to state that cycling is 55 times deadlier than being in a car, particularly when death using either mode is extremely rare. And especially as it is likely that a car is implicated in most of these cycle deaths! We can see that there is a major reduction in car-based deaths over time, whereas there is a modest reduction in cycle-based deaths. So, part of the relatively high cycle death rate in 2003 is an artefact of cars becoming much safer for their passengers.

c. (Optional) Aside from their mode of transport, comment on how children who are driven may differ from children who walk or children who cycle in a setting which your group is familiar with.
   And again - no 'correct' answer here! What are the implications when you are comparing two groups of children who are different in multiple ways, and not only by their mode of transport? Again, we will formally explore this concept in teaching week 5 (confounding and causality).

Note that the analyses by Sonkin et al and Snow are both examples of ecologic studies. As such, the incidence and rate figures are not true incidence and rates. For this exercise though, we ask you to treat these analyses as if they were using individual-level data.

- Sonkin used data from a national survey to estimate the distance travelled by mode of travel for the denominators, and data from a separate register for mortality for the numerators. We don't actually know if the children who died were actually engaged in a given form of transport at the time of death, or how many passenger-miles each child travelled.

- Snow used 1851 census data for the population of each borough as the denominator, and a death registry from 1854 for cholera deaths for numerators. This same estimation method is used to calculate the "maternal mortality ratio" in the present day.

References

1. Snow J. On the mode of communication of cholera. 2nd ed. London, UK: John Churchill; 1855.

2. Central Bureau of Statistics. Nepal Multiple Indicator Cluster Survey 2019, Final Report. Kathmandu, Nepal: Central Bureau of Statistics and UNICEF Nepal; 2019. https://www.unicef.org/nepal/media/11081/file/Nepal%20MICS%202019%20Final%20Report.pdf

3. Rathod SD, Nadkarni A, Bhana A, Shidhaye R. Epidemiological features of alcohol use in rural India: a population-based cross-sectional study. BMJ Open. 2015 Dec;5(12):e009802.

4. Sonkin B, Edwards P, Roberts I, Green J. Walking, cycling and transport safety: an analysis of child road deaths. J R Soc Med. 2006 Aug 1;99(8):402–5.