

MEASURING HEALTH AND DISEASE

Rationale

Different measures of health and disease are widely used to describe the health of populations. This topic will introduce you to some of these measures to help you to use and interpret this information correctly.

Introduction

One of the principal roles of epidemiology is to measure the health of the community. This information can then be used to:

- Identify health problems
- Compare one group of people with another
- Set health policies
- Guide health service delivery.

Although we are mainly interested in 'health', in reality we usually measure 'ill-health' or 'disease' as it is easier to measure. In this topic we will introduce you to the main ways in which disease is measured, and will show you where these measures come from, what they mean, and how you can interpret them.

What are we measuring?

Epidemiologists use a *case definition* when they measure disease. The case definition is a set of diagnostic criteria that must be fulfilled in order to identify a person as a case of a particular disease. Case definitions can be based on clinical, laboratory or combined clinical and laboratory criteria, or a scoring system with points for each criterion that matches the features of the disease.

Measures of disease frequency

Once we have defined what we mean by disease, we can then go on to study how often the disease occurs in a population. This is called the *disease frequency*.

There are different ways to measure disease frequency. The following example will help you to understand the different measures.

‘The population of Tasmania in 2001 was 456 600 people. Imagine that there were about 5 000 people with Hepatitis C living in Tasmania on 31st December 2001. During 2002, another 600 people were diagnosed with Hepatitis C. How can we describe the amount of Hepatitis C infection in Tasmania?’

1. Calculate the percentage of Tasmanians who were positive for Hepatitis C on 31 December 2001.
2. Calculate the percentage of Tasmanians who became Hepatitis C positive during 2002.

The answers, and how they were derived, appear in Appendix 1 of this topic. You should have found that 1.1% of Tasmanians were Hepatitis C positive on 31st December 2001 and that 0.13% of Tasmanians became infected with Hepatitis C in 2002.

What you calculated were, for Question 1, the *prevalence* of Hepatitis C and, for Question 2, the *incidence rate* of Hepatitis C. These are two measures of *disease frequency* of Hepatitis C.

Prevalence: The prevalence of a disease tells us what proportion of the population has the disease. It is often expressed per 100 people (%) or per 1 000, or per 100 000 people. It doesn’t matter, as long as you are clear which is being used.

Incidence rate: The incidence rate of a disease tells us how quickly people are newly getting the disease. This differs from prevalence as incidence rate only considers *new* cases of the disease that occurred in a given time period. Incidence rates are usually shown per year.

Measures of mortality

In public health, many different types of rates are used to measure mortality. Some of these rates will be discussed in this section. Mortality rates are defined as estimates of the portion of a population that dies during a specified period. This can be calculated in various ways, as shown below.

The other term you will hear used is morbidity. Morbidity is any departure, subjective or objective, from a state of physiological or psychological wellbeing. In this sense, sickness and illness are synonyms for morbidity. The World Health Organization Expert Committee on Health Statistics says that morbidity can be measured in terms of three units:

- People who were ill,
- The illnesses the people experienced and
- The duration of the illnesses

Some of the measures commonly used in public health to describe morbidity, incidence rate and prevalence, have been discussed above.

Crude mortality rate – This is an estimate of the portion of a population that dies during a specified period that does not account for any other feature of the population under study. It is calculated as:

The number of deaths from a particular cause in a specified period

The number of people at risk of dying in that same period $\times 10^n$

For example, if, in a year, 2800 people out of a population of 10 000 died from cancer, the crude mortality rate for cancer in that population would be:

$$\frac{2800}{10\,000} \times 1000 \quad \text{or} \quad 280 \text{ per } 1000 \text{ people per year}$$

Specific mortality rate – You will often see reports with specific mortality rates, rather than crude rates within them. There is a good reason for this. A major problem with crude mortality rates is that they do not take into account the differences between different populations. If you want to compare rates between different populations, you must account for these differences first.

For example, it is a fact that different populations have different age structures and that the risk of dying varies with age. Clearly, the older a person is, the greater the risk of them dying from most diseases. Consider the following table:

Crude and age-specific mortality rates (per 100 000 people) for heart disease in selected countries, 1980

Country	Crude rate	Age specific rate		
		45-54 years	55-64 years	65-74 years
France	368	97	266	500
Mexico	95	132	327	330

If you were to just look at the crude rates for heart disease, you would think that France has a high death rate from heart disease and Mexico has a low death rate. But what if the population in France was older than in Mexico? Couldn't the higher death rate in France be because there are more old people than young people (in contrast to Mexico, where there are probably more young people than old people)?

The way to account for this possibility is to calculate separate mortality rates for different age groups: these are called *age-specific* rates and are one example of a specific mortality rate. You can see that when you do this for France and Mexico, that

in fact, the death rate from heart disease in younger people is actually higher in Mexico than in France.

Standardised mortality rate – If specific mortality rates are presented for a large number of different age groups, as well as for both sexes, you end up with a lot of numbers to compare and interpret. An alternative is to summarise or combine these specific rates using a mathematical process called *direct standardisation*. This process is a little complicated. Essentially it is a set of techniques used to remove as much as possible the effects of differences in age or other factors when comparing two or more populations. The specific rates in the study population are calculated and averaged, then applied to something called a ‘standard population’ (a population in which the age and sex composition is known precisely as a result of a census or by an arbitrary means). Alternatively, a process called *indirect standardisation* can be used. This is used to compare study populations for which the specific rates are either not reliable or not known.

You do need to be familiar with the concept of standardisation and know why we use standardised mortality rates as many health documents contain them (for example the ‘State of Public Health Report’ for Tasmania for 2003 reports all mortality rates as standardised rates).

Using the example above, if we now add the standardised mortality rates for France and Mexico, what do we find?

Crude, age-specific and age-standardised mortality rates (per 100 000 people) for heart disease in selected countries, 1980

Country	Crude rate	Age specific rate			Age standardised rate
		45-54 years	55-64 years	65-74 years	
France	368	97	266	500	164
Mexico	95	132	327	330	163

When we remove the effect of the different age breakdowns of the populations of France and of Mexico (which is what age standardisation does for us), we can see that there is essentially no difference in the mortality rates from heart disease in France and Mexico.

Other mortality rates

1. Standardised mortality ratio (SMR) – When indirect, rather than direct, standardisation is used, the death rate you derive is the ratio of the number of deaths observed in the study population compared with the number that would be expected if the study population had the same specific age rates as the standard population. It is usually expressed as a percentage and is calculated as:

$$\text{(Observed deaths / Expected deaths) x 100}$$

2. Proportionate mortality ratio (PMR) – This is a measure of the relative importance of a particular cause of death in a given population. For example, if the PMR for heart disease in Australia was 33%, this means that a third of all deaths were due to heart disease.
3. Maternal mortality rate – This describes the number of deaths in women from causes related to childbirth during a given year for a specified geographical area and includes only death that occur within 42 days of childbirth. It is calculated as:

$$\text{(The number of deaths from pregnancy during a given year / The number of live births that occurred in the same population during the same year) x 1000}$$

4. Stillbirth or foetal death rate – This is the number of stillbirths in one year (stillbirth is defined as death of a foetus after 28 weeks pregnancy) as a proportion of the total number of births (live births + foetal deaths) in the same year.

5. Perinatal mortality rate – This is the deaths of babies around the time of birth (from 28 weeks pregnancy through to the first week of life) divided by the total number of births (live births + foetal deaths) in the same year.
6. Neonatal mortality rate – This the number of deaths in children aged less than 28 days, in a given year, as a proportion of the number of live births in the same year.
7. Infant mortality rate – This rate is the most widely used single indicator of the overall health of a community. It measures the death rate in children during the first year of life and is calculated as the number of deaths of children aged less than one year, in a given year, as a proportion of all live births in the same year.
8. Life expectancy – This is the average number of years than an individual of a given age is expected to live *if current mortality rates continue*.

Conclusions

Having completed this topic, you should now be able to interpret most measures of disease frequency and mortality you come across in your reading. Assignment 2 will reinforce some of these principles.

Appendix 1 – Answers to the Hepatitis C Question

‘The population of Tasmania in 2001 was 456 600 people. Imagine that there were about 5 000 people with Hepatitis C living in Tasmania on 31st December 2001. During 2002, another 600 people were diagnosed with Hepatitis C. How can we describe the amount of Hepatitis C infection in Tasmania?’

- 1. Calculate the percentage of Tasmanians who were positive for Hepatitis C on 31 December 2001.**

$$\begin{aligned}\% \text{ Positive for Hepatitis C in 2001} &= (5\,000 / 456\,600) \times 100 \\ &= 1.1\%\end{aligned}$$

- 2. Calculate the percentage of Tasmanians who became Hepatitis C positive during 2002.**

$$\begin{aligned}\% \text{ Becoming positive in 2002} &= [600 / (456\,600 - 5\,000)] \times 100 \\ &= 0.13\%\end{aligned}$$

(Note: you cannot become positive for hepatitis C if you are already hepatitis C positive. Therefore, for question 2, the 5 000 people already positive for hepatitis C need to be subtracted from the total population of 456 600)

Self-Assessment

Question 1

Table 1 shows the results of a study of smoking and stroke in women. Complete the table by calculating the incidence rate of stroke for:

1. Non-smokers
2. Ex-smokers
3. Current smokers

How many times more likely were:

4. A current smoker to have a stroke relative to a non-smoker?
5. An ex-smoker to have a stroke relative to a non-smoker?

Table 1 – Relationship between cigarette smoking and incidence of stroke in a study of women for 1 year

Smoking category	Number of cases of stroke	Number of people	Incidence rate
Never smoked	70	395	
Ex-smoker	65	232	
Current smoker	139	280	
Total	274	907	

Question 2

Table 2 shows the number of deaths as well as the direct age-standardised death rate (deaths per 100 000) from accidents in men aged 65 and over for the years 1995 to 1997, in four regions, making up a country of 25 million people.

Table 2 – Deaths from accidents in men aged 65 and over – 1995 to 1997

Region	Crude death rate	Age-standardised death rate
A	807	65.5
B	639	64.7
C	625	61.9
D	669	80.8
Country	2740	62.5

1. What is the difference between a crude death rate and an age-standardised death rate?
2. What do the data show?