

Factors affecting mortality

1. Age structure: main determinant
2. Environment
3. Economic development
4. Technological advance
5. Medical services/science and development of public health



Population health status comparison

- Crude death rate
- Age specific death rate
- Standardised death rate
- Standardised mortality ration (SMR)
- PYLL Index (Potential Years Life Lost)

Comparing disease and health event rates

- **Disease and mortality rates can be used to compare:**
 - disease/mortality rates between populations
 - the same population over time.
- **When comparing rates we should be aware of the characteristics of the population(s) that may affect the rates.**
- **The age and sex structure of two populations being examined may differ and these differences will affect the rates.**

Standardisation of rates

- Crude rates do not allow comparison in Space (region or countries) or time

*For example for **death rates**, the differences observed between two populations' **crude death rates** could only be due to the **demographic** differences between the population studied. A population with a higher proportion of elderly people will have a higher number of total death than a young population.*

Standardized mortality rate

- **we know that:**

- death is closely related to age
- the age structure of the a some groups could be different to that of the total population

- **Therefore we need to adjust for the effect of the age structure to make a meaningful comparison.**

- **This can be done using standardization**

■ **Standardisation of rates is a method of **weighting** the rates on one factor which has an influence on the rate, such as age or sex. Once the influence of that factor has been eliminated with the standardisation the rates can be compared.**

Two methods of standardisation of rates

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graph TD; A[Two methods of standardisation of rates] --> B[Direct]; A --> C[Indirect]
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Direct

Indirect

Direct Standardisation

- is used to compare large populations
- uses a **standard reference population** to compare both populations
- applies the age-specific disease/death rates of the population of interest to the standard population
- allows us to compare death rates, by calculating what their death rates would be if the populations of interest had the same age population structure as the reference population.

Direct standardisation

Direct standardisation uses a standard *population demographic structure*.

- one of the populations studied
- or a combination of both.

The result obtained is an **age standardised rate** which would represent the rate in the study population if the age structure of that population was the same as the reference population. The standardised rates can then be compared, but this **standardised rates have no absolute meaning**, they are only meaningful in the context of the reference population used. Using a different reference population will give a different standardised rate.

Calculation

$$\text{Age standardized rate} = \left(\begin{array}{l} \text{Overall rate in standard population if} \\ \text{the age – specific rates were the same} \\ \text{as those of the population of interest} \end{array} \right) = \frac{\sum w_i \times \lambda_i}{\sum w_i}$$

w_i are the weights

λ_i rates

This compares the death rates from heart diseases in 1966, between Puerto-Rico and the U.S.A.. The crude death rates shows a higher rate in the U.S.A - 368.46 per 100,000 as compared to 124.23 per 100,000 in Puerto_Rico.

	Puerto Rico			USA		
Age	population	No. of deaths	death rate per 100,000	population	No. of deaths	death rate per 100,000
<15	1000600	34	3.40	55786173	764	1.37
15-24	458400	24	5.24	24020004	875	3.64
25-34	317000	34	10.73	22818310	3500	15.34
35-44	258300	73	28.26	24081352	17868	74.20
45-54	208100	214	102.84	20485439	55580	271.31
55-64	132300	447	337.87	15572317	114780	737.08
65-74	89000	753	846.07	10996842	191348	1740.03
75+	49300	1543	3129.82	5562738	276021	4961.96
total	2513000	3122	124.23	179323175	660736	368.46

This table shows the calculation of the age standardised mortality rate from heart diseases in Puerto-Rico using the population of the U.S.A. as a reference.

Age	US population	Puerto Rico death rates	Expected deaths in U.S. population
<15	55786173	3.40	1895.59
15-24	24020004	5.24	1257.59
25-34	22818310	10.73	2447.39
35-44	24081352	28.26	6805.80
45-54	20485439	102.84	21066.24
55-64	15572317	337.87	52613.95
65-74	10996842	846.07	93040.70
75+	5562738	3129.82	174103.54
total	179323175		353230.81

age standardised rate = $353230.81 / 179,323,175 * 100,000 = 196.98$ per 100,000 per year.

Advantages and disadvantages of direct age standardisation

Advantages

■ The direct method preserves consistency, between the populations being compared, i.e. if each age-specific rate in area A is greater than each of the corresponding age-specific rates in area B, then the directly standardised rate for area A will always be higher than that of area B irrespective of the standard population used. Consequently it is the preferred method for comparing a number of different populations against each other.

■ Directly standardised rates can readily be compared over time provided the same standard population is used.

Disadvantages

■ The direct method requires that the observed events in the subject population are available broken down by age. If this information is not available the directly standardised rate cannot be calculated.

■ For small subject populations the age-specific rates of the subject population are based on small numbers and consequently are unstable. Small changes in the number of deaths in a particular age band may result in large changes in the directly standardised rate.

Indirect standardization and SMRs

- **allows valid comparisons between populations with different age and sex structures**
- **Adjusts for differences in age by calculating the number of deaths 'expected' in a population, based on its age structure, if it had the same mortality experience as a reference population.**

Indirect standardisation

- The indirect method of standardisation is mostly used in the standardisation of mortality rates (although not exclusively). It involves the calculation of the *standardised mortality ratio* or **S.M.R.**
- Indirect standardisation is easier to use
- permit some statistical calculations of probability (95% confidence intervals).
- The information necessary to calculate the S.M.R. is also often more easily available than for the direct method.

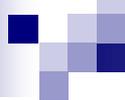


Indirect standardisation

- Useful in the presence of low death rate for example for younger age groups

The principle of its calculation uses standard age specific rates in a reference population. It then calculates the number of deaths (or cases) expected in the study population if the age specific rates in this study population were the same as in the reference population. The ratio of the number of observed death (or cases) to the number of expected and multiplied by 100 is calculated

$$SMR = \frac{\textit{Observed deaths}}{\textit{Expected deaths}} \times 100$$


$$SMR = \frac{d}{\sum n_i R_i} \times 100$$

d is the number of deaths in the study population,
n_i is the number of people in the **ith** group of the study population,
R_i is the crude death rate in the **ith** group of the standard population.

Confidence interval for SMR

The 95% CI for an SMR is obtained by

$$\mathbf{CI = SMR \pm (1.96 \times SE)}$$

Where SE = SMR / \sqrt{d}

d = number of observed deaths

The S.M.R. is a **ratio**, it has no unit and can take any value between 0 and infinity.

■ **SMR =100**

The study population has the same mortality rate as the reference population.

■ **SMR >100**

The study population has a mortality higher than the reference population.

e.g. **SMR=120** means that the mortality in the study population is **20% higher** than in the reference population

■ **SMR <100**

The study population has a mortality lower than the reference population.

e.g. **SMR=50** means that the mortality in the study population is **50% less** than in the reference population.

Example

Calculation of standardised mortality ratio (S.M.R.) for two occupational groups in England using the whole population of England as a reference population (Original data 1959-63)

Occupation	Number in Occupational group	Observed death	Crude death rate per 1000 per year
Farmers, foresters and fishermen	705910	20973	5.9
Armed force	301120	4282	2.8

Calculation of expected number of deaths using the age specific death rates of England as a reference

	Annual death rates/ 1000 in England	Farmers, foresters, fisher men		Armed Force	
Age		Number in occupation	Expected deaths 1959-1963	Number in occupation	Expected deaths 1959-1963
15-24	5.139715	134560	691.6	165030	848.3
25-34	5.589847	124100	693.7	73240	409.4
35-44	12.05491	132220	1593.9	42250	509.3
45-54	35.36006	160110	5661.5	15930	563.3
55-64	108.5502	154920	16816.6	4670	506.9
Total expected deaths			25457.3		2837.2

Calculation of S.M.R.

Farmers, foresters and fishermen:

$$\text{SMR} = 20973 / 25457.3 * 100 = 82.4$$

Armed forces

$$\text{SMR} = 4282 / 2837.2 * 100 = 150.9$$

Conclusions

- **The SMR of the Farmers etc is lower than the one of the Armed force.**
- **The SMR of the farmers etc is less than 100**
- **The SMR of the armed force is more than 100**
- **The mortality rate of the farmers is lower than the average for England by 17.6%. The mortality of the armed force is higher than the average in England by 50.9%.**

Advantages and disadvantages of indirect age standardisation

Advantages

- The indirect method requires only the total number of observed events in the subject population and may therefore be used in some situations where the direct method cannot.
- Indirect standardisation is more stable as it minimises the variance, giving a smaller standard error and narrower confidence intervals than the direct method. It is therefore more appropriate when dealing with the statistical significance of small populations

Disadvantages

- Indirect standardisation does not necessarily preserve consistency between the populations being compared, and in extreme situations may give misleading results.
- Indirectly standardised ratios for areas A and B may be compared to the standard but should only be directly compared to each other if the age structures of areas A and B are similar to the standard, or if the ratio of their age-specific mortality rates to that of the standard is consistent across the age groups.
- Indirect standardisation can be used for comparisons over time, but only by freezing the standard rates at a fixed point in time. This is often felt to be less than intuitive. The validity of the comparisons is subject to the

The choice of standard population

Whether indirect or direct methods are used, there are some general principles for choosing a standard population:

1. Always choose a standard population *similar* to the study populations. For example, if the units of interest are all the local authorities in a country, then use the national population; if the units of interest are two wards in a local authority, then the local authority population or the average of the two wards may be appropriate.
2. Do not standardise the study populations to different standard populations.
3. Examine the age structures of the study populations as well as the standard population. If the study age structures differ widely from each other and from the proposed standard, then indirect standardisation will generate misleading results.