Standardisation

Why standardise?

Ill-health, disease and risk factors within a particular population will depend on the age and gender structure of that population (as well as many other factors such as deprivation). Generally, standardised rates are age-standardised or age-gender-standardised, but rates can also be standardised to other differences within the populations. The standardised rate is adjusted (usually for age and gender) so that the rate refers to a rate relative to a 'standard' population. If numerous rates are adjusted to the same standard population then this makes it possible to compare the rates.

In terms of the provision of resources, it is necessary to report the prevalence of ill-health, disease and risk factors in the population without taking into account the age and gender distribution of the population. As it is necessary to treat and have the provision to treat the population as it is, regardless of the age and gender structure. However, if one wishes to assess whether one population has an excess rate of disease or if there is a difference in the prevalence of disease among different levels of deprivation, it is necessary to take the age and gender structure into consideration. Otherwise any differences found may be simply due to differences in the age and gender structure of the different populations, and not due to the factor of interest, e.g. deprivation. The age and gender structure can be taken into consideration by using standardisation.

Direct standardisation involves applying the rates of disease observed in the study group of people to a 'standard' population. Indirect standardisation involves applying the rates of disease in a 'standard' population to the study group of people. The rates of disease are calculated for each gender and age group, for example, males aged 0-9, 10-19, 20-29 years etc and females aged 0-9, 10-19, 20-29 years etc. The standard population can be an English population or a local population for a specific time period. Direct standardisation results in an age-gender standardised rate of disease and may be presented as the number of deaths or cases/events per 1,000 population. Indirect standardisation results in a standardised mortality (or morbidity) ratio (SMR). The SMR will take the value of 100 if the sample group has the same mortality (or morbidity) rate as the 'standard' population, and will be higher if the population of interest has a higher mortality (or morbidity) than the standard population (based on their age and gender distribution).

Standard population

The choice of the standard population depends on available data, and the purpose of the analysis. The European Standard population is often used for national data, however, mortality rates produced are not representative of any English rates as the European Standard population has a much lower proportion of elderly people. For example, standardised mortality rates using the European Standard population will result in rates that are lower than those that would result if using the English population (for a specific time point). This is because the mortality rates are being applied to a standard population with a relatively small number of elderly people (who have the highest mortality rates) and the expected number of deaths in the standard population will be fewer as there are few elderly people.

If the purpose is simply to compare two or more rates obtained for different groups, e.g. the mortality rate in an affluent population compared to the mortality rate in a deprived population, then the choice of the standard population is not important. However, it eases interpretation if the resulting standardised mortality rate reflects the local mortality or national mortality, and therefore, it is often useful to use the national population or a local population as the standard population.

Data required

Table 1 gives the information required for direct and indirect standardisation. In general, the choice of method is determined by the available data and their relative accuracy. Indirect standardisation gives more accurate results when there are small numbers of events in any of the age-sex groups of the study populations whereas direct standardisation is preferable if it is difficult to obtain data on age-sex specific rates for the standard population.

Table 1: Data required for indirect and direct standardisation

	Direct standardisation	**Indirect standardisation**
Method	Study rates applied to standard population	Standard rates applied to study population
Data required		
Study population(s)	Age-sex specific rates	Age-sex composition (& total events)
Standard population	Age-sex composition	Age-sex specific rates (& overall rate)
Result	Age-sex adjusted rates	Standardised mortality or morbidity ratio (& age-sex adjusted rate)

Example of direct standardisation

The example given below uses local data; male mortality rates for St Andrew's ward for 2004 are to be standardised to the Hull population. The population data comes from GP registrations for October 2004, and is based on patient's residence. The mortality data for the year 2004 comes from the file provide by ONS annual of all deaths which occur to residents. The data is illustrated in ***Table 2***.

Table 2: Data to illustrate method of direct standardisation

Age group	**St Andrew's ward 2004**		**Hull 2004**
	Deaths (men)	**Population (men)**	**Population (men)**
0-9	0	531	15,377
10-19	0	540	18,471
20-29	4	788	20,601
30-39	4	807	21,621
40-49	2	616	18,724
50-59	3	528	15,422
60-69	10	369	10,412
70-79	29	219	7,394
80+	21	117	3,305
Total	**73**	**4,515**	**131,327**

The male crude mortality rate for St Andrew's for 2004 is 73 divided by 4,515 which gives 0.0162 or 16.2 deaths per 1,000 males.

The calculations performed in calculating the standardised rate is given in ***Table 3***.

Table 3: Method of calculating direct standardised rate

Age group (years)	**St Andrew's ward 2004**		**Hull 2004**	**Based on mortality rates in St Andrew's ward 2004**	
	Deaths (men)	**Population (men)**	**Population (men)**	**Calculated age-specific rate (per 1,000)**	**Expected deaths in standard population**
0-9	0	531	15,377	0.000	0.0
10-19	0	540	18,471	0.000	0.0
20-29	4	788	20,601	0.005	104.6
30-39	4	807	21,621	0.005	107.2
40-49	2	616	18,724	0.003	60.8
50-59	3	528	15,422	0.006	87.6
60-69	10	369	10,412	0.027	282.2
70-79	29	219	7,394	0.132	979.1
80+	21	117	3,305	0.179	593.2
Total	**73**	**4,515**	**131,327**	**0.016**	**2,214.6**

Firstly, calculate the age-specific rates for the population of interest. In this case for the St Andrew's ward. This is undertaken by calculating the rate for each group (whether this is in each age group as in this example or each age-gender group, or each age-gender-deprivation group). For the age group 80+ years, the value 0.179 is obtained from 21 deaths divided by 117 population which gives 0.179. It could be multiplied by 1,000 to help presentation to give 179 deaths per 1,000 males aged 80+ years.

Secondly, calculate the expected number of cases in the standard population for each group (assuming that the local rates apply to the standard population). In this case for the 80+ age group, this involves multiplying 0.179 by the standard population of 3,305 men. This gives an expected number of 593 deaths in the standard population when applying the local rates of disease.

Thirdly, sum the expected number of cases. Note that the numbers presented in ***Table 3*** are for illustrative purposes only and therefore do not include all the decimal places. It is very important to retain all decimal places when calculating the values above as 'rounding' errors occur, and the resulting standardised rate is not correct. In this case, adding up the expected numbers gives a total of 2,215 deaths.

Fourthly, the standardised rate is calculated dividing the total expected number of events in the standard population by the total standard population. In this case, 2,214.645 divided by 131,327 which gives 0.0169 or multiplying by 1,000 gives 16.9 deaths per 1,000 men. This is slightly higher than the crude rate calculated above because there is a slightly lower percentage of men above the age of 60 years in St Andrew's. The standardised rate is higher because if there had been more elderly men in St Andrew's as there are in the standard population of Hull, there would have been more deaths overall as this is the age range where there are the most deaths.

Example of indirect standardisation

Using the same data as above with the addition of the mortality rates for Hull for 2004, we can calculate the indirectly standardised mortality rate (or SMR). As well as the data in ***Table 4***, the total number of deaths in St Andrew's is required (which is 73 from Table 2) is required to calculate the SMR.

Table 4: Data to illustrate method of indirect standardisation

Age group	**Hull 2004**		**St Andrew's ward 2004**
	Deaths (men)	**Population (men)**	**Population (men)**
0-9	4	15,377	531
10-19	2	18,471	540
20-29	24	20,601	788
30-39	35	21,621	807
40-49	44	18,724	616
50-59	105	15,422	528
60-69	208	10,412	369
70-79	385	7,394	219
80+	409	3,305	117
Total	**1,216**	**131,327**	**4,515**

As before, the male crude mortality rate for St Andrew's for 2004 is 73 divided by 4,515 which gives 0.0162 or 16.2 deaths per 1,000 males.

The calculations performed in calculating the indirectly standardised mortality rate is given in ***Table 5***. As can be seen, the calculations are very similar to those for direct standardisation (calculations are applied to the other population).

Table 5: Method of calculating indirect standardised mortality rate

Age group (years)	**Hull 2004**		**St Andrew's ward 2004**	**Based on mortality rates in Hull 2004**	
	Deaths (men)	**Population (men)**	**Population (men)**	**Calculated age-specific rate (per 1,000)**	**Expected deaths in St Andrew's**
0-9	4	15,377	531	0.000	0.1
10-19	2	18,471	540	0.000	0.1
20-29	24	20,601	788	0.001	0.9
30-39	35	21,621	807	0.002	1.3
40-49	44	18,724	616	0.002	1.4
50-59	105	15,422	528	0.007	3.6
60-69	208	10,412	369	0.020	7.4
70-79	385	7,394	219	0.052	11.4
80+	409	3,305	117	0.124	14.5
Total	**1,216**	**131,327**	**4,515**	**0.009**	**40.7**

The SMR is calculated by dividing the observed or actual number of deaths in the population of interest by the expected number of deaths if the mortality rates in the standard population were applied. That is, 73 divided by 40.7 which gives 1.79. SMRs are traditionally multiplied by 100 for ease of presentation so the SMR is 179. This is a ratio of the observed and expected number of deaths, and if the expected number of deaths was the same in the population of interest and the standard population then the SMR would be 100. Thus, if the SMR is greater than 100, then this implies that the mortality rate is higher than expected based on its age or age-gender structure, and if the SMR is lower than 100 this implies that the mortality rate is lower. The mortality rate for St Andrew's is considerably higher than that of Hull (79% higher). As it is the most deprived ward in Hull based on the Index of Multiple Deprivation 2004, the resulting SMR is not surprising. There will be poorer conditions such as housing, increased unemployment, higher expectation of poor health, etc, and there will be a higher prevalence of risk factors such as smoking and poor diet.

It is possible to obtain the age adjusted mortality rate for St Andrew's by multiplying the SMR with the crude mortality rate of the standard population. The crude mortality rate for Hull for 2004 is 0.009 or 9.26 per 1,000 men (1,216 divided by 131,327). So the age adjusted mortality rate for St Andrew's is 0.009 multiplied by 1.79 which gives 0.0166 or 16.6 per 1,000 men. A value which is 79% higher than Hull as a whole.