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Why do we continue to use standardized mortality ratios for small area comparisons?

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Summary

Public health practitioners are often faced with the necessity to compare the mortality experience of different geographical areas. Indirect standardization, producing a 'standardized mortality ratio' (SMR) is the most commonly used technique for doing this. However, as we show, indirect standardization is inappropriate for such comparisons, as SMRs for different geographical areas have different denominators. The fact that indirect standardization is usually chosen for this type of comparison is probably based on two beliefs: (1) that direct standardization yields only a rate rather than a more easily interpreted ratio or index; (2) that direct standardization cannot be carried out in many cases because the sub-group specific mortality rates in the groups to be compared are not available or, in at least some age classes, are based upon such small numbers as to be completely unreliable. In this paper we show that a simple index (the comparative mortality figure) can be calculated from the directly standardized rate in most cases. Using a comparison of the overall mortality experience of electoral wards in Sheffield between 1980 and 1987 we demonstrate also that the advantage gained by the smaller standard error of the SMR is outweighed by the bias inherent in its construction. We recommend that the SMR is used only when absolutely necessary, that is, in the rare circumstance when data are not available for the calculation of age- and sex-specific subgroup rates in the study population.

Keywords: small area statistics, standardization

Introduction

There are at least a dozen alternative methods for the standardization of mortality and other rates,[1,2] of which only two, the direct and indirect methods, are commonly described.[3] One of the most common applications of mortality standardization is to compare different geographical areas, such as Health Districts in a region or electoral wards in a District. Comparison of crude mortality rates may be confounded by differences in the population structure of the areas being compared. Standardization allows comparisons free of the effects of differences in the number of individuals in sub-groups of the populations. These sub-groups are typically defined by age or age and sex. Standardization works by making a weighted sum (or weighted average) of the sub-group specific mortality rates in the study populations. Indirect standardization, producing a 'standardized mortality ratio' (SMR) is the most commonly used technique for doing this: for many years SMRs have been used in the allocation of resources in the National Health Service, and tables displaying Districts, together with their SMRs and ranks, constitute a major part of the public health common data set.[4,5]

The SMR was adopted as the index of choice in the 1951 Registrar General's decennial supplement,[6] having been compared with another index, the comparative mortality figure (CMF – see below) in the Supplements of 1921 and 1931.[7,8] This adoption, however, was despite the assertion by Yule, in 1934, that the SMR was not a valid index.[9] Nevertheless, the SMR is the index most often used for the comparison of mortality between different geographical areas, probably as a result of two beliefs: (1) that direct standardization yields only a rate rather than a more easily interpreted ratio; (2) that direct standardization cannot be carried out in many cases because the sub-group specific mortality rates in the groups to be compared are not available or, in at least some age classes, are based upon such small numbers as to be completely unreliable. These beliefs are widely quoted in textbooks and papers. In this paper we examine the justification for them.

Belief (1) – direct standardization yields only a rate rather than a more easily interpreted ratio

Calculation of the SMR

The SMR is calculated as the ratio of the number of deaths observed in a study population over a specified time period (e.g.

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1 year) to those expected in that population if it had the same age- and sex-specific death rates as a 'standard' population:

$$\text{SMR} = \frac{\text{Observed deaths (in study population)}}{\text{Expected deaths (in study population)}}. \quad (1)$$

To demonstrate the calculation of the denominator (the expected number of deaths) we express this equation as

$$\text{SMR} = \frac{\text{Observed deaths (in study population)}}{\sum_{i=1}^{k} n_i \frac{D_i}{N_i}}$$

and, although the calculation is not usually performed, we can express the numerator in an analogous fashion:

$$\text{SMR} = \frac{\sum_{i=1}^{k} n_i \frac{d_i}{n_i}}{\sum_{i=1}^{k} n_i \frac{D_i}{N_i}} \quad (2)$$

where n_i is the number of persons in the ith group of the study or local population, d_i is the number of deaths in the ith group of the study or local population, N_i is the number of persons in the ith group of the standard population, D_i is the number of deaths in the ith group of the standard population and k is the number of groups

In each of these and subsequent formulae the time component has been left out for the sake of simplicity.

Calculation of the directly standardized rate

The directly standardized death rate (DSR) for a specific study population is calculated as

$$\text{DSR} = \sum_{i=1}^{k} \frac{N_i}{N_p} \frac{d_i}{n_i} \quad (3)$$

where n_i, d_i, N_i, D_i and k are as defined previously for the SMR, and N_p is the total number of persons in the standard population.

The first belief quoted above (i.e. that direct standardization yields only a rate rather than a more easily interpreted ratio) is easily disproved. In most circumstances a single easily interpreted ratio can be obtained from the directly standardized rate simply by dividing the expected number of deaths in the standard population by the observed number of deaths in the standard population over the same time period. This ratio is termed the comparative mortality figure (CMF), and was first proposed in 1884.[10] Some difficulty may be encountered, however, when using artificial populations such as the European Standard Population for which, obviously, no observed deaths are available. In these circumstances it will still be necessary to use standardized rates for the purposes of comparison.

Calculation of the CMF

The CMF is calculated as the ratio of the expected number of deaths in the standard population to those observed:

$$\text{CMF} = \frac{\text{Expected deaths (in standard population)}}{\text{Observed deaths (in standard population)}}. \quad (4)$$

This time, expected deaths form the numerator of the equation. The equation for the CMF can be expressed as

$$\text{CMF} = \frac{\sum_{i=1}^{k} N_i \frac{d_i}{n_i}}{\text{Observed deaths (in standard population)}}$$

or in full

$$\text{CMF} = \frac{\sum_{i=1}^{k} N_i \frac{d_i}{n_i}}{\sum_{i=1}^{k} N_i \frac{D_i}{N_i}}. \quad (5)$$

A comparison of the formulae [equations (2) and (5)] for the SMR and CMF reveals two differences. First, the CMF is the quotient of expected over observed deaths, whereas the SMR is the quotient of observed over expected deaths. This makes no difference to their interpretation, however, as the CMF is calculated with reference to the standard population and the SMR with reference to the study population. The CMF can be expressed as the ratio of the death rate that, say, England and Wales would have if it had the same mortality experience as a district under study, and the death rate that England and Wales actually has. A CMF of over 1.0 (or over 100 per cent, depending on whether it is converted into a percentage) represents an unfavourable mortality experience, in the same way as an SMR of over 1.0 (or 100 per cent).

A second and more interesting difference is that the age and sex sub-group weights used in the denominator of the SMR depend on the characteristics of the study population, whereas those used in the denominator of the CMF do not. If the SMRs for several districts are compared, therefore, the weights used to create the weighted sum of sub-group specific mortality rates, and thus the relative importance assigned to deaths in different sub-groups, will differ from district to district, each being based upon the population characteristics of the study population under consideration. In other words, a different denominator applies in the calculation for each district. In contrast, if the same is attempted with CMFs, the denominators will all consist of the same observed number of deaths from the standard population. Putting this another way, SMRs are not standardized with each other, but serve only to provide a comparison with the population from which the 'standard' death rates are drawn. The expected number of cases in each group, and the magnitude of the variation over or under one, will depend on the age and sex distribution of the district under study. Unless these distributions are identical, which will rarely be the case, each SMR is standardized to a different population, despite the fact that each uses the same 'standard' population to provide its expected rates.[11–13] The use of the word 'standard', when referring to the population from which death rates are drawn for the calculation of an expected number of deaths, is clearly incorrect, as the population structure of the 'standard' is not used. This is something of a paradox: the aim of the SMR is to allow for different population structures, but two districts can only be compared via their SMRs if they have identical population structures! Even those who favour SMRs have to make excuses for them: a popular textbook on statistical methods in epidemiology says of indirectly standardized rates (ISR – analogous to the SMR):[14] 'Because indirect age adjusted rates for different areas do not *all* use *exactly* the same weighting factors (as would be true for directly adjusted rates), it is *technically* incorrect to compare ISR_a with ISR_b.' Removal of the italicized words changes the meaning of the sentence considerably! The invalidity of comparing SMRs for different geographical areas and populations is a little recognized fact amongst public health physicians, however. Although the problems inherent in comparing SMRs are widely quoted in statistical and epidemiological text,[12,13,15] many introductory textbooks for public health physicians, including a standard textbook on public health medicine read by many registrars studying for Part I of the MFPHM examination, make no mention of them at all.[3] The first argument for SMRs can therefore be discounted. It is perfectly simple to construct an easily understandable ratio using a direct method of standardization, and the ratio so constructed has advantages over the SMR in terms of its validity.

Belief (2) – that direct standardization cannot be carried out in many cases because the sub-group specific mortality rates in the groups to be compared are not available or, in at least some age classes, are based upon such small numbers as to be completely unreliable

Most public health physicians will be aware that situations in which age and sex at death of subjects in a study population are not known are rare. Mortality returns have been collected in England and Wales since 1839, and by cause since 1854, and the age at death of the patient forms part of the death certificate. The same does not always hold true of data on morbidity (for example, records of patients transported by emergency ambulance) and there may be a case for the use of indirect standardization under such circumstances. It is certain, however, that this is not the case in the calculation of overall death rates, nor of hospital admission rates, at a district level in the United Kingdom.

More widespread, and more widely quoted, is the belief that the SMR is inherently more reliable than its directly standardized alternative. As will be shown, this is to some extent true. To estimate the importance of this difference we turn now to the comparative sizes of the standard errors of standardized ratios produced by indirect and direct methods.

Standard error of the SMR

Taking O to be the number of observed deaths and E the number expected from equation (1), the standard error of the SMR is approximately[15–17]

$$\frac{\sqrt{O}}{E}. \tag{6}$$

Because of the skewed distribution of the SMR it may be preferred to transform it to the log scale. The approximate standard error for the transformed SMR is[15–17]

$$\mathrm{SE}\,(\log \mathrm{SMR}) = \frac{\mathrm{SE}\,(\mathrm{SMR})}{\mathrm{SMR}} = \frac{1}{\sqrt{O}}. \tag{7}$$

Calculation of confidence intervals for the SMR

It is not necessary to know how to calculate confidence intervals in order to effect the comparison between standard errors for the SMR and the CMF. However, they are now ubiquitous in the presentation of statistics and it seems reasonable to include them here. For a small number of observed deaths (i.e. ≤ 100) one can calculate confidence intervals using statistical tables[16] under the assumption that the deaths observed follow a Poisson distribution.[13] For a large number of deaths (i.e. >100) one can calculate the 95 per cent confidence interval as[18]

$$\frac{(1-\sqrt{O})^2}{E} \text{ to } \frac{[1+\sqrt{(O+1)}]^2}{E}.$$

Alternatively, from equation (7) the 95 per cent confidence interval can be taken to be from

$$\frac{\mathrm{SMR}}{\exp\left(\frac{1.96}{\sqrt{O}}\right)} \text{ to } \mathrm{SMR} \times \exp\left(\frac{1.96}{\sqrt{O}}\right)$$

Standard error of the CMF

The approximate standard error (SE) of the CMF is given by[15,16]

$$\mathrm{SE}\,(\mathrm{CMF}) = \frac{\sqrt{\left(\sum_{i=1}^{k} N_i^2 \frac{d_i}{n_i^2}\right)}}{\text{Observed deaths (in standard population)}} \tag{8}$$

As with the SMR it may be preferable to use the log transformed CMF to account for its skewed distribution. The approximate standard error for the transformed CMF is

$$\mathrm{SE}\,(\log \mathrm{CMF}) = \frac{\mathrm{SE}\,(\mathrm{CMF})}{\mathrm{CMF}}. \tag{9}$$

Table 1 Age-specific rates for the standard population and two wards in Sheffield

Age group	Standard population: Deaths	Population	Rate/1000	Brightside: Deaths	Population	Rate/1000	SMR denominator	CMF numerator	Firth Park: Deaths	Population	Rate/1000	SMR denominator	CMF numerator
0–4	51639	3183200	16.22	20	1169	17.11	18.96	54460.22	25	1069	23.39	17.34	74443.41
5–14	8575	5238100	1.64	1	2928	0.34	4.79	1788.97	4	2428	1.65	3.97	8629.49
15–24	30877	8113800	3.81	8	2738	2.92	10.42	23707.23	14	2918	4.80	11.10	38928.44
25–34	33250	7065300	4.71	8	2608	3.07	12.27	21672.70	14	2058	3.80	9.69	48063.27
35–44	67205	6863200	9.79	26	2348	11.07	22.99	75997.96	22	1748	12.59	17.12	86378.95
45–54	161857	5442900	29.74	74	1498	49.40	44.55	268874.90	96	1828	52.52	54.36	285841.57
55–64	485954	5417400	89.70	158	1378	114.66	123.61	621153.26	252	2018	124.88	181.02	676503.87
65–74	999579	4458100	224.22	334	629	531.00	141.03	2367258.19	569	989	575.33	221.75	2564872.50
75+	2229463	3293300	676.96	663	897	739.13	607.23	2434178.26	1114	1629	683.86	1102.76	2252140.09
Total	4068399	49075300	1056.79	1292	16193	1468.7	985.85	5869091.69	2110	16685	1482.82	1619.11	6035801.59

Calculation of confidence intervals for the CMF

From equation (9), the 95 per cent confidence interval can be taken to be from

$$\frac{\text{CMF}}{\exp\left[\frac{1.96 \times \text{SE}(\text{CMF})}{\text{CMF}}\right]} \text{ to } \text{CMF} \times \exp\left[\frac{1.96 \times \text{SE}(\text{CMF})}{\text{CMF}}\right].$$

Practical comparison of the SMR and CMF

It is evident from equations (2), (5), (6) and (8) that if both the study and reference populations had the same distribution, then the CMF and SMR would give identical answers, i.e. SMR = CMF and SE(SMR) = SE(CMF). If the two population distributions differ then the SMR and CMF will give different results and, as the SMR is the maximum likelihood estimate, it will tend to have a smaller error than the CMF.[16] This has been used as the main argument for the continuing use of the SMR. We consider, however, that this does not make it the best estimate as it is biased, in the sense that is dependent on the population sub-group distribution in the study populations.

To demonstrate the differences between SMR and CMF we undertook an empirical investigation of the results of calculating SMRs, CMFs, and their respective standard errors according to equations (2), (5), (6) and (8), using an exemplary set of data on all cause mortality from 29 electoral wards in Sheffield between 1981 and 1987. Standardization was carried out first using 1986 England and Wales mid-year population estimates, and the corresponding death rates from the same year, and second using local Sheffield population estimates for 1986, and summed deaths for all 29 wards for the 7 years studied. Populations were stratified into nine age bands (0–4, 5–14 . . . 65–74, 75+) and by gender. As a worked example the SMR is calculated by dividing the observed number of deaths in each ward by the expected number derived from national death rates applied to the local population. For Brightside this is calculated to be

$$\text{SMR} = 100 \times 1292/985.85 = 131.05 \text{ (see Table 1).}$$

Similarly, the CMF is estimated by dividing the expected number of national deaths, calculated using death rates from an individual ward and national population structure, by the observed number of deaths nationally. Thus, for Brightside,

$$\text{CMF} = 100 \times 5869091.69/4068399 = 144.26.$$

The results for two wards are summarized in Tables 1 and 2. From these tables it is evident that although Brightside enjoys

Table 2 SMR and CMF for two wards in Sheffield

	SMR	CMF
Brightside	131.05	144.26
Firth Park	130.32	148.36

Table 3 The CMF, SMR, rank placement determined by both, and difference in rank placement between CMF and SMR for 29 electoral wards in Sheffield, calculated using national population as standard (England and Wales)

Ward	CMF	CMF rank (1)	SMR	SMR rank (2)	(1) – (2)
Chapel Green	128.57	12	115.49	11	1
Beauchief	106.02	2	94.27	2	0
Birley	123.02	9	110.10	9	0
Brightside	144.26	22	131.05	23	–1
Broomhall	128.53	11	116.25	12	–1
Burngreave	159.62	29	140.38	27	2
Castle	140.03	18	129.18	21	–3
Darnell	144.21	21	128.80	19	2
Dore	116.91	6	101.44	4	2
Ecclesall	102.77	1	93.49	1	0
Firth Park	148.36	24	130.32	22	2
Norton	147.44	23	129.18	20	3
Hallam	106.23	3	94.56	3	0
Handsworth	137.03	16	122.99	16	0
Heeley	120.61	8	109.35	8	0
Hillsborough	124.85	10	111.36	10	0
Intake	138.32	17	123.29	17	0
Manor	159.24	28	145.78	29	–1
Mosborough	115.63	4	103.91	5	–1
Nether Edge	116.24	5	108.04	7	–2
Nether Shire	133.29	14	118.17	14	0
Nether Thorpe	151.56	25	135.55	25	0
Owlerton	143.96	20	132.01	24	–4
Park	133.78	15	119.68	15	0
Sharrow	159.07	27	143.54	28	–1
Southey Green	152.96	26	138.61	26	0
Walkley	118.72	7	106.71	6	1
Stocksbridge	129.42	13	116.61	13	0
South Wortley	143.17	19	127.59	18	1

Table 4 The standard error (SE) for the CMF and SMR with the appropriate 95% confidence interval, calculated using national population as standard (England and Wales)

	CMF		SMR	
Ward	SE	95% CI	SE	95% CI
Chapel Green	7.07	115.43–143.21	3.04	109.68–121.60
Beauchief	5.06	94.97–118.36	2.31	89.85–98.91
Birley	6.60	110.73–136.66	2.76	104.82–115.65
Brightside	8.59	128.36–162.13	3.65	124.10–138.40
Broomhall	8.57	112.78–146.47	3.37	109.84–123.04
Burngreave	8.32	114.13–176.78	3.33	134.00–147.06
Castle	8.21	124.83–157.09	3.41	122.66–136.04
Darnell	7.31	130.57–159.27	2.95	123.14–134.72
Dore	6.25	105.28–129.83	2.44	96.77–106.34
Ecclesall	5.99	91.68–115.21	2.38	88.94–98.28
Firth Park	7.56	134.25–163.95	2.84	124.87–136.00
Norton	7.23	133.93–162.32	2.80	123.81–134.78
Hallam	6.20	94.75–119.09	2.46	89.86–99.51
Handsworth	6.74	124.44–150.90	2.81	117.62–128.62
Heeley	6.81	107.98–134.72	2.71	104.18–114.79
Hillsborough	6.62	112.53–138.52	2.59	106.40–116.55
Intake	7.03	125.21–152.81	2.89	117.76–129.08
Manor	8.32	143.74–176.42	3.47	139.13–152.76
Mosborough	6.10	104.27–128.22	2.57	99.00–109.06
Nether Edge	7.31	102.75–131.50	2.95	102.41–113.99
Nether Shire	7.16	119.97–148.10	2.73	112.93–123.64
Nether Thorpe	8.16	136.38–168.43	3.07	129.67–141.70
Owlerton	7.76	129.53–159.99	3.22	125.85–138.47
Park	7.00	120.73–148.23	2.71	114.48–125.11
Sharrow	9.19	142.04–178.13	3.71	136.84–151.41
Southey Green	8.11	137.86–169.71	3.26	132.37–145.44
Walkley	6.95	105.86–133.14	2.78	101.40–112.40
Stocksbridge	8.78	113.31–147.82	3.68	109.68–124.10
South Wortley	6.44	131.08–156.37	2.68	122.45–132.95

Table 5 The CMF, SMR, rank placement determined by both, and difference in rank placement between CMF and SMR for 29 electoral wards in Sheffield, calculated using local population as standard (Sheffield)

Ward	CMF	CMF rank (1)	SMR	SMR rank (2)	(1) – (2)
Chapel Green	97.15	11	96.21	11	0
Beauchief	79.70	1	79.75	1	0
Birley	89.77	7	90.84	7	0
Brightside	110.02	22	109.61	22	0
Broomhall	100.19	15	102.29	16	–1
Burngreave	118.36	28	118.49	27	1
Castle	104.06	18	105.81	18	0
Darnell	107.89	20	107.88	20	0
Dore	86.89	5	86.59	5	0
Ecclesall	79.98	2	80.84	3	–1
Firth Park	111.12	24	110.39	24	0
Norton	109.32	21	109.39	21	0
Hallam	80.42	3	80.63	2	1
Handsworth	101.75	16	102.05	15	1
Heeley	92.57	9	92.29	8	1
Hillsborough	95.02	10	95.48	10	0
Intake	103.87	17	103.48	17	0
Manor	118.27	27	119.09	28	0
Mosborough	85.61	4	86.15	4	–1
Nether Edge	91.42	8	92.48	9	0
Nether Shire	99.29	13	98.92	13	–1
Nether Thorpe	115.32	26	114.95	26	0
Owlerton	110.10	23	109.81	23	0
Park	99.59	14	99.35	14	0
Sharrow	121.56	29	121.62	29	0
Southey Green	112.75	25	113.54	25	0
Walkley	89.65	6	89.77	6	0
Stocksbridge	97.61	12	97.58	12	0
South Wortley	107.76	19	107.72	19	0

Table 6 The standard error (SE) for the CMF and SMR with the appropriate 95% confidence interval, calculated using local population as standard (Sheffield)

	CMF		SMR	
Ward	SE	95% CI	SE	95% CI
Chapel Green	5.32	87.27–108.15	2.53	91.37–101.31
Beauchief	4.37	71.39–88.96	1.95	76.01–83.68
Birley	4.88	80.70–99.86	2.28	86.48–95.42
Brightside	6.48	98.02–123.48	3.05	103.79–115.75
Broomhall	6.38	88.44–113.50	2.96	96.65–108.27
Burngreave	6.20	106.81–131.15	2.81	113.11–124.14
Castle	6.21	92.57–116.98	2.79	100.47–111.43
Darnell	5.49	97.66–119.20	2.47	103.14–112.84
Dore	4.63	78.27–96.46	2.08	82.60–90.77
Ecclesall	4.50	71.62–89.31	2.06	76.90–84.98
Firth Park	5.71	100.48–122.89	2.40	105.78–115.21
Norton	5.38	99.27–120.38	2.37	104.85–114.14
Hallam	4.64	71.82–90.06	2.10	76.62–84.85
Handsworth	5.03	92.35–112.11	2.33	97.59–106.71
Heeley	5.17	82.98–103.26	2.28	87.92–96.88
Hillsborough	4.97	85.77–105.27	2.22	91.23–99.93
Intake	5.25	94.07–114.69	2.42	98.84–108.34
Manor	6.22	106.68–131.12	2.84	113.66–124.79
Mosborough	4.56	77.13–95.02	2.13	82.08–90.42
Nether Edge	5.57	81.12–103.01	2.53	87.66–97.57
Nether Shire	5.41	89.24–110.48	2.29	94.54–103.50
Nether Thorpe	6.18	103.82–128.10	2.60	109.97–120.16
Owlerton	5.89	99.13–127.27	2.68	104.69–115.18
Park	5.28	89.77–110.49	2.25	95.04–103.85
Sharrow	6.93	108.71–135.92	3.14	115.62–127.93
Southey Green	6.09	101.42–125.35	2.67	108.43–118.89
Walkley	5.26	79.91–100.59	2.34	85.30–94.47
Stocksbridge	6.60	85.50–111.45	3.08	91.74–103.80
South Wortley	4.81	98.74–117.61	2.26	103.38–112.24

lower age-specific rates than Firth Park for all age groups, except the over-75s, it has a higher SMR. This non-intuitive finding is due to the bias present in the calculation of an SMR and from which the CMF is free, Brightside having a lower CMF than Firth Park.

Tables 3 and 4 give the results for all the wards in Sheffield when national standards are used. Table 3 shows CMF, SMR, rank placement determined by both, and difference in rank placement between CMF and SMR, and Table 4 gives the standard error and 95 per cent confidence interval for all 29 wards. Several differences in rank order of electoral wards exist between CMF and SMR, the difference in rank varying by up to four places for some wards. In addition, it can be clearly seen that the CMF for the Sheffield wards is on average 11.4 per cent higher than the SMR.

From Table 4 it is evident that, in general, SMRs have a smaller standard error than do their directly standardized alternatives, when both are calculated using the same assumptions. Nevertheless, this difference, in our empirical example, is small and is outweighed by the bias inherent in SMRs: the point estimates for 14/29 SMRs do not even lie within the 95 per cent confidence intervals of the corresponding CMF! Furthermore, by using larger datasets, perhaps by including data from more than one year, the standard error of directly standardized rates and CMFs can be reduced. The bias inherent in SMRs, however, cannot be controlled. If the central estimate of the standardized rate is to be used in a resource allocation formula then plainly the bias in the estimate is more important than its precision.

Is it possible to alleviate this bias in any way? Tables 5 and 6 give the equivalent figures to Tables 3 and 4 using the local (all Sheffield) population rates as a standard, rather than England and Wales rates. The CMF is now much closer to the SMR in all cases: point estimates for each SMR now lie within the 95 per cent confidence intervals for the corresponding CMF. Differences in rank order are much diminished, although still present.

Conclusion

The supposed advantage of SMRs in terms of their smaller standard error is not great, and is easily outweighed by their disadvantages in terms of validity. Rates should be directly standardized when making comparisons between different groups, geographical or otherwise. The SMR should only be used to compare different populations when it is strictly necessary to do so (that is, when event data are not available by age) and wherever possible rates used for the calculation of expected numbers of deaths should be as local as possible (i.e. should not extend outside the combined populations of the groups under study). Otherwise, the SMR should be employed only for its original purpose – to compare the mortality from different causes within a single population, such as an occupationally exposed group.

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