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Occupational mortality: work or way of life?*

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SUMMARY For more than 100 years the Registrar General has reviewed mortality in depth in a series of supplements relating extra information provided by decennial censuses to deaths in a period before and after the census. The volume describing occupational mortality in 1970-72 was recently published (Registrar General, 1978). Here we consider in more detail one of the questions raised by occupational mortality studies: how much does mortality of an occupation group reflect work environment and how much way of life? We first describe the traditional method of distinguishing these direct and indirect influences (that is, the comparison of the mortality of men following an occupation with that of their wives) and then introduce an alternative which we call 'social class standardisation'.

Introduction

Certain environmental influences upon mortality are easy to recognise but others are less obvious, mainly because of the long delay between cause and effect. The direct effects of occupations are readily seen in accidents; construction workers, transport workers, miners, and fishermen are groups whose accident rates are clearly related to their work. Delayed effects specifically due to a particular type of exposure may also stand out. For example, the various dust diseases recorded among miners, potters, foundrymen and cotton workers are clearly occupational in origin. However, the influence of these occupations on death rates for other respiratory diseases or for cancers is less clear, because the rates for these conditions are also affected by factors outside work related to way of life. The rates are therefore indirectly associated with occupations through common life styles.

When Stevenson analysed deaths in 1921-23, he gained the 'impression' that the influence of occupations was on the whole more indirect than direct (Registrar General, 1927). He suggested that women provided the means of 'roughly' differentiating between the two types of occupational influences on men. 'For no trade could longer be regarded as directly prejudicial to health if it were found to entail as much excess risk for the wife as for the husband'.

The social classes used in this study evolved from the classification Stevenson developed in the early 1920s (Stevenson, 1923; 1928). He felt that 'of the two types of influence . . . , the direct has attracted . . . more than its due share of attention'. The analysis of mortality of broad social classes and the use of wives' mortality as a standard has altered the balance of commentaries on occupational mortality; in more recent volumes, emphasis has shifted to the discussion of socio-environmental influences.

Example comparing male and female SMRs

The standardised mortality ratios (SMRs) for bronchitis by sex and social class for 1949-53 and 1970-72 are given in Fig. 1. For the earlier period the SMRs for men are compared with those for married women. For the later period the SMRs for married men are given. Married women have been assigned to social classes on the basis of their husbands' occupations. In 1949-53 and in 1970-72 similar social class gradients were noted for men and for their wives.

In 1965, at the request of the Minister of Pensions and National Insurance, the Medical Research Council set up a committee to examine the role of occupation in the aetiology of chronic bronchitis, with particular reference to the coal mining industry. This committee compared the SMRs for men with those of their wives (Medical Research Council, 1966). The committee concluded after examining the top half of Fig. 1 that social class differences were similar for men and women in 1949-53. It reasoned that since women were not exposed to occupational factors, this would indicate the importance of other factors. Further evidence to support this conclusion was provided by a similar comparison between the mortality of men and their wives in selected dusty occupations.

*This paper is based on a talk given last year at the annual conference of the Society for Social Medicine.

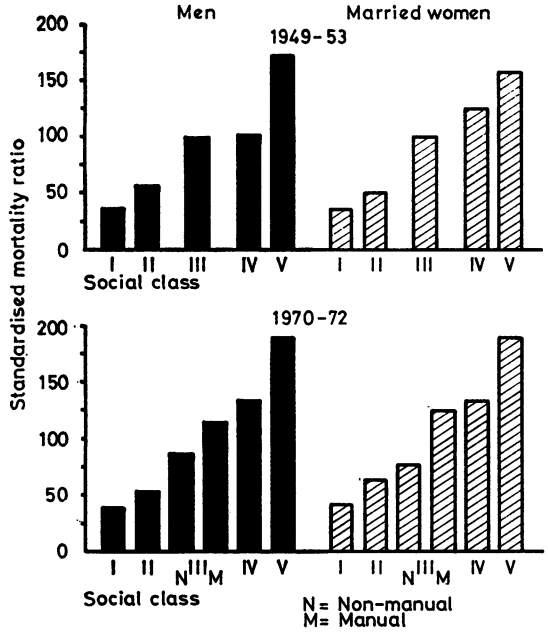


Fig. 1 *SMRs for bronchitis by sex and social class.*

Table 1 *SMRs for bronchitis by sex and occupation*

		SMR		
		Men	*Married women*	*W*‡
1949–53	Coal miners	135	175	
	Face workers	200	190	
	Iron and steel foundry workers	158	213	
	Agricultural workers	53	82	
	Farmers	31	52	
1970–72†	Farmers, foresters and fishermen	77	81	-0·5
	Miners and quarrymen	245	233	0·6
	Glass and ceramics makers	172	109	1·8
	Furnace, forge, foundry, etc., workers	180	154	1·1
	Textile workers	128	185	-2·0*

* $P < 0.05$
† Married men compared with married women
‡ Relative sex differential (standardised difference between male and female SMR)
Source: Registrar General, 1958; 1978

Table 1 gives the figures reviewed by the MRC committee and the more recent figures for deaths in 1970-72. In the later period married men are again compared with married women, who are assigned to occupations on the basis of their husbands' work. A formal measure of the significance of a difference is obtained from *W*, the relative sex differential, which is the standardised difference between male and female SMRs. In both periods, high SMRs for men were matched by high SMRs for women. The only significant difference in 1970-72 was for textile workers, for whom the female SMR was much higher than the male.

Assumptions of male-female comparison

Two assumptions are central to the male-female mortality comparison. The first is that direct influences of occupations are not present in female mortality rates; the second is that indirect influences are the same for women as for men. The first assumption can be looked at in several ways. It might be expressed in the form 'women do not work', or 'women are not exposed to occupational hazards', or 'women's occupations are not related to those of their husbands'.

Whichever way the assumption is formulated, it is necessary to look at its validity. For example, Fig. 2 shows the proportion of married women aged 15-64 recorded as 'economically active or retired' in the censuses of 1931, 1951 and 1971. Even though it may have been justified to assume that in 1931 few women were, or had been, economically active, this is no longer the case. Almost half the married women in 1971 were in active employment.

Women's health is affected by their work. For example, studies of women asbestos workers point to excess mortality from the same diseases as men in the industry. This is reflected in rates of mesothelioma, lung cancer and asbestosis. Most of the effects of exposure to asbestos, cotton dust and silica are delayed and chronic, so the associations that have been noted for women reflect not only recent exposures but also earlier employment patterns. Women who worked during the war in factories manufacturing gas masks have been found, 20 or more years after they ceased to be exposed, with radiological evidence of lung changes; yet most of them had had *x* rays that showed no abnormalities when they left the industry.

The suggestion that female employment may bias

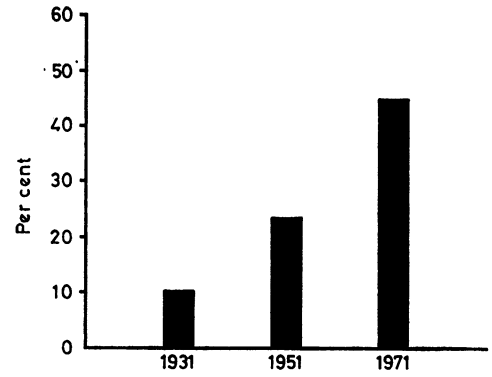


Fig. 2 *Percentage of married women aged 15-64 economically active or retired.*

comparisons is not new. Stocks warned about the influence of women directly involved in their husbands' occupations or working independently in a similar job outside the home (Registrar General, 1938). For example, he pointed out that innkeepers' wives generally helped their husbands, and that in textile and pottery towns women were often employed in the same industry as their husbands.

It is interesting, therefore, to look at the relationship between wives' occupations and those of their husbands. Table 2, based on the 1971 census, clearly indicates that considerably more wives follow certain occupations than would be expected if the wife's and husband's occupations were independent. The occupations presented showed the strongest associations between wives' and husbands' jobs, but there was clear evidence of a relationship for almost every occupation order.

Table 2 *Women's related to husbands' occupations*

	Same as husband		
Occupation	*No.*	*Expected†*	*Ratio*
Farmers, foresters and fishermen	1969	111	18
Glass and ceramics workers	146	4	37
Leather workers	258	4	37
Textile workers	572	37	16

†Assuming independence
Source: Registrar General, 1978

Women may do the same jobs as their husbands or they may work in related occupations with similar exposures. The relatively high proportions of coal miners' wives in the pottery and cotton industries as well as in unskilled jobs (Table 3) may be relevant to the MRC committee's conclusion that non-occupational factors were more important than occupational factors in chronic bronchitis. No doubt exposure to dust in the course of such work affects women's mortality rates for bronchitis just as it does their husbands'.

Table 3 *Women's related to husbands' occupations*

Occupations followed by miners' wives			
	No.	*Expected†*	*Ratio*
Glass and ceramics workers	57	24	2·4
Textile workers	147	110	1·3
Labourers	168	106	1·6

†Expected values were calculated on the assumption that there was no relationship between the occupations of the wives and those of their husbands

Source: Registrar General, 1978

The validity of the second broad assumption—that indirect influences are the same for women as for men—may also be questioned. It might be seen to include two more specific assumptions: that the 'way of life' is the same for wives as for husbands, and that similar exposures have similar relative effects for men and women. For several reasons, the suggestion that the 'way of life' of husbands and wives are similar appears sensible. Nevertheless, there are large sex differences in, for example, cigarette and alcohol consumption which might differentially affect male and female social class gradients. Also, since all comparisons are based on SMRs, the assumption is that each factor increases mortality proportionately, say by x per cent, and not absolutely, say by y deaths per million living per year, and that the effect is similar in each age group. For example, cigarette consumption is assumed to affect male and female death rates for bronchitis in the same proportions, although the bronchitis death rates for men are more than four times those for married women of the same age.

These are some of the weaknesses inherent in the assumptions on which the male-female comparison relies. We have not, however, considered the extent of such weaknesses and the general robustness of the approach. Certainly the comparison is valuable, as anyone will recognise who has studied decennial supplements.

Social class standardisation

In searching for a measure to support the traditional SMR, our aim was to look at the data in another light. Data on occupational mortality are notorious for pitfalls. Throughout the latest volume on the subject, an attempt has therefore been made to throw light on the data from different angles, never relying on one particular form of analysis. In this way the impact of biases should be reduced and real associations teased out.

Social class standardisation is conceptually simple. Instead of comparing the mortality rates for a group, such as an occupation order, with the rates for all men, comparison is made with men in the same social class or classes. Table 4 illustrates the comparison in the simplest case, when all men in the group are assigned to the same social class. The overall mortality of stevedores and dock labourers was some 40% higher than national rates but only 6% higher than the rates for men in Social Class V. Similarly the rates for bus conductors were 18% higher than national rates but only 4% higher than the rates for men in Social Class IV. At the other end of the scale, teachers' rates were 34% lower than rates for all men and 18% lower than those for men in Social Class II, while doctors' rates were 19% lower than those for all men and 5% higher than those for men in Social Class I.

Table 4 *Social class standardisation using men in the same social class as the standard for comparison*

Occupation	Social class	SMR	Standardised for social class
Stevedores and dock labourers	V	140	106
Bus conductors	IV	118	104
Painters and decorators	IIIM	112	105
Clerks	IIIN	104	105
Teachers	II	66	82
Doctors	I	81	105

Source: Registrar General, 1978

The comparison becomes slightly more complex for an occupation group spanning more than one social class—for example, transport and communications workers (Occupation Order XIX). Although nearly 70% of the total of 1 000 000 men in this category were assigned to Social Class III M, some 5% were assigned to Social Class II, and 25% to classes IV and V.

Table 5 gives observed and expected deaths class by class. The expected deaths are based on death rates for the particular class. On this basis, transport and communications workers in Social Class II are seen to have had higher rates than all men in Social Class II, whereas in Social Class V they had lower rates than all men in that class. The sum of observed and expected deaths across the social classes indicates that the social class standardised SMR was 102. This compares with an age-standardised SMR of 111 and suggests that social class explains much of the high mortality.

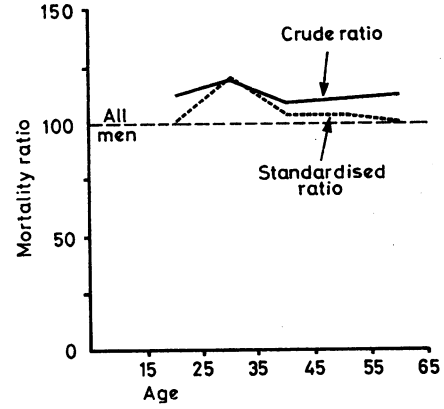
Table 5 *Social class standardised SMRs for transport and communications workers*

Social class	Deaths Observed	Deaths Expected*	Ratio
All (unstandardised)	23 791	21 370†	111
I	—	—	—
II	1 503	1 144	131
IIIN	356	316	113
IIIM	14 779	14 053	105
IV	4 319	4 455	97
V	2 834	3 279	86
All (standardised)	23 791	23 247	102

*Based on age social class-specific death rates
†Based on age-specific death rates, otherwise expected deaths
Source: Registrar General, 1978

The approach does not inhibit more detailed analysis, say by age group. For transport and communications workers in particular, a residual excess remains in the 25-34 group after social class standardisation (Fig. 3). Analysis of the cause points to accidents involving cars, boats, trains and aeroplanes: clearly direct effects of occupations.

Fig. 3 *Mortality of male transport and communications workers by age.*



A second example illustrates how social class standardisation might help to separate direct from indirect effects of occupations. Each year some 10 000 households are questioned for the General Household Survey about occupations, smoking habits, etc. Measures of smoking by occupation can be related to mortality rates by occupation to shed light on the link between smoking and mortality. The SMRs for lung cancer are plotted in Fig. 4 against the smoking score for the 25 occupation orders (excluding the armed forces and the inadequately described occupations). The smoking score is the ratio of the number of men smoking to the number expected on the basis of national proportions. This measure is similar to the one used in the recent report on doctors' mortality by specialty (Doll and Peto, 1977). In the decennial supplement, smoking habits are distinguished as (a) whether or not smoking; and (b) quantity smoked. Only the former was used in the construction of Fig. 4. The quantity smoked showed a much weaker relationship, as might be expected, because this measure varied only a little with different occupations.

The high correlation in Fig. 4 (+0·72) is clear. However, when the lung cancer mortality rates are standardised for social class, the correlation is only +0·16. We have not attempted to interpret this residual correlation except to suggest that it might reflect an association between smoking and occupation over and above the association between smoking and social class. This could be an interaction between smoking habits and occupations, or between smoking habits and the direct effects of occupations. Men in some occupations smoke more than men in other occupations in the same social classes, so one might expect some residual

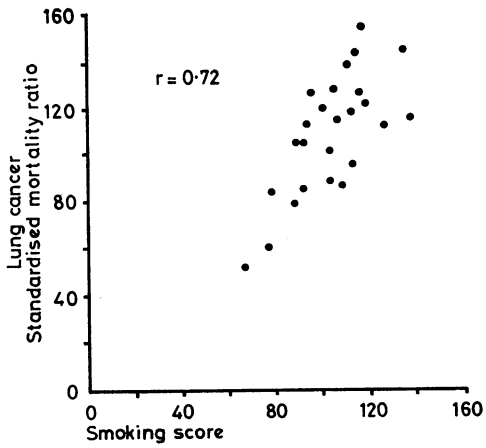


Fig. 4 *Lung cancer and smoking by occupation order. For definition of smoking score, see page 76.*

association with their lung cancer death rates. Also, smoking may interact with job environment, as with asbestos workers, to produce a multiplicative effect. The rough standardisation we have made does not allow us to separate these factors.

In a third example, social class standardisation has been used in a different context; not to separate direct from indirect effects but to separate social class from regional effects. Regional differences in mortality rates throughout England and Wales have persisted for more than 100 years. High rates are generally found in the north and west and low rates in the south and east. There are differences within regions and between causes, but the overall pattern remains. Social class has been cited as one of the main reasons for these differences. The argument is that compared with the south and east, the north and west have a higher proportion of men in Social Class V, whose higher mortality contributes more to the higher mortality of these regions.

Table 6 shows the effect of standardising regional mortality for social class. It is based on all deaths of adult males aged 15-64 but the conclusions are the same when the analysis is repeated for infant mortality as well as for major causes of death. The finding that social class does *not* explain such large regional differences is not altogether surprising. After all, the centre of gravity of each region remains somewhere in Social Class III (Manual) and the social class mortality gradient is not steep enough for a small shift in centre of gravity to cause a large change in death rate.

Table 6 *Regional mortality standardised for social class*

	Standardised mortality ratio	
Region	*Age*	*Age and social class*
Northern	113	113
Yorkshire	106	105
North West	116	116
East Midlands	96	94
West Midlands	105	105
East Anglia	84	83
South East	90	90
South West	93	93
Wales I	114	117
Wales II	110	113
England and Wales	100	100

Source: Registrar General, 1978

Work or way of life

Having illustrated three uses of social class standardisation, we finally return to our original question—how much does mortality reflect work environment and how much way of life? Social class standardisation can be used to study the variation in mortality between occupations (once again the example uses occupation orders). Observed and expected deaths are compared for each of the 25 occupations in the standard manner giving a χ^2 value. The sum of these values measures the total variation between occupation orders. The calculations may then be repeated, basing the expected deaths on social class-specific death rates to measure the variation associated with direct occupational influences. The difference between this and the total variation might be thought of as the variation reflecting differences in way of life.

This oversimplified calculation, ignoring interactions between direct and indirect influences, is clearly very crude, Even so, it may shed some light on the question asked. Table 7 indicates the results of this analysis for all causes of death and for selected major groups of causes. The Table suggests that overall, some 18% of the variation between occupation orders was occupationally related—that is, more than 80% was explained by social class standardisation. For some causes the proportion

Table 7 *Variation in mortality between orders associated with work and way of life*

Cause of death	*Total between order variation*	*Variation associated with*	
		Work	*Other†*
Infective and parasitic diseases	356·3 100%	25%	75%
Cancer	2570·9 100%	12%	88%
Circulatory diseases	2357·4 100%	32%	68%
Respiratory diseases	5168·5 100%	28%	72%
Accidents	2774·3 100%	23%	77%
All causes	8861·4 100%	1599·8 18%	7261·6 82%

†Way of life, etc.

associated with work was lower; surprisingly, only 12% of cancer variation appeared to be associated with work. For other causes, such as circulatory and respiratory diseases, the proportion was nearer 30 per cent.

Conclusion

We have not studied the properties of social class standardisation in depth; the assumptions on which it relies and its robustness need to be evaluated as critically as the male-female comparison. Although it provides numerical estimates of the direct and indirect influences of occupations, it is not clear what this separation means. Selective factors associated with entry to different occupations may be more strongly associated with work than life style, and these may explain some of the difference. Alternatively, occupations may be associated with a life style not reflecting that of other men in the same social class—coal miners, for example, smoke more than other men in Social Classes III and IV, and clergymen smoke less than other men in Social Class I. Whatever the reservations about the final example, the earlier ones should have demonstrated the potential of this approach.

Reprints from Dr. A. J. Fox, Medical Statistics Division, Office of Population Censuses and Surveys, Kingsway, London WC2B 6JP.

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