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Do socioeconomic differences in mortality persist after retirement? 25 Year follow up of civil servants from the first Whitehall study

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Abstract

***Objective*—To assess the risk of death associated with work based and non-work based measures of socioeconomic status before and after retirement age.**

***Design*—Follow up study of mortality in relation to employment grade and car ownership over 25 years.**

***Setting*—The first Whitehall study.**

***Subjects*—18 133 male civil servants aged 40-69 years who attended a screening examination between 1967 and 1970.**

***Main outcome measure*—Death.**

***Results*—Grade of employment was a strong predictor of mortality before retirement. For men dying at ages 40-64 the lowest employment grade had 3.12 times the mortality of the highest grade (95% confidence interval 2.4 to 4.1). After retirement the ability of grade to predict mortality declined (rate ratio 1.86; 1.6 to 2.2). A non-work based measure of socioeconomic status (car ownership) predicted mortality less well than employment grade before retirement but its ability to predict mortality declined less after retirement. Using a relative index of inequality that was sensitive to the distribution among socioeconomic groups showed employment grade and car ownership to have independent associations with mortality that were of equal magnitude after retirement. The absolute difference in death rates between the lowest and highest employment grades increased with age from 12.9 per 1000 person years at ages 40-64 to 38.3 per 1000 at ages 70-89.**

***Conclusions*—Socioeconomic differences in mortality persist beyond retirement age and in magnitude increase with age. Social differentials in mortality based on an occupational status measure seem to decrease to a greater degree after retirement than those based on a non-work measure. This suggests that alongside other socioeconomic factors work itself may play an important part in generating social inequalities in health in men of working age.**

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Introduction

Do social inequalities in death rates that are apparent at younger ages persist into old age? It might be imagined that as the cumulative probability of death for each person approaches 100% social and other predictors of differences in death rates would discriminate less well. In Britain much of the analysis of social class differences in adults has used the registrar general's classification based on occupation and has therefore been confined to people of working age. Other social classifications show differentials in mortality continuing beyond age 65, but differences are reduced.[1-3] In the United States the shorter life expectancy of people with less education continues but the black-white differential in mortality (largely social in origin) is reversed after age 75.[4]

A major question with occupation based social class differentials in mortality is the extent to which resulting mortality differences are due to occupation itself or to broader social differentials.[5] If due to work, social differences in mortality should narrow after retirement; if due to other factors associated with socioeconomic position, the narrowing may be less. We examined this in data from the 25 year follow up of British civil servants in the first Whitehall study. By using a work based measure of status (employment grade) the Whitehall study showed an inverse social gradient in mortality that was steeper than that observed nationally with the registrar general's classification of social class.[6] A non-work based measure (car ownership) added to the predictive power.[7] By using both work based and non-work based socioeconomic measures and analysing mortality differentials before and after usual retirement age we can examine the persistence of social gradients in mortality into older ages and the specific contribution of a work-based measure.

Subjects and methods

In the Whitehall study 19 019 men aged 40-69 years attended the initial screening between September 1967 and January 1970. Men were classified into four employment grades: administrative, professional and executive, clerical, and other. "Other" included messengers and other unskilled manual workers. For some analyses we grouped the four employment grades as high (administrative and professional and executive) and low (clerical and other). For 886 men from the diplomatic service and the British Council employment grading was different. These men were excluded from analysis.

Data regarding car ownership were available from answers to the question, "Do you own a car?" The questionnaires used in the study were modified during the study, and data on car ownership were collected only from the 70% of men seen during the middle period of the survey. Other studies have used access to a car rather than ownership of a car as a classification of social class. We expect there to be almost perfect agreement between these two definitions, as the Whitehall study men were middle aged and most likely the head of household.

Records from 99.3% of the remaining 18 133 men were identified and flagged at the National Health Service Central Registry, which notified us of all deaths up to the end of January 1995. A total of 18 001 men were therefore fol-

Table 1—*All cause mortality per 1000 person years (No of deaths), attributable risk, and rate ratio by employment grade and age at death*

Age at death (years)	Grade				Attributable risk†	Rate ratio (95% confidence interval)		
	Administrative (n = 962)	Professional and executive (n = 12269)	Clerical (n = 2981)	Other (n = 1789)		Other v administrative‡	Relative index of inequality§‡	Relative index of inequality¶
40–64	4.7 (65)	7.3 (1209)	12.4 (360)	17.6 (237)	12.9	3.12 (2.4 to 4.1)	3.06 (2.5 to 3.7)	2.30 (1.8 to 3.0)
65–69	17.4 (70)	17.3 (860)	26.7 (303)	32.1 (217)	14.7	1.73 (1.3 to 2.3)	2.12 (1.7 to 2.6)	1.87 (1.4 to 2.5)
70–89	32.6 (157)	44.8 (2642)	65.4 (1101)	70.9 (785)	38.3	1.86 (1.6 to 2.2)	1.77 (1.6 to 2.0)	1.52 (1.3 to 1.8)
Test for trend in rate ratios							P<0.001	P = 0.007

†Difference in death rates between other and administrative grades.
‡Adjusted for age and length of follow up.
§Rate ratios for bottom versus top of socioeconomic hierarchy based on grade by using relative index of inequality (see subjects and methods section).
¶Adjusted for age, length of follow up, and car ownership.

lowed up for a minimum of 25 years. Each man's follow up period was partitioned into single years of observation. For each individual year of follow up a new record was created, consisting of each man's current age at risk together with his employment grade and car ownership details and length of follow up during that year. Deaths were allocated to the appropriate current age category. This expanded dataset was used as the basis for all analyses of mortality. As comparatively few deaths occurred in men aged over 90 analyses were restricted to ages 40-89. Death rates were calculated by using person years at risk as outlined above.

The groups before and after retirement spanned age ranges of 25 and 20 years respectively. We therefore adjusted for the residual confounding effects of age by using five year age groups. Men at lower risk of death had, on average, longer follow up. Hence when comparing employment grades or men with and without a car the lower risk subjects had, on average, longer follow up. Over the follow up period death rates in England and Wales declined. In all analyses, therefore, estimated rate ratios for employment grade and car ownership were adjusted for length of follow up to avoid these effects being overestimated.

The proportions of men in the lower employment grades and without a car differed greatly according to age at entry into the study. These proportions also differed for given ages at entry. When comparing the effects of employment grade and car ownership the rate ratios for these effects may be expected to be larger for classifications which produce smaller, more extreme groups at the margins of the population. We overcame this problem by using the relative index of inequality, based on employment grade and car ownership.[8] For each measure the socioeconomic position of each group within each five year age band is assigned a value between zero and one according to the proportion of subjects in the population who are above the midpoint of that group. Values of zero and one therefore correspond to subjects who are at the top and bottom of the socioeconomic hierarchy. Rate ratios estimated by this method therefore show the relative death rates for subjects at the bottom of the socioeconomic hierarchy compared with those at the top. The relative index of inequality has the additional benefit that it enables employment grade categorised into four levels to be compared directly with car ownership categorised in two levels.

Adjusted rate ratios, their confidence intervals, and tests for linear trend in the rate ratios were computed by Poisson regression, fitted by using the statistical package GLIM.[9]

Results

Table 1 shows (by age at death) death rates per 1000 person years for the four employment grades together with the rate ratios for the lowest versus the highest grades and those for the bottom versus the top of the socioeconomic hierarchy by using the relative index of inequality based on grade. For men dying at 40-64 years of age (before retirement in most cases) there was a strong gradient in death rates across the four employment grades, corresponding to a rate ratio of 3.06 (95% confidence interval 2.5 to 3.7) based on the relative index of inequality. After retirement the relative increase across the grades was not so steep and the corresponding rate ratio declined to 1.77 (1.6 to 2.0). Men aged 65-69 years included some in work and some retired, and we therefore kept them separate in the analysis. The grade gradient for this group fell between those for the pre-retirement and post-retirement groups.

The lower rate ratio after retirement than before retirement was consistent more with a change after retirement than simply with a weakening of the social differential with age. Before retirement there was no change with age: the rate ratios (by using the relative index of inequality based on grade) were 3.06 at ages 45-49, 2.66 at 50-54, 3.64 at 55-59, and 2.94 at 60-64 (test for trend: P>0.5). Follow up before age 45 was not used in this comparison as only eight deaths occurred in this age range. After retirement there was a small

Table 2—*All cause mortality per 1000 person years (No of deaths) and rate ratio by car ownership and age at death*

Age at death (years)	Car owner		Rate ratio (95% confidence interval)		
	Yes (n = 8535)	No (n = 3395)	No v yes†	Relative index of inequality†‡	Relative index of inequality§
40–64	7.1 (818)	11.8 (426)	1.57 (1.4 to 1.8)	2.41 (1.9 to 3.1)	1.75 (1.4 to 2.3)
65–69	18.1 (628)	25.8 (340)	1.37 (1.2 to 1.6)	1.83 (1.4 to 2.4)	1.43 (1.1 to 1.9)
70–89	44.4 (1885)	64.2 (1155)	1.34 (1.3 to 1.4)	1.77 (1.5 to 2.1)	1.48 (1.3 to 1.8)
Test for trend in rate ratios				P = 0.04	P = 0.35

†Adjusted for age and length of follow up.
‡Rate ratios for bottom versus top of socioeconomic hierarchy based on car ownership by using relative index of inequality (see subjects and methods section).
§Adjusted for age, length of follow up, and employment grade.

suggestion of a decline with age, though the trend was not significant (P = 0.43): rate ratios were 1.81 at ages 70-74, 1.83 at 75-79, 1.74 at 80-84, and 1.45 at 85-89.

Given the rise in death rates with age the absolute difference in death rates (attributable risk) between grades was greater after retirement. For example, the lowest employment grade had a death rate higher by 12.9 per 1000 person years at ages 40-64, increasing to 38.3 at ages 70-89 (table 1). Overall, 30% of men in the administrative grade died during the 25 year follow up compared with 69% of men in the lowest grade.

Table 2 shows the death rates according to car ownership and age at death, the rate ratios for car ownership, and the rate ratios based on using the relative index of inequality. Before retirement the rate ratio for non-owners of cars versus car owners was much less than that between the "other" and administrative grades (rate ratios 1.57 *v* 3.12 respectively; P<0.001). These two grade levels were more extreme socioeconomic groups in the population compared with the car ownership groups. However, using the relative index of inequality reduced but did not remove this difference (rate ratios 2.41 *v* 3.06 respectively; P = 0.13). After retirement the rate ratios based on car ownership declined, though the trend was not as large as for employment grade (comparison of trends: P = 0.17) and the predictive effects of car ownership and grade were equal but still highly significant.

Figure 1 shows the rate ratios for the combined effects of grade (bottom two grades versus top two grades) and car ownership by age at death. The two measures of socioeconomic status show independent effects. The last columns in tables 1 and 2 show that these independent effects were highly significant both before and after retirement—that is, the confidence intervals for the rate ratios do not overlap 1.0.

As with grade the absolute difference in death rates between non-owners of cars and car owners was greater after retirement.

Discussion

Among men aged 40-69 years at entry to the Whitehall study two different socioeconomic measures continued to be associated with differences in death rates over a 25 year follow up period to age 89. Lack of ownership of a car was associated with a 57% higher mortality before retirement and 34% higher mortality after retirement. Grade of employment was inversely associated with mortality, with a 212% higher mortality in the lowest grade compared with the highest grade up to age 64. The relative difference was less after age 69 (when most men would have retired) than up to age 64 (before retirement for most men). Even with the decrease in relative mortality after retirement there was still an 86% increase in mortality among men in the lowest grade compared with the highest.

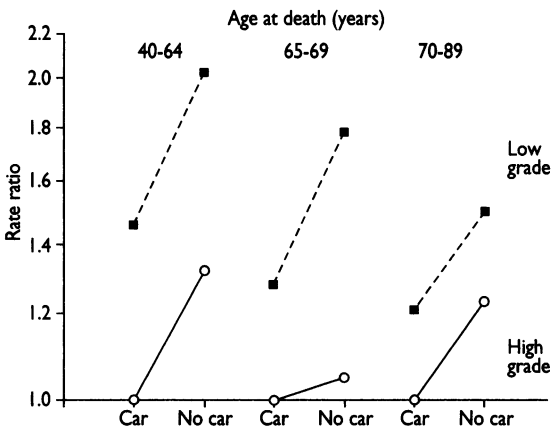

Fig 1—*Rate ratios (logarithmic scale) for all cause mortality by grade and car ownership according to age at death*

Declining social differences in mortality ratios with increasing age may be expected if there is selective removal of sick people at younger ages leaving a survivor population at older ages.[4] Other analyses of these data show that this was unlikely to be the case in our study, with only a small percentage of the decline in the grade rate ratios possibly due to a survivor effect (P J van de Mheen *et al*, unpublished observations). An alternative explanation might be that subjects at older ages had on average a shorter time between examination and death. However, we adjusted for length of follow up, which made little impact on the declining rate ratios for grade with age.

In detailed analyses of the Office of Population Censuses and Surveys longitudinal study that followed up a 1% sample of the 1971 census population of England and Wales, Fox *et al* showed that social differences in mortality at older ages could not easily be attributed to sick people being downwardly mobile socially.[10] They also argued that if sickness influenced social position rather than the reverse this effect would be most evident in the first five years of mortality follow up after determination of social position. In our study 91% of the deaths occurred five or more years after the baseline examination at which grade was determined.

Grade of employment was a powerful predictor of mortality and morbidity in both the Whitehall and Whitehall II studies.[6 11] Though grade is a measure of position in the occupational hierarchy, it reflects more than experience of work. It relates to educational and social background, status, self esteem, and income and associated living conditions. The Whitehall II study measured these directly in an attempt to sort out which may be most important in generating the social gradient in ill health.

The present analyses suggest two different ways of approaching the question of the contribution of work: examining the degree to which a work based and a non-work based measure of socioeconomic position predict mortality; and examining mortality before and after presumed retirement age. Car ownership was chosen as a non-work based socioeconomic measure because it was shown to predict mortality in the Whitehall study[7] and is closely related to car access, which predicted mortality in the Office of Population Censuses and Surveys longitudinal study.[12] In 1971, when the longitudinal study began, about half the households in Britain had access to a car. In general these were the wealthier households. Car ownership therefore served well as a general socioeconomic measure.

DECLINE IN PREDICTIVE POWER OF GRADE

Pre-retirement, employment grade (the work based measure), and the non-work measure independently predicted mortality. After retirement the ability of the general social measure to predict declined less than the predictive power of the work based measure. This decline in predictive power of employment grade seems more compatible with an effect of retirement than of diminution with age given the lack of an age grade interaction before retirement and the shallow diminution with age of the grade association after retirement.

This comparison of grade and car ownership needed to take into account the fact that there were four employment grades but only two car ownership groups. Other things being equal, comparing smaller extremes of a distribution will give apparently greater predictive power than comparing two halves. We therefore used the relative index of inequality, which allows direct comparison between the predictive power of the two measures by using the slope of the relation with mortality independent of the size of the groups. The

Key messages

- Socioeconomic differences in mortality persist up to age 89
- Relative differences in mortality between low and high employment grades are less after retirement, suggesting the importance of work in generating inequalities in health
- A non-work based measure of socioeconomic status (after adjustment for employment grade) continues to predict relative differences in mortality after retirement
- Absolute differences in mortality between less and more advantaged groups increase at older ages

ability of grade to predict independent of the effect of "car" declined significantly after retirement, which was not the case for car ownership independent of the effect of grade. However, the difference between the slopes was not significant and, though plausible, it is perhaps an overinterpretation to conclude that the effect of work on mortality but not that of other factors associated with socioeconomic status declines after retirement.

There is clear evidence in these data of a non-work effect. Adjusting the association of car ownership with mortality for the effect of employment grade is probably a good way to remove the effects of work. It is therefore likely that the association between car ownership and mortality after grade adjustment represents a minimum estimate of the effect on mortality of factors other than those associated with work. The reverse is not the case. Adjusting the grade-mortality association for "car" does not mean that the residual association is all due to work, though some of it is likely to be. The problem in separating the effect of work from other influences associated with social position is that grade is a guide to work and social circumstances outside work, but not all of these non-work effects are summed up in the car ownership measure.

There are two conclusions to be drawn from these analyses. Firstly, important socioeconomic differences in mortality persist beyond retirement age, at least up to age 89. On an absolute scale these differences increase with age. Secondly, social differentials in mortality based on an occupational status measure decrease after retirement whereas those based on a non-work measure seem to decline less. This suggests that, alongside other socioeconomic factors, work itself may play an important part in generating social inequalities in health in men of working age. We cannot conclude from these data that improving socioeconomic circumstances of older people would necessarily reduce social differentials in mortality. There are, however, other reasons for believing that this is a desirable policy objective.

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Xylitol chewing gum in prevention of acute otitis media: double blind randomised trial

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Abstract

***Objective*—To examine whether xylitol, which reduces the growth of *Streptococcus pneumoniae*, might have clinical importance in the prevention of acute otitis media.**

***Design*—A double blind randomised trial with xylitol administered in chewing gum.**

***Setting*—Eleven day care nurseries in the city of Oulu. Most of the children had had problems with recurrent acute otitis media.**

***Subjects*—306 day care children: 149 children in the sucrose group (76 boys; mean (SD) age 4.9 (1.5) years) and 157 in the xylitol group (80 boys; 5.0 (1.4) years).**

***Intervention*—Either xylitol (8.4 g a day) or sucrose (control) chewing gum for two months.**

***Main outcome measures*—The occurrence of acute otitis media and antimicrobial treatment received during the intervention and nasopharyngeal carriage of *S pneumoniae*.**

***Results*—During the two month monitoring period at least one event of acute otitis media was experienced by 31/149 (20.8%) children who received sucrose compared with 19/157 (12.1%) of those receiving chewing gum containing xylitol (difference 8.7%; 95% confidence interval 0.4% to 17.0%; P = 0.04). Significantly fewer antimicrobials were prescribed among those receiving xylitol: 29/157 (18.5%) children had at least one period of treatment versus 43/149 (28.9%) (difference 10.4%; 0.9% to 19.9%; P = 0.032). The carriage rate of *S pneumoniae* varied from 17.4% to 28.2% with no difference between the groups. Two children in the xylitol group experienced diarrhoea, but no other adverse effects were noted among the xylitol users.**

***Conclusion*—Xylitol seems to have a preventive effect against acute otitis media.**

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Introduction

Xylitol is a polyol sugar alcohol and is referred to as birch sugar because it can be produced from birch trees. Natural sources of xylitol include plums, strawberries, raspberries, and rowan berries.[1] Xylitol has the same