

## **SOCIAL CLASS DIFFERENCES IN MORTALITY IN GREAT BRITAIN AROUND 1981**

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### **1. INTRODUCTION**

THE Decennial Supplement on Occupational Mortality published in 1978 commented on mortality differences between the social classes (Chapter 8) using data from the 1971 Census and the deaths in the period 1970-72.<sup>(1)</sup> The analysis was based on life tables prepared for the individual social classes from which derived indices, for example expectations of life, were calculated. It is proposed here to repeat this exercise using the data for males recently published in microfiche form by the Office of Population Censuses and Surveys—OPCS.<sup>(2)</sup> This time, the Decennial Supplement has omitted to provide an analysis and commentary and we propose to make some attempt to remedy this deficiency. In our analysis, the Decennial Supplement data have been supplemented by data from the OPCS Longitudinal Study.

The plan of the paper is as follows. Section 2 considers the definition of social class. Sections 3 and 4 describe in detail the nature of the occupational mortality data available from the two sources: the Decennial Supplement and the Longitudinal Study. Section 5 describes the construction of the life tables for specific social classes from the data available. Section 6 describes results, with particular reference to mortality differentials between the social classes. Section 7 looks at the difficulties of interpreting the results and §8 provides some conclusions.

### **2. DEFINITION OF SOCIAL CLASS**

The definition of social class used in the demographic statistics collected routinely by OPCS is based solely on occupation, as follows:

- I professional occupations
- II employers and managers
- IIIN skilled non-manual occupations
- IIIM skilled manual occupations
- IV semi skilled occupations
- V unskilled manual occupations.

The use of social classes by the Registrar General can be traced back to

William Farr who recognized the advantages to be gained by examining mortality rates for the limited number of broad population groups.<sup>(3)</sup> He compared the experience of men in the professional class, domestic class, agricultural class, industrial class and the indefinite and non-productive class.

The traditional reason for using occupation, as the basis of a social class definition, is that it is the single objective attribute which is most easily, most widely and most accurately recorded. In the case of death certificates, former occupation is the only indication of social class available at registration and so adopting this narrow definition of social class is the only practical way of proceeding.

Social class, however, in modern society is a multi-dimensional concept. If the term is used to represent total lifestyle or mode of living, a number of characteristics should be considered alongside occupation, for example, housing tenure, home amenities, number of cars, diet, educational status, area of residence, income, working conditions. Some of the characteristics listed are recorded at censuses and hence may be investigated, others are more difficult to classify or to measure or, even if measurable, impossible to obtain (e.g. income).

If we are to rely solely on occupation for our definition of social class, then we must implicitly assume that all the other factors contributing to the measurement of total lifestyle and with a potential influence on mortality are associated with occupation in the same general direction. This assumption must be remembered when conclusions are drawn.

### 3. DECENNIAL SUPPLEMENT

As indicated above, there are two distinct sources of data available on occupational and social class mortality. In this section, we consider the Decennial Supplement investigation of occupational mortality.

After each Census, a Decennial Supplement is published which investigates the variation of mortality rates by occupation (and by social class).

For a proper study of occupational mortality, we would require: (a) the number of deaths (from each cause) by age and sex in each occupation (and by duration of employment in the occupation if possible); and, (b) the relative population at risk, similarly classified. On a national basis, it is not practicable to obtain information on duration of employment in an occupation either at a Census or at a death registration. Occupational details are recorded at the Census and this enables populations at risk in particular occupations (and hence social classes), applicable at the Census date (or nearby times), to be derived. The occupation of a deceased person is routinely provided by the 'informant' at death registration. It is usual to combine three or five years' deaths in the investigation in order to provide a sounder basis for analysis, hence minimizing the number of occupations about which inferences may be based on few deaths.

An important advantage of the Decennial Supplement approach to occupational mortality is that the study is based on a large number of deaths so that the

derived mortality indices have relatively low standard errors. Also the volume of data means that analyses by specific causes of death, as well as for the more detailed occupational units, can be carried out.

The interpretation of occupational mortality data from Decennial Supplements is very difficult and is hindered by what have been called 'numerator-denominator' biases (i.e. lack of correspondence between numerator and denominator) in the specific mortality rates.<sup>(1)</sup> These biases arise because this type of investigation necessitates the bringing together of two distinct sources of data, viz. the Census and the death certificate, which are completed in different ways. Thus, whereas an individual may fill in his own occupation on a Census form, the 'informant' registering the death may be unfamiliar with the work performed or the appropriate, specific job title.

It is not proposed to provide a full discussion of these biases here; however, we give below a list of the principal factors leading to difficulties of interpretation:

1. Vagueness in the entry of occupation in Census returns and death registrations makes the coding difficult. It is usual for a Census to request more detailed information on employment than at death registration. The effect is that a disproportionate number of deaths are classified in what could be described as the residual occupation groups (i.e. the less specific job titles).
2. The tendency for informants to give erroneous occupations for the deceased causes problems. One such aspect concerns occupations which may be regarded as prestigious, particularly if they involve earlier retirement than is normal. Often at death registration the informant will report this prestigious post rather than the last occupation, presumably because this is how they remember the deceased or how they wish to remember the deceased.<sup>(1)</sup> Such problems apply, for example, to the Armed Forces, policemen, firemen, pilots, coal miners. Although such reporting of 'main' occupation may be more relevant than last occupation in terms of mortality experience (see below), this raises problems for analysis when carried out inconsistently and to an unknown extent.
3. The misreporting of occupation at death, involving the 'promotion' of the deceased, for example a technician being described as an engineer, is a potential problem although there is little evidence that this is a serious or common practice.<sup>(1)</sup>
4. The Census has limitations in that seamen and fishermen who were out of the country are undercounted. Mortality for these occupations may thus be artificially raised although the degree and even existence of such undercounting is debatable and may be balanced by a deficit in the recording of the number of deaths.<sup>(1)</sup>

Apart from these statistical problems with the data, further difficulties in the interpretation of mortality differentials arising from the Decennial Supplement type of study are caused by the lack of information on duration of employment

and the presence of selection. These two sources of distortion are discussed briefly below.

At death registration, the occupation to be recorded is the last full-time employment followed by the deceased. There is no mention of duration in that job or in previous jobs. This is of particular relevance when considering hazards that may have a long latency period so that an occupation followed by the deceased many years before his death may be more relevant than that followed at the time of death.

A particular case of distortion from the use of last occupation can arise when the reason for the deceased's change of occupation was ill-health. This is one example of selective, health-related movements between occupational groups and in and out of the labour force. Thus, selection can operate on entry into an occupation (the 'healthy worker effect') and/or on withdrawal from an occupation. Individuals may become promoted during their lifetime and this upward mobility may involve, for example, a move from social class IIIN to social class II. Also, individuals may become sick or disabled and may have to take on less exacting and less highly-graded jobs. An occupation may show a high mortality not because it is hazardous but because it contains a high proportion of persons suffering chronic illness or having a predisposition to illness. Conversely, occupations requiring a high standard of health or fitness may appear favourable in mortality statistics, partly because the participants were initially fitter and healthier than average and partly because those not maintaining that standard of health may have to find alternative employment.<sup>(4)</sup>

These difficulties can apply to the interpretation of mortality indices specific for social class, as well as for occupation.

#### 4. LONGITUDINAL STUDY

The OPCS Longitudinal Study is a completely different type of investigation from the Decennial Supplement study. As its name suggests, it is an example of an investigation where samples of people are followed through time and changes in their circumstances are recorded.

The initial cohort in this study is derived from 1971 Census records and numbers about half a million people—approximately 1% of the population of England and Wales. The most convenient way of achieving this sampling fraction was by including people born on 4 pre-selected days of the year. This also facilitated the linkage of different types of demographic records. The study is intended to continue to represent, as time goes by, the population as a whole so that births after the 1971 Census and immigrants after the 1971 Census are also included, using the same sampling basis.

Because date of birth is used to select the sample, the study is restricted to those record systems which routinely record date of birth. Thus, marriage and divorce are omitted. However, below is a complete list of the records incorporated in the OPCS Longitudinal Study:

- (i) the National Health Service Central Register;
- (ii) 1971 Census;
- (iii) 1981 Census;
- (iv) birth registration (for people born on sample dates after the 1971 Census);
- (v) children's birth records (for children born after April 1971 to sample members);
- (vi) children's stillbirth records (for children born after April 1971 to sample members);
- (vii) children's death records (for children of sample members who died after 1971 Census aged less than 1 year at death);
- (viii) movements recorded by the National Health Service Central Register;
- (ix) immigration;
- (x) emigration;
- (xi) entry into long-stay psychiatric hospital;
- (xii) cancer registers (for sample members who were registered as suffering from cancer after 1970);
- (xiii) death records of spouses (for spouses of sample members who died after April 1971);
- (xiv) death registration.

A fuller description of the Longitudinal Study is provided by Fox and Goldblatt.<sup>(5)</sup>

For our purposes, there are two important differences between the Longitudinal Study (linked) and Decennial Supplement (unlinked) approaches to the calculation of mortality rates. Firstly, as noted in the previous section, an important weakness of the unlinked approach as used in occupational mortality investigations comes from 'numerator-denominator' biases. These result from the separate, independent classification of individuals on the basis of information about them, collected from different people in entirely different situations (for example at a Census and at death registration). The linked, prospective nature of the Longitudinal Study facilitates the calculation of mortality rates according to individuals' characteristics (e.g. occupation) as recorded at a single event (e.g. 1971 Census). Since the death record for an individual is linked to that individual's Census record, the same characteristics (e.g. occupation) can be assigned to deaths as to the population at risk. Secondly, the Decennial Supplement uses a mid-year estimate of the population at risk in the calculation of mortality rates whereas the Longitudinal Study is able to provide a more accurate estimate of the exposed to risk. This difference of approach becomes important when examining mortality rates for subgroups of the population with irregular age structures.

As Benjamin and Pollard,<sup>(6)</sup> amongst others, have noted, longitudinal studies represent a "more profitable development for future research" than cross-sectional studies. This arises because of the difficulty of extending any evidence of

association between social factors (like occupation) and mortality to causative hypotheses and because of the long chain of events that might lead up to death. Longitudinal studies enable the first symptoms of disease to be observed in those initially free of disease so that the point of observation is much closer to the actual conditions associated with the incidence of disease. Thus, in the long-term, the OPCS Longitudinal Study should be able to provide information on occupational mortality and health, allowing analysis by previous occupations and the last occupation prior to death.

Further, the linked approach to mortality of the Longitudinal Study enables one to study the rate at which the effects of selection wear off over time and can thus indicate the extent to which the measured mortality of a particular population sub-group is biased (see § 3). Hence, it is possible to assess the role of selection in the mortality differentials observed. Selection is discussed in detail by Fox and Goldblatt.<sup>(5)</sup>

#### 5. CONSTRUCTION OF LIFE TABLES

The OPCS social class classification (described in § 2) was condensed to produce three composite classes:

- (a) social classes I & II;
- (b) social classes IIIN & IIIM;
- (c) social classes IV & V.

This grouping was carried out in order to produce three classes of approximately equal size and in order to avoid the presence of groups with an uneven age structure (e.g. social class I on its own). It is believed that such a grouping does not unduly increase the level of heterogeneity in the classes under comparison. However, we shall return to a consideration of the composition of the social classes and the underlying trends in § 7. There, it will be noted that social classes I and II have been particularly affected by changes in composition, thus increasing the desirability of forming a composite group.

As noted earlier, there are two distinct sources of data on the mortality of the population subdivided by social class. The first source is the classical study of occupational mortality reported after each Census in the Decennial Supplement. Here, the numbers of deaths in a period around the Census (subdivided by sex, age and occupation at death) are related to a measure of persons exposed to risk based on the Census count (and subdivided similarly).

From the Decennial Supplement the following data for males in Great Britain were obtained: population at the 1981 Census subdivided by social class at Census and attained age at Census (in groups: 20–24, 25–34, 35–44, 45–54, 55–64) based on a 10% sample; numbers of deaths in the four calendar years 1979, 1980, 1982 and 1983 subdivided by social class and attained age at death registration. (Figures are not available for 1981 because of an industrial dispute.)

The small numbers in some of the social classes at ages 16–19 have persuaded us to omit this age group from consideration.

Retired people are assigned to a social class if an adequate description of their former occupation is given on the Census form and at death registration. The proportion of men recorded as retired without mention of their last occupation differs between the 1981 Census and the death registration data for ages over 65. For this reason, the analysis by occupation of mortality rates at these ages from the Decennial Supplement would be suspect and hence is excluded from this study.

Table 1 shows the population of males at the 1981 Census based on a 10% sample, subdivided by age and social class, and the total numbers of deaths in the four calendar years, similarly subdivided.

At the 1981 Census, students were classified as unoccupied and so are excluded from the social class classification. This exclusion partly explains the small percentage of men from social classes I & II in the age range 20–24.

The data described above were used to produce grouped central mortality rates ( ${}_n\dot{m}_x$ ) for males for the three composite social classes using the formula:

$${}_n\dot{m}_x = \frac{{}_n\theta_x}{40{}_nE_x}$$

where  ${}_n\theta_x$  are the observed deaths in 1979, 1980, 1982 and 1983 with ages at death in the range  $(x, x+n)$  and  ${}_nE_x$  is the exposed-to-risk based on the 10% sample of the 1981 Census population. Hence, the factor '40' is used to uprate the sample data and reduce the numerator to annual terms.

Table 1. *Population numbers at 1981 Census and numbers of deaths for decennial supplement for G.B.—males*

Social Class	Population numbers at 1981 Census (10% sample)—age					Total 20–64
	20–24	25–34	35–44	45–54	55–64	
I & II	29,312 (7.2%)	112,667 (27.6%)	103,498 (25.3%)	88,808 (21.7%)	74,188 (18.2%)	408,473
IIIN & IIIM	90,040 (13.6%)	174,737 (26.3%)	145,898 (22.0%)	132,367 (19.9%)	121,085 (18.2%)	664,107
IV & V	44,782 (14.1%)	70,782 (22.3%)	59,181 (18.7%)	66,737 (21.0%)	75,713 (23.9%)	317,195
Numbers of deaths (1979, 1980, 1982, 1983)—age						
I & II	680	2,748	5,358	16,324	42,233	67,343
IIIN & IIIM	2,847	5,779	11,416	34,554	94,992	149,588
IV & V	2,143	3,912	6,907	22,913	70,114	105,989

The second data source is the OPCS Longitudinal Study. The following data were made available on microfiche: person-years exposed-to-risk and numbers of deaths for males subdivided by calendar year (1971–81 inclusive), social class and attained age (in quinquennial age groups: 20–24, 25–29, . . . , 80–84, 85 and over). Again, ages under 20 were excluded. The data for the full 1971–81 period are shown in Table 2.

As for the Decennial Supplement, students have been excluded. It should be noted that social class for the cohort in the Longitudinal Study refers to that recorded at the 1971 Census. Retired males in this study are assigned to a social class if an adequate description of their former occupation is given on the 1971 Census form (regardless of whether they are contributing to the numerator or the denominator of the mortality rate or both). If no adequate description is given, they have been excluded from this analysis. (This excluded group represents 1·6% of the sample in 1971 and 3·2% in 1981.) It is thus possible to have credible mortality rates for men specific to social classes at ages over 65.

These data were used to produce grouped central mortality rates for males for the three composite social classes, using the formula:

$${}_n\hat{m}_x = \frac{{}_n\theta_x}{{}_nE_x}$$

where  ${}_n\theta_x$  are the observed deaths from the particular period chosen from the Longitudinal Study investigation and  ${}_nE_x$  is the corresponding number of person-years exposed-to-risk, relating to ages at death in the range  $(x, x+n)$ .

Table 2. *Numbers exposed-to-risk and numbers of deaths for OPCS longitudinal study—males—1971–81*

Age	Numbers exposed-to-risk (person years)			Numbers of deaths		
	Social Class			Social Class		
	I & II	III N & M	IV & V	I & II	III N & M	IV & V
20–24	9,373	53,607	24,386	6	32	21
25–29	27,131	86,378	36,048	20	53	35
30–34	37,056	84,864	34,240	26	71	42
35–39	37,151	76,679	31,702	33	107	59
40–44	38,349	73,873	31,441	78	177	98
45–49	39,320	74,037	33,449	139	332	189
50–54	38,960	74,863	36,976	265	603	358
55–59	36,034	68,228	37,966	397	960	597
60–64	31,925	59,493	37,740	595	1,346	907
65–69	25,223	49,039	35,239	791	1,908	1,474
70–74	16,560	33,047	26,142	856	2,032	1,703
75–79	9,596	18,627	14,200	789	1,778	1,444
80–84	5,074	8,797	6,015	642	1,292	913
85 & over	2,726	4,186	2,588	517	998	633



These calculations were carried out for the full decade's data from the Longitudinal Study (1971–81) and separately for the more recent quinquennium (1976–81).

Thus, for each of the three composite social classes, three sets of grouped age-specific central mortality rates were calculated:

- (a) from the Decennial Supplement 1979–83 (but truncated at age 65);
- (b) from the Longitudinal Study 1971–81;
- (c) from the Longitudinal Study 1976–81.

From these grouped central mortality rates  $s\hat{m}_x$ , central mortality rates were calculated by single year of age at pivotal ages using the approximation:

$$s\hat{m}_x \doteq \hat{m}_{x+2}.$$

These were plotted on a semi-logarithmic scale and from these, smooth graduated mortality rate curves were drawn for the ages 20 to 65, extended to age 85 on the basis of the shape of the Longitudinal Study rates and then further extended up to age 112 (Figures 1, 2 and 3). Two constraints were applied:  $m_{112}$  was fixed at 2.0 and  $m_{105}$  was made as close as possible to .65. These constraints were employed in the spline graduations of English Life Tables No. 14<sup>(7)</sup> which relate to the period 1980–82 and all males (and all females separately). The male life table provides a useful reference point in this exercise. For reasons of consistency and convenience, these two constraints have been adopted here. (They have little numerical effect on the indices derived from the life tables.)

Thus, the mortality rates from the Longitudinal Study have been used as a basis for extrapolating the Decennial Supplement rates. This approach, although indirect, has the advantage of using the linked statistical information of the Longitudinal Study which, when referring to the social class assignment of males dying in retirement, is more reliable than a classification based on two separate sources of data (as in the Decennial Supplement). This has been discussed fully in §§ 3 and 4.

The graduations were performed graphically rather than parametrically for reasons of convenience and simplicity. The level of accuracy and degree of smoothing afforded by a parametric approach was not necessary in the applications explored here. Were full social class specific life tables to be used widely, then such an approach might be justified.

The graduated central mortality rates were converted to mortality rates,  $q_x$ , at exact ages using the formula

$$q_x = m_x \frac{1 - \frac{1}{2}m_{x-1}}{1 + \frac{5}{12}(m_x - m_{x-1}) - \frac{1}{6}m_{x-1} \cdot m_x}$$

This formula is exact if  $l_t$  is quadratic over the age interval  $[x-1, x+1]$ . This algorithm was used in the construction of English Life Tables No. 14 and again we have adopted the same approach for consistency.

Three social class specific life tables were then constructed in the conventional

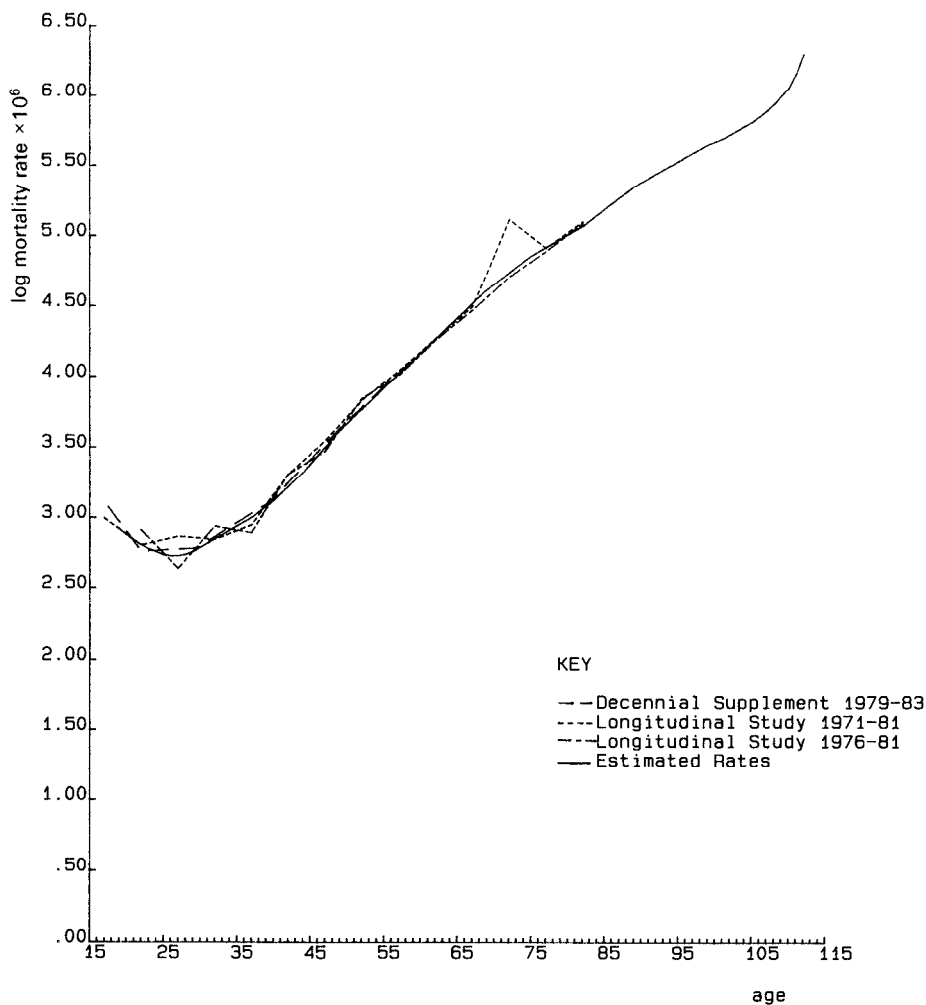


Figure 1. Age-specific mortality rates for social classes I & II.

way using a radix of  $l_{20} = 10,000$ . The complete expectation of life was then calculated according to the following classical approximate formula:

$$e_x = \frac{1}{2} + \sum_{t=1}^{112-x} \frac{l_{x+t}}{l_x}$$

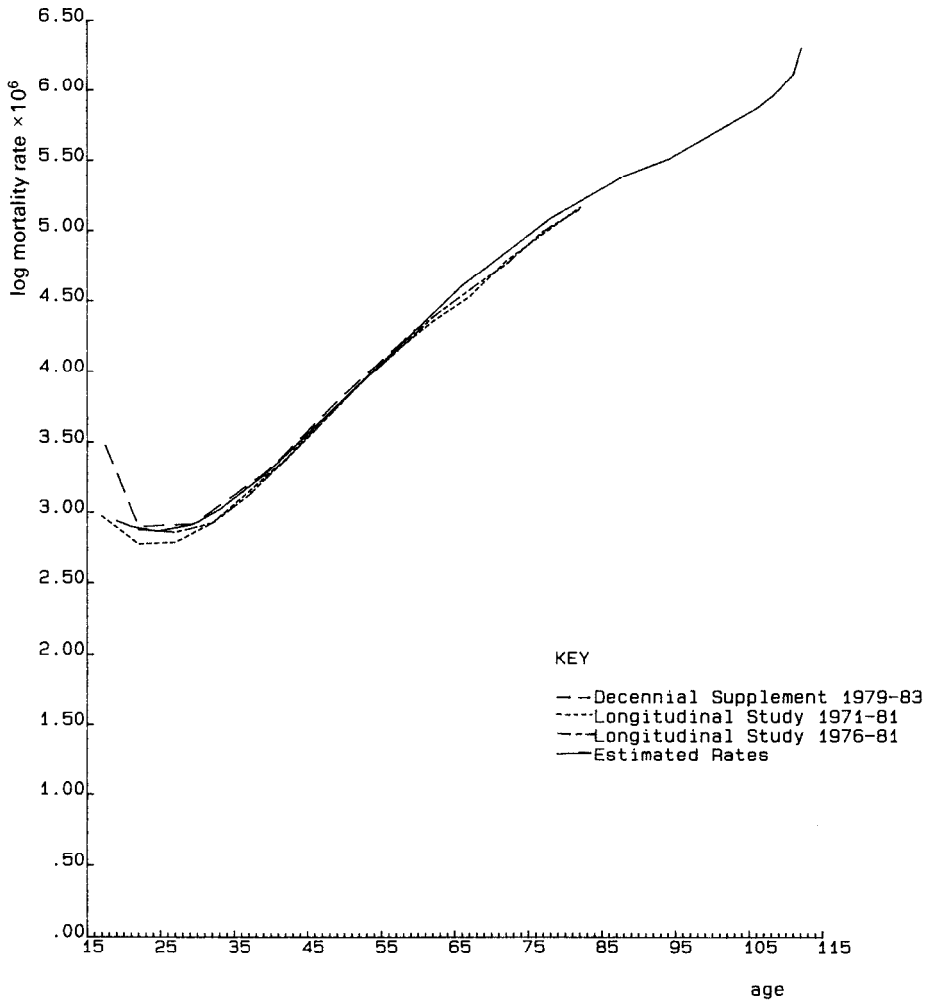


Figure 2. Age-specific mortality rates for social classes IIIN & IIIM.

The extrapolations were checked, by comparing the values of  $e_{85}$  in these life tables with the value in English Life Tables No. 14 (males) and with those values predicted by Horiuchi and Coale's approximate method:

$$\frac{1}{e_{85}} = M(85 + ) \exp \left[ \frac{\beta r(85 + )}{M(85 + )^\alpha} \right]$$

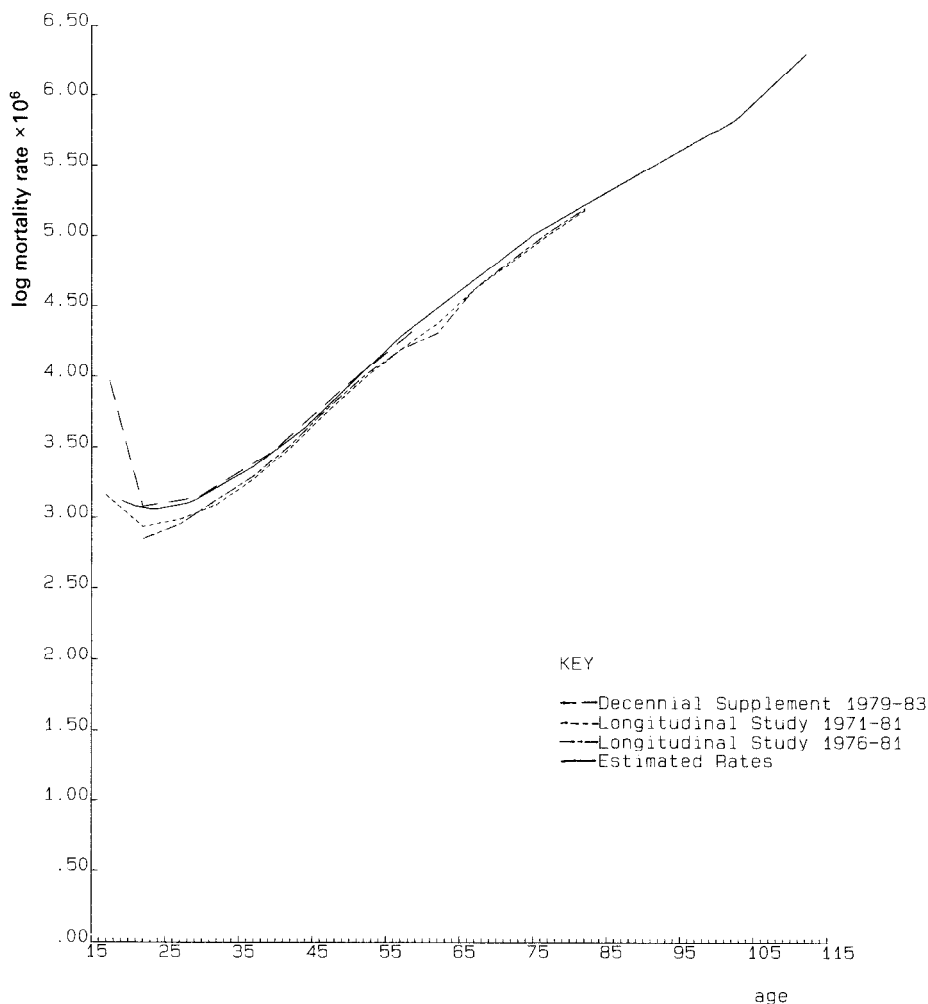


Figure 3. Age-specific mortality rates for social classes IV & V.

where  $\alpha$  and  $b$  are regression parameters estimated by Horiuchi and Coale,<sup>(8)</sup>  $M(85+)$  is the observed death rate for those aged over 85 and  $r(85+)$  is the intrinsic rate of natural increase for the population aged over 85 which is assumed stable, for the purposes of this approximation. Using the OPCS Longitudinal Study data for 1971-81 and 1976-81, it is possible to calculate  $M(85+)$  and  $r(85+)$  and hence possible to compare the values of  $\ell_{85}$  from the

Table 3. *Comparison of  $\hat{e}_{85}$  values from graphical extrapolation with those obtained theoretically from longitudinal study data*

Social classes	Estimates of $\hat{e}_{85}$		
	Graphical $\hat{e}_{85}$	Horiuchi and Coale's method	
		Using 1971-81 Long. study	Using 1976-81 Long. study
I & II	4.72	5.10	5.32
IIIN & M	4.33	4.08	4.31
IV & V	3.96	3.94	3.86

three life tables with those predicted by the above method. The results in Table 3 indicate that the values of  $\hat{e}_{85}$  do not differ markedly from those predicted by this independent method.

Mitra's improved method of estimating  $\hat{e}_x$  is not feasible here, since it would require the average age of those aged 85 and over, which is not easily available.<sup>(9)</sup>

The value of  $\hat{e}_{85}$  from English Life Tables No. 14 (males) is 4.345. This is consistent with the values of 4.72, 4.33, 3.96 produced here for the three social class groupings (Table 3).

Both the Decennial Supplement and the Longitudinal Study treat unoccupied and permanently sick men separately from those in occupations. In § 7 this is discussed further, but for the moment it should be noted that both sources effectively have a residual group of men 'not classified by social class'. This is worth noting because the three composite social classes used here may not add up to the total population so that comparison between our results and those of English Life Tables No. 14 is not wholly valid though this error is probably not significant.

A further caveat concerns the nature of a life table which is necessarily given a cohort interpretation. The life tables constructed here provide a summary of age-specific mortality data for males in the three composite social classes. It should be noted that the life tables, and any derived indices, should be interpreted on the assumption that a man will be subject throughout his future life to the derived mortality rates for the appropriate composite social class.

## 6. RESULTS—MORTALITY DIFFERENTIALS

Figures 1, 2 and 3, as mentioned above, show the age variation in mortality rates for each of the three composite social classes. From the three resulting life tables that have been constructed, Figures 4 and 5 have been drawn.

Figure 4 shows the number of survivors at ages up to 100, expected from each life table arising from an initial group of 10,000 at age 20. The curve of survivors from social classes IV & V drops below the other two curves after age 23, remaining below them for the rest of the age range. The curves for social classes I & II and social classes IIIN & IIIM diverge at age 26. The latter remains

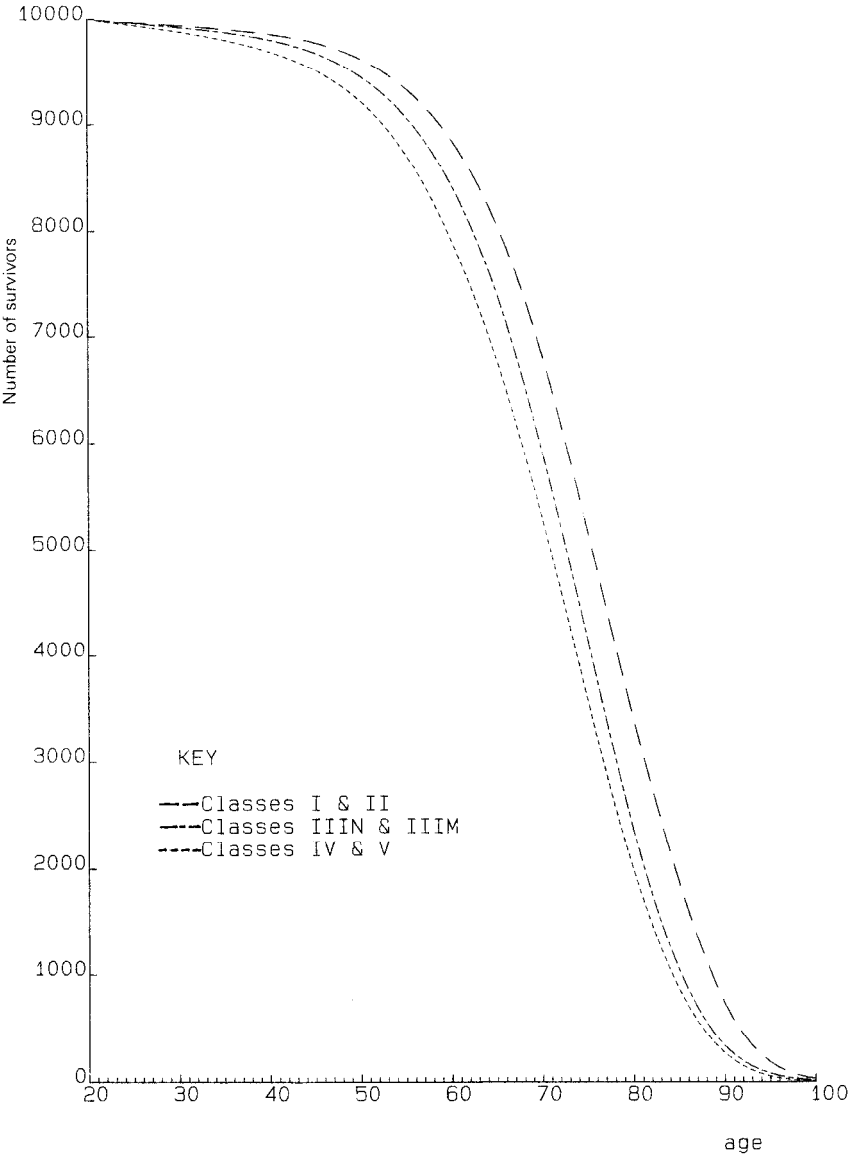


Figure 4. Survival curves ( $l_x$ ) from the life tables for the three composite social classes.

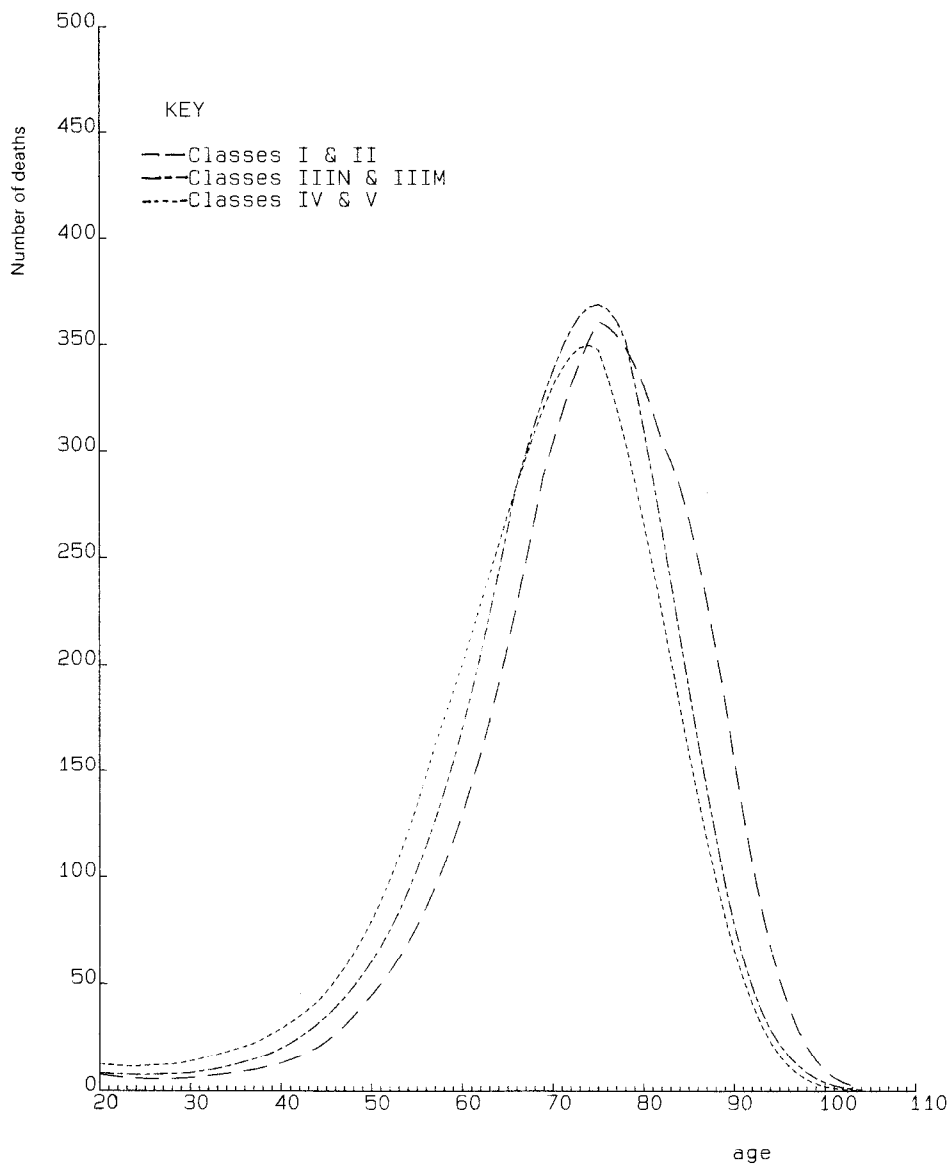


Figure 5. Curves of deaths ( $d_x$ ) from the life tables for the three composite social classes.

sandwiched between the curves for social classes I & II and IV & V, moving closer to the curve for social classes IV & V in old age.

Figure 5 shows the distribution of the numbers of deaths over the range extending up to age 105. These 'curves of deaths' have the familiar skewed appearance. The curve for social classes IV & V is shifted more to the left with a younger modal age, indicating an earlier distribution of deaths than the other two composite classes.

Table 4 contains some of the key indices extracted from the three full life tables. The expectation of life figures indicate that a man aged 20 in social classes I or II can expect to live 3.01 years longer than a counterpart in social classes IIIN or IIIM and 5.06 years longer than a 20 year old man in social classes IV or V. The difference between social classes IIIN & M and social classes IV & V is 2.00 years. This represents an excess expectation of life over that for social classes IV & V of 4.1% for social classes IIIN and IIIM and 10.2% for social classes I & II.

At age 65, the expectations of life indicate that a man in social classes I or II can expect to live 1.93 years longer than one in social classes IIIN or IIIM and 2.43 years longer than a man in social classes IV or V. Thus, the expectation of life at age 65 for classes I and II is 21.5% longer than for social classes IV & V. For social classes IIIN & IIIM the excess expectation of life over that for social classes IV & V is 4.4%. These relativities at age 65 of 21.5% and 4.4% are wider than the corresponding relativities at age 20. This indicates the extent to which the social class differences in mortality persist throughout life and in particular the importance of such differences beyond normal retirement age.

Pollard has suggested a scientific method of apportioning the difference between two expectations of life across the underlying age span.<sup>10</sup> His method enables one to analyse the difference between two social class specific expectations of life. An outline of his method is given in the Appendix. The method has been applied to the expectation of life figures at age 20 for the three composite social classes. The expectation of life indices used are truncated at age 105. This has been done because the calculations for Pollard's method are made easier with

Table 4. *Selected statistics from the social class life tables*

	Social classes			English Life Tables No. 14. All males
	I & II	IIIN & IIIM	IV & V	
1. Complete expectation of life at age 20 $\hat{e}_{20}$	54.23	51.22	49.22	52.496
2. Probability of survival from age 20 to age 65 $l_{65}/l_{20}$	.805	.740	.677	.759
3. Age of median survival from age 20	75.4	72.6	70.9	74.2
4. Complete expectation of life at age 65 $\hat{e}_{65}$	13.73	11.80	11.30	13.036
5. Probability of survival from age 65 to age 75 $l_{75}/l_{65}$	.641	.559	.528	.621
6. Age of median survival from age 65	78.2	76.2	75.5	77.6



Table 5. *Differences in expectation of life at age 20*

Age	I & II v. IV & V	I & II v. IIIN & IIIM	IIIN & IIIM v. IV & V
20-24	·13	·03	·10
25-29	·15	·05	·10
30-34	·18	·06	·12
35-39	·23	·09	·13
40-44	·29	·14	·15
45-49	·37	·18	·19
50-54	·51	·24	·27
55-59	·68	·33	·34
60-64	·68	·43	·26
65-69	·59	·45	·15
70-74	·51	·38	·13
75-79	·39	·36	·05
80-84	·23	·23	·01
85-89	·08	·07	·01
90-94	·02	·01	·01
95-99	·00	·00	·00
100-104	·00	·00	·00
	<u>5·04</u>	<u>3·05</u>	<u>2·02</u>

grouped ages (here quinquennial age groups) and because the three life tables terminate soon after age 105. The results are shown in Table 5. Looking firstly at the differences between social classes I & II and IV & V in column 1, we see that, of the 5·04\* overall difference, 20% is attributable to ages 20-44, 44% to ages 45-64, 34% to ages 65-84 and 2% to ages 85 and over. The summary figures are repeated below with those for the other two comparisons:

	I & II v. IV & V	I & II v. IIIN & M	IIIN & M v. IV & V
20-44	20%	12%	30%
45-64	44%	39%	52%
65-84	34%	46%	17%
85 and over	2%	3%	1%
	<u>100</u>	<u>100</u>	<u>100</u>

These indicate that the first two composite groups have expectations of life at age 20 which differ primarily because of mortality differences at ages 45-84. However, there is a sizeable contribution to the difference between social classes IIIN & M, and IV & V from mortality differences at ages 20-44.

Table 4 also compares the ages of median survival from age 20 (defined to be the age  $y$  such that  $l_y = \frac{1}{2}l_{20}$ ), the ages of median survival from age 65 and the probabilities of surviving from age 20 to normal retirement age and from normal retirement age for a further ten years.

\* The differences in Table 5 differ from those reported in Table 4 because of rounding.

The probability of surviving from age 20 to age 65, relative to that of social classes I & II is .919 for social classes IIIN & M, i.e. their probability is 91.9% of that of classes I & II and is .841 for social classes IV & V.

Similarly the relative probabilities of surviving for ten years beyond normal retirement age is .872 for classes IIIN & M and .824 for classes IV & V.

Life tables are available from the 1970–72 Decennial Supplement on Occupational Mortality.<sup>(1)</sup> These provide a benchmark for comparison although the published indices are not always in directly comparable form. The previous study used age 15 as a radix rather than age 20. Unfortunately,  $l_x$  was only published at ages 15, 45, 55 and 65 in the 1970–72 Decennial Supplement. However, a graph was also published which enables one to estimate approximately  $l_{20}$  for the five social classes. (The original source data are not available.) With these estimates (albeit crude), it is possible to construct the estimates in Table 6.

Comparison of the two halves of Table 6 suggests that the probabilities of survival have changed little over the last decade for social classes IV & V. For social classes IIIM & N, there have been improvements. For social classes I & II the improvements are noticeable, with the current probability of survival from 20 to 65 being higher than that for social class I *alone* ten years previously by a factor of about 3% and also being higher for ages 45 to 65 by a factor of about 3%. Conversely, the probabilities of death between ages 20 and 65 and between ages 45 and 65 are lower by a factor of about 12%.

These comments suggest that, in the decade between Decennial Supplements, the social class differentials in mortality have widened.

Table 6. 1970–72 decennial supplement on occupational mortality—  
comparison with derived statistics for the period around 1981

Social class	1970–72 Decennial supplement—probability of surviving—age		
	20–65	20–45	45–65
I	.778	.973	.799
II	.769	.972	.791
IIIN	.730	.965	.756
IIIM	.709	.965	.735
IV	.699	.957	.730
V	.648	.936	.692
1981 Derived indices—probability of surviving—age			
I & II	.805	.977	.824
IIIN & M	.740	.967	.765
IV & V	.677	.951	.712

On expectations of life, the 1970-72 report produced two sets of figures. Assuming no social class differences beyond age 65,  $e_{15}$  was estimated to be as follows:

	years
I	57.2
II	57.0
IIIN	56.0
IIIM	55.7
IV	55.1
V	53.5

Thus, the expectation of life for social class I was 6.9% higher than that for social class V. Assuming that men in social class I were subject to mortality rates at ages over 65 that were 20% lower than those for all men at these ages and that men in social class V were subject to rates that were 20% higher than those for all men, the figures were estimated as 58.6 for social class I and 52.7 for social class V, a relative difference of 11.2%.

The results shown earlier (Table 4) for this latest investigation indicate a relative difference of 10.2% in the expectation of life at age 20. Because of the lack of precision in the earlier results, it is not possible to confirm the picture of a widening mortality differential over the decade since the previous investigation.

## 7. SOCIAL CLASS CLASSIFICATION AND INTERPRETATION DIFFICULTIES

It is important in making inferences from the analyses in this paper to note certain features of the data used and the underlying classification by social class.

Firstly, there are the problems associated with the investigations into occupational mortality reported in the Decennial Supplements and discussed in § 3. These investigations are of the classical type where deaths in a period are related to a measure of the central exposed-to-risk. For the deaths the social class category refers to that reported at death whereas for the exposed-to-risk the social class category is that reported at the Census. This difference in meaning of social class leads to 'numerator-denominator' biases when mortality rates specific to social class are calculated.<sup>(1)</sup> As discussed in § 4, the Longitudinal Study data do not suffer from these biases as the data relate to a cohort followed up since the 1971 Census and the social class category (for both deaths and exposed-to-risk) is that recorded at the 1971 Census.

Secondly, there is evidence that the 1981 Decennial Supplement is more affected by 'numerator-denominator' biases than earlier Supplements.<sup>(2)</sup> This makes the use of social class mortality indices "suspect for anything other than internal comparisons".<sup>(2)</sup> The Supplement notes that this bias is particularly extreme for social class V (where the occupation unit, labourers and unskilled workers not elsewhere classified, has a much higher level of mortality than the other class V occupations). These problems are tempered by our combining of

social classes IV & V and our use of Longitudinal Study mortality rates which are free of such biases.

Thirdly, comparisons with the earlier 1970–72 Decennial Supplement indices are hindered by various sources of distortion.

The Decennial Supplement for 1970–72 exhibited wider social class differentials than the Longitudinal Study data. This is because of the treatment of the unemployed and permanently sick. The Decennial Supplement records very low mortality indices for the unemployed and permanently sick—this is because very few deaths have occupation at death recorded as unemployed, the tendency being to quote the last known occupation while the exposed-to-risk based on the 1971 Census count does record people as unemployed. Since the unemployed and permanently sick were not assigned a specific social class at the 1971 Census, these groups are excluded completely from the Longitudinal Study data. Of course, this refers only to those unemployed and permanently sick at the 1971 Census. As time goes by and the length of follow-up in the Longitudinal Study after 1971 increases, persons in each social class become sick (with a higher incidence in the lower social classes) so mortality is raised and the mortality gradient between the social classes widens. This distortion is mitigated to some extent by our use of Longitudinal Study data over extended periods, viz. 1971–81 and 1976–81 separately.<sup>(4)</sup>

The 1981 Decennial Supplement is less affected by this problem since, at the 1981 Census, the permanently sick were assigned to a social class by reference to their former occupation, whenever an adequate description was given.

Another source of distortion is the considerable change that took place in the composition of several of the Registrar General's social classes between the 1971 and 1981 Censuses. A full discussion of this change is provided by Goldblatt's recent working paper.<sup>(11)</sup>

Briefly there are four separate effects, relating to men.

(a) *Structural changes in the labour force*

During the decade, there were large structural changes in the labour force resulting mainly from a fall in the number of men employed. This fall was greatest in heavy industry and so mainly affected social classes IIIM, IV & V. Men in these classes were thus more likely to be classified at the Census as seeking work or permanently sick.

(b) *Changes in the types of job in which men are employed*

This effect, linked to (a), involved a shift from jobs with less skill, responsibility or a manual aspect to jobs which were non-manual, required an educational qualification or other skill, or carried some form of responsibility. The net effect was to increase the size of class I (more engineers and scientists) and to increase the size of class II (more in the education professions and more managers). Class IIIN experienced a small fall because there were fewer men in routine clerical jobs. Class IIIM changed its composition because there were more foremen and fewer men in non-craft jobs. The decline in the latter category leads to class IV

and in particular class V experiencing net losses (the latter declining by about 47%<sup>(11)</sup>).

(a) and (b) are real effects. These are masked by two classification effects.

(c) *Change from 1970 to 1980 Classification of Occupations*

The net effects here were to increase the size of class II and to increase a little the size of class IIIN. Classes IV & V changed little in terms of size but there is a substantial effect in terms of turnover.

(d) *Classification of permanently sick*

As noted above, the permanently sick are coded at the 1981 Census if an adequate occupational description is provided. As a result, 61% were classified to a social class, with most allocated to social class V. Had this not been done, the degree of distortion would have been worse than in 1971 because a major portion of the permanently sick are men who are unemployed but who also suffer from an illness or disability which they believe prevents them from seeking work—the size of the permanently sick has grown in line with increased unemployment over the last decade.

Social classes I & V, the two extremes in terms of mortality, have been particularly affected by each of the above types of change. Hence, it is reasonable to combine the classes as in this paper to form three composite groupings for comparison.

The classification changes and structural changes to the labour force do constrain the routine comparisons of trends in the mortality rates for the various social classes. Nevertheless, there is an intrinsic interest in determining which sections of the community have low mortality rates and whether or not the relative advantages have remained stable over time. Individual occupations may provide a better index of trends in mortality rates than social classes because they have been affected by classification changes to a lesser extent but they are subject to problems of small numbers, selection and bias (as discussed in § 3).

## 8. CONCLUSIONS

Using data from two separate sources, viz. the latest Decennial Supplement Occupational Mortality and the OPCS Longitudinal Study (1971–81), it has been possible to construct approximate life tables for three composite social classes. Indices from these life tables, in particular expectations of life and probabilities of survival, have been compared between the three composite social classes and with the corresponding indices from the 1970–72 Decennial Supplement on Occupational Mortality and the English Life Table No. 14 (males).

Because of the difficulties outlined in § 7, it is difficult to conclude categorically that mortality differentials between the social classes are significant statistically or have widened since 1970–72. However, there is evidence from the derived life tables constructed here of a marked difference in mortality rates between the

three social class groupings and evidence that this differential has widened since 1970–72. The indices suggest that, since 1970–72, mortality rates have fallen for social classes I & II but *not* for social classes IV & V. As noted earlier, the reasons for the apparent widening in the differentials may include the different treatment of the permanently sick at the two Decennial Supplements, structural changes in the labour force, changes in the types of job in which men are employed, classification changes, *or*, this alternatively may be a real effect.

The presence of such a mortality differential is of significance in life insurance (individual and group). In particular, the suggested absence of an improvement in mortality rates over the last decade for social classes IV & V should be borne in mind. Further, the mortality differential may need to be allowed for in the pricing of protection policies, in particular group life premiums.

Mortality rates can be thought of as composed of two elements—incidence of a disease and case fatality from that disease. The differentials noted here in mortality rates can be linked to corresponding differentials in either or both of these components. Thus, Haberman<sup>(12)</sup> has reported occupational differences in disability incidence rates for (individual and group) permanent health insurance (PHI) and social security invalidity benefits.

#### 9. ACKNOWLEDGMENT

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## APPENDIX: DIFFERENCES IN EXPECTATIONS OF LIFE

Pollard<sup>(10)</sup> has shown that the difference between expectations of life from two populations, denoted here by superscripts 1 and 2, may be written:

$$\hat{e}_x^2 - \hat{e}_x^1 = \int_0^{105-x} (\mu_{x+t}^1 - \mu_{x+t}^2) w_t dt$$

where  $\mu_{x+t}$  is the corresponding force of mortality at age  $x+t$  and  $w_t$  is a weighting function given by:

$$w_t = \frac{1}{2} \left[ \frac{{}_t p_x^1}{{}_t p_x^2} (T_{x+t}^2 - T_{105}^2) + \frac{{}_t p_x^2}{{}_t p_x^1} (T_{x+t}^1 - T_{105}^1) \right] .$$

As usual,  $T_x = \int_0^\infty l_y dy$ .

With  $x=20$  and  $Q_y^i = -\log_e (l_{y+5}^i / l_y^i)$  for  $i=1$  and 2 it is proposed to evaluate the integral using the trapezium rule as:

$$\hat{e}_{20}^2 - \hat{e}_{20}^1 = \sum_{y=20}^{100} {}^{(5)}(Q_y^1 - Q_y^2) w_{y+2\frac{1}{2}}.$$