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Health Statistics Quarterly and *Population Trends* are journals of the Office for National Statistics. Each is published four times a year in February, May, August and November and March, June, September and December, respectively. In addition to bringing together articles on a wide range of population and health topics, *Health Statistics Quarterly* and *Population Trends* contain regular series of tables on a wide range of subjects for which ONS is responsible, including the most recently available statistics.

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Articles: 5,000 words max.

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in brief

Trends in life expectancy by social class, 1972–2005

The series on life expectancy by social class derived using the Office for National Statistics (ONS) Longitudinal Study has been updated on the National Statistics website to give data for the period 2002–05 for the first time. It is available at: www.statistics.gov.uk/statbase/Product.asp?vlnk=8460

The main points were:

- males in the professional class had a life expectancy at birth of 80.0 in the period 2002–05, compared with 72.7 years for those in the manual unskilled class
- females in the professional class had a life expectancy at birth of 85.1 years compared with 78.1 years for the unskilled manual class

Between 1972–76 and 2002–05, both males and females classified to non-manual occupations had a greater increase in life expectancy at birth and at age 65 than those classified to manual occupations.

In contrast, between 1997–2001 and 2002–05:

- life expectancy for males at birth and at age 65 increased more for those classified to manual occupations (1.8 and 1.2 years respectively), than to non-manual occupations (1.3 and 0.8 years respectively)
- for females, estimates of life expectancy increased by a similar amount for those classified to non-manual and manual occupations

Healthy and disability-free life expectancy for local authorities in England and Wales, 2001

ONS has published estimates of healthy life expectancy (HLE) and disability-free life expectancy (DFLE) at birth and at age 65 for local authorities in England and Wales for the year 2001 on the Neighbourhood Statistics website, www.neighbourhood.statistics.gov.uk. Data are presented at national and Government Office Region (GOR) levels, in addition to local authority, and the data and meta data can be downloaded in a number of different formats. The healthy and disability-free life expectancy at birth and at age 65 figures are produced seperately for males and females.

The HLE estimates were calculated by combining:

- age and sex specific mortality rates (life tables), with
- age and sex specific rates of good/fairly good general health from the 2001 Census

The DFLE estimates were calculated by combining:

- age and sex specific mortality rates (life tables), with
- age and sex specific health rates of people reporting no limiting long-term illness, also from the 2001 Census

HLE and DFLE at birth and at age 65, calculated using the Sullivan method, are examples of summary measures of health known as health expectancies (such as expected years in good health or without a disability), which are commonly used for measuring and monitoring population health at national and international level. They are used as an indicator of progress in government strategies for tackling poverty and social inclusion, for sustainable development, and on public health. The provision of these estimates at local authority level extends their utility for use in local planning.

Population estimates: mid-2006 and revised mid-2002 to mid-2005

England and Wales/United Kingdom

On 23 August 2007 ONS published the mid-2006 population estimates and the revised mid-2002 to mid-2005 population estimates. These give estimates of the population for the United Kingdom; constituent countries; Government Office Regions; local authorities in England and Wales; Council Areas within Scotland; District Council Areas in Northern Ireland and Health Authorities/Boards. Full information on these mid-year population estimates are available on the National Statistics website at: www.statistics.gov.uk/popest

The revised 2002 to 2005 mid-year population estimates shown in this volume have been updated to include the latest revised estimates that take into account improved international migration estimates. Further details on the revisions are available at: www.statistics.gov.uk/imps under 'Updates'.

Scotland
Mid-2006 population estimates for Scotland were released by the General Register Office for Scotland on 27 July 2007. Information on these estimates are available at: www.gro-scotland.gov.uk/statistics/population.html

Northern Ireland
Mid-2006 population estimates for Northern Ireland were released by the Northern Ireland Statistics and Research Agency on 31 July 2007. Information on these estimates are available at: www.nisra.gov.uk/demography/default.asp?cmsid=20_21_24&cms=demography_population%20statistics_Mid%2Dyear+population+estimates&release=

Consultation on restructuring ONS mortality statistics – update

Following the recent consultation on mortality statistics, (which is available at: www.statistics.gov.uk/about/consultations/mortality_outputs.asp), ONS received ten responses from a variety of data users including the Department of Health, the Welsh Assembly Government and local authorities. Responses supported the proposal to change the reporting basis for mortality statistics from deaths occurring, to deaths registered, in a calendar year, as well as a move towards new themed packages of mortality outputs.

ONS intends to publish a report outlining the responses to the consultation before the end of the year on the National Statistics website. This will include more information on the future content of mortality outputs.

Delay in publication of unexplained deaths in infancy report for 2006

The above report was due for publication in the autumn 2007 edition of *Health Statistics Quarterly*. The unexplained deaths report was first published in 2005 using 2004 data and we have since found that it is too early to publish provisional figures in the autumn as most of these deaths have not been registered by then.

The majority of the unexplained deaths are certified by a coroner either with or without an inquest and it takes much longer for these deaths to be registered. Hence the provisional figure for unexplained deaths is much lower when compared to the final figure. For example, provisional figures for 2004 showed there were 261 unexplained deaths and the rate was 0.41 per 1,000 live births while the final figures showed there were 309 deaths with a rate of 0.48 per 1,000 live births (17 per cent higher than the provisional rate). There was however a 12 month interval between the publication of these provisional and final figures. In order to publish meaningful, provisional figures for 2006, the number of unexplained deaths registered each month is currently being monitored. Figures will be published as soon as we are confident that most deaths have been registered.

Effects of problems with birth and death registration systems on ONS statistical outputs

As described in the previous edition of *Health Statistics Quarterly*, problems with the introduction of the new registration on line system (RON) at register offices in England and Wales have led to the temporary suspension of some ONS outputs that rely on the completeness of births and deaths registered between the end of March and the beginning of May 2007. Births and deaths records for this period, which were held only on paper at register offices, have now been entered onto the RON system. Statistical quality assurance and compilation processes are now being completed.

How this affects reference tables in *Health Statistics Quarterly*
Provisional conceptions figures for June quarter 2006 (which rely on March quarter 2007 and June quarter 2007 birth registrations), due to be published in the August edition of *Health Statistics Quarterly*, have been quality assured and are released in this edition. Provisional births, deaths and childhood mortality figures for the quarter ending March 2007 for England and Wales, also due to have been published in the August edition, are also included in this edition.

Excess winter mortality
Unlike the winter edition of *Health Statistics Quarterly* in 2006, this edition does not contain a report on excess winter mortality. Provisional figures for winter 2006/07 have however been calculated and are available on the National Statistics website at: www.statistics.gov.uk/statbase/Product.asp?vlnk=10805&More=n

These figures are available by age group, for England and Wales, English Government Office Regions, and Wales. Comparable trend data for winters from 1990/91 onwards are also available.

Health at a Glance – OECD Indicators 2007

The Organisation for Economic Co-operation and Development (OECD) publishes a biennial summary of health and healthcare comparisons across its 30 member countries. *Health at a Glance – OECD Indicators 2007* is due to be published during November and will be available at: www.oecd.org/health/healthataglance. The content of *Health at a Glance* is based on the annual OECD health data collection, which ONS co-ordinates for the UK. *OECD Health Data 2007: Statistics and Indicators for 30 Countries* is available at: www.oecd.org/health/healthdata.

'Recent publications' are listed on page 96

Health indicators

England and Wales

Figure A Population change (mid-year to mid-year)

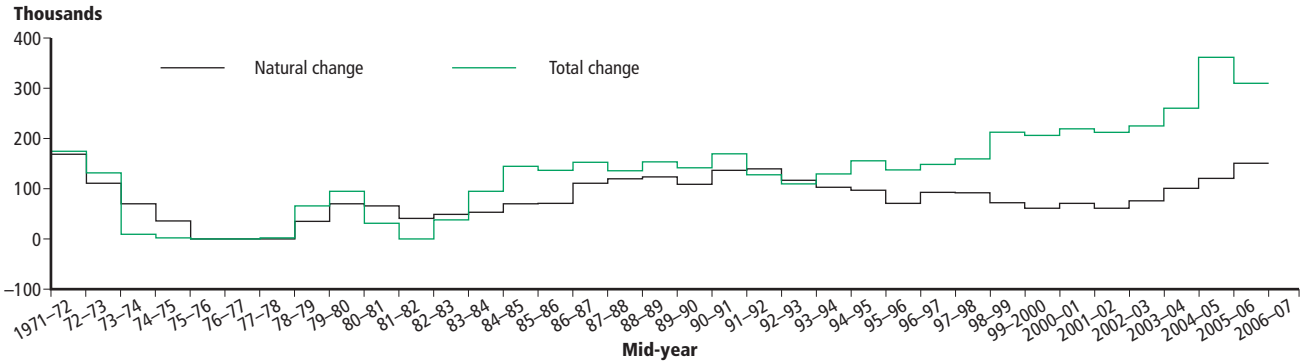


Figure B Age-standardised mortality rate[1]

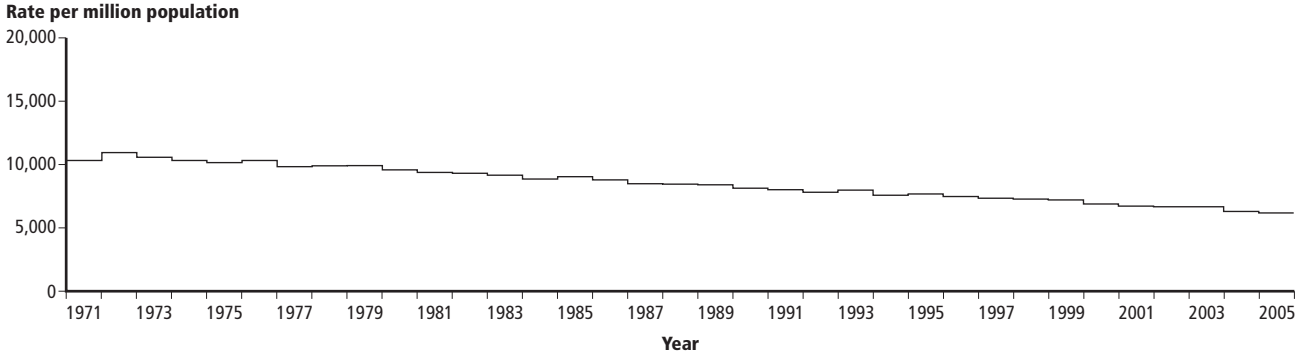


Figure C Infant mortality (under 1 year)

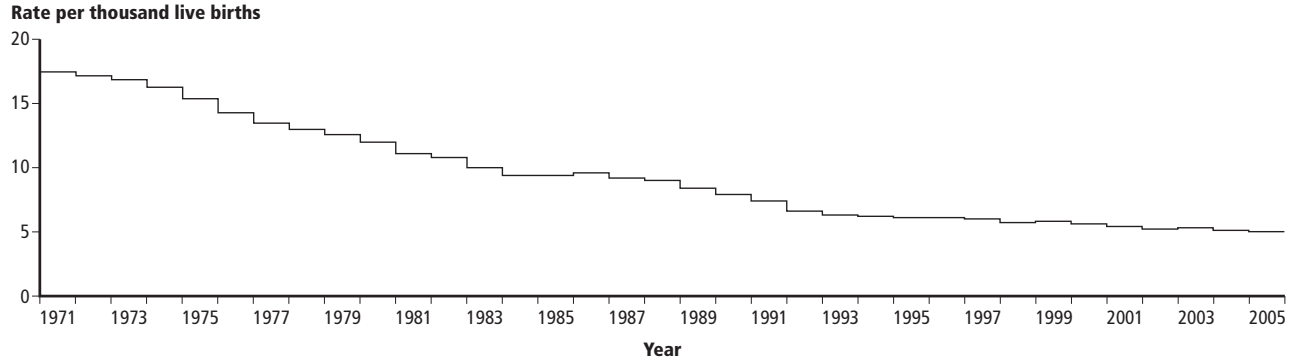
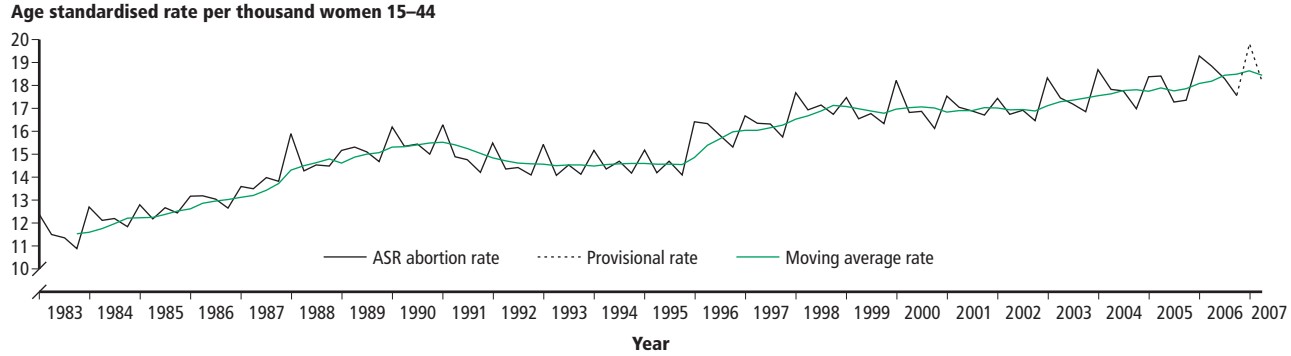


Figure D Age-standardised quarterly abortion rates – residents[2]



[1] The age-standardised mortality rate for 2004 is based on mid-2004 population estimates published on 25 August 2005.

[2] Rates for 2006 and March quarter 2007 are based on 2004 projected projections.

Social inequalities in adult male mortality by the National Statistics Socio-Economic Classification, England and Wales, 2001–03

Chris White, Myer Glickman, Brian Johnson and Tania Corbin
Office for National Statistics

This article reports social inequalities in mortality in men aged 25–64 years in England and Wales, in the period 2001–03 using unlinked data sources and 2001–04 using linked data sources. It represents the first official analysis of premature mortality by the final version of the National Statistics Socio-economic Classification introduced in 2001, and updates the tradition of decennial reporting of mortality by socio-economic status.

These results set a benchmark for inequalities in mortality in men of this age, providing insights into the impacts of different social and occupational circumstances in the early 21st Century and enabling future monitoring. The Office for National Statistics intends to extend this work to examine inequalities to mortality in females of the same age, in causes of death and by Government Office Region.

Introduction

This article describes social inequalities in the all-cause mortality of men aged 25–64 years, in England and Wales, in the period 2001 to 2003. It is the first analysis of adult mortality using the final version of the National Statistics Socio-Economic Classification (NS-SEC), which was introduced in 2001; although previous analyses of male mortality for the period 1991–93 have been published, using an interim version of NS-SEC.[1,2,3] This current analysis establishes an essential benchmark for the measurement of health inequalities in the early 21st century, and it will inform the development of methods for future research, including options for an inter-censal time series. Further planned analyses of mortality by NS-SEC will report on females of working age, life expectancy, causes of death, and differences between Government Office Regions.

The analysis presented here uses four data sources: the 2001 Census, the mid-year population estimates for 2001–03, deaths of men aged 25–64 occurring in 2001–03, and the Office for National Statistics (ONS) Longitudinal Study (LS). The LS is a sample of around one per cent of the population of England and Wales, which links census and vital events data from 1971 onwards.[4] This analysis departs from previous decennial analyses of mortality by socio-economic status through explicit use of linked records from the LS to quantify and correct for the potential for previously reported biases in unlinked data,[5,6] allowing a more valid and reliable set of estimates with which to establish trends in the future.

Background

Social inequalities in mortality in the UK are well-established, particularly among men of working age, and their study has a history

dating back to the Registrar General's reports of the mid-nineteenth century.[7,8,9,10,11,12] The large body of evidence assembled since the publication of the influential Black Report in 1980 shows that such inequalities are a feature of many industrialised societies,[13, 14,15] and that a gradient in mortality risk can generally be observed across the range of socio-economic groups in society, however those groups are categorised.[16,17]

Since 1911, the principal social classification used in UK official statistics has been the Registrar General's Social Classification (RGSC) based on occupation and employment status. Significant inequalities in mortality by RGSC have been reported in the literature throughout the 20th century. While mortality rates overall declined during the 20th century, the gap in mortality across the social spectrum has persisted or widened.[9,18,19] In 1931, the mortality rate among unskilled male workers was 1.2 times the rate among professionals; this difference had increased to 2.9 times in 1991–93.[20,21] The marked contrast between professionals and unskilled manual workers in the rate at which mortality fell between 1970–72 and 1991–93 was responsible for the widening of the social class gradient among men of working age during this period. The scale of inequality in mortality can be illustrated with reference to age-specific rates of death: in 1991–93, men in unskilled occupations aged 20–24 had a higher rate of death than professional men aged 40–44.[21] This increasing inequality in mortality risk by socio-economic status led the UK government to commission a second independent inquiry into inequalities in health[22] in 1997, which led to the funding of a number of national initiatives designed to tackle the poorer life chances of the socially disadvantaged.[23,24,25]

The RGSC has provided a relatively consistent basis for the monitoring of health inequalities over time, but has been criticised for lacking a coherent theoretical basis and insensitivity to the changing patterns of industry and employment in modern economies.[26] The diminishing number of men in unskilled manual occupations (social class V) since 1970 has led to criticism of RGSC from both statistical[27,28] and sociological perspectives;[29,30] the health status of this social group can be seen as of decreasing relevance to the population as a whole,[31] and increasingly difficult to measure with statistical reliability. At the same time, the expansion of managerial, technical and routine non-manual occupations during the 1980s and 1990s reflects the impact of a growing service-based economy, and casts increasing doubt on the hierarchical social distinctions implicit in the RGSC.[32]

The NS-SEC, like the RGSC, is based on occupation and employment status (and for some occupations, number of employees in the workplace) but was developed on the basis of a classification of employment relations, and aims to reflect the socio-economic structure of 21st century societies and the major shift in the UK economy from manufacturing to service industries.[33] Important distinguishing features include the separation of small employers and own-account workers into a discrete class, the removal of the historical distinction between manual occupations and other occupations of a routine or semi-routine nature and an increase in the size of the class populations at the extremes of the scale. Another difference between the classifications is that RGSC is an assumed hierarchy of occupational skill and social standing, whereas NS-SEC is an explicit measure of employment relations characteristics[34] that aims to minimise within-class and maximise between-class heterogeneity.[33] The capture of qualitative differences in employment relations inherent in the NS-SEC schema counters the assumption of a hierarchy of classes, but establishes distinct occupational groupings, which provide greater scope for explaining statistical relationships. Specifically, the relationship between mortality and NS-SEC can suggest how different types of employment relations and conditions may impact on health, and, consequently, the role of social organisation in the formation and persistence of health inequalities.

Previous analysis of mortality in males of working age by an interim version of NS-SEC examined deaths in the period 1991–93 by major cause. For all causes of death, although statistically significant differences were found between classes, the mortality pattern departed from the familiar linear relationship characteristic of analyses by social class in one important respect; the **Small employers, own account workers** had lower mortality than men working in **Intermediate and Lower supervisory and technical** occupations.[2] Another relevant distinction between analyses by RGSC and NS-SEC in the period 1991–93 was the lower rate of death found among men working as **Large employers, higher managers** compared with men in RGSC social class I, and the lower rate in men working in **Routine** occupations compared with men in RGSC social class V. The lower mortality rate at each end of the NS-SEC scale maintained consistency with the gradient found in analysis by RGSC for the same period.

Further information about NS-SEC, its rationale, development, and application is available on the National Statistics website.[35]

Analytical approach

Examinations of social inequalities in mortality have generally used one of two approaches, the cross-sectional approach using unlinked records, or the follow-up approach, using linked records. The decennial analyses published by ONS and its predecessors have used unlinked records, in which mortality rates are calculated using the population recorded at a census as the denominator and the number of deaths registered in a period around the census as the numerator. Since the inception of the LS, many important analyses have used the linked records approach, which tracks a defined sample of individuals over time.[6, 7, 11, 12, 17, 21, 36, 39, 56, 66] Mortality rates calculated from linked records use the time members accrue in the sample (person years at risk, PYRs) as the denominator and deaths to sample members as the numerator.

Both approaches have strengths and weaknesses. The unlinked approach is subject to numerator-denominator biases, in particular, but, as the figures are based on the entire population, the data allow analyses into detailed breakdowns and the results have a high level of stability. Numerator-denominator biases can arise from differences in the reporting of occupation and employment status, and hence NS-SEC, at death registration and census.[5,36,37] One difference is that reporting at census is generally by the individual concerned, whereas at death it is by the person registering the death, and may therefore be less accurate. Another is that the information provided at census relates to current or most recent occupation and economic position, while at death what is recorded is usually the main lifetime occupation or career.

The potential for numerator-denominator biases is particularly relevant for analyses using the 2001 Census; a rule applied by ONS in the processing of records coded men and women under the age of 65 reporting an occupation to the residual NS-SEC category **Not classifiable for other reasons** if they had not worked since 1995 and were not classified as 'never worked' or 'long-term unemployed'.[38] This rule (known as Filter X) has the potential to distort mortality estimates by socio-economic status through the artificial reduction of occupied NS-SEC populations at census and differential occupational propensities for not having worked since 1995. This coding rule was not applied to 2001 Census records in the LS, enabling the use of linked records to correct for numerator-denominator biases resulting from Filter X, described below.

Another weakness of analyses using unlinked records is the inability to detect and account for the possible presence of health selection, which also has potential to distort inequalities in mortality by socio-economic status. The operation of health selection is complex, and has received substantial examination in the literature.[7, 15, 21, 39, 40, 41, 42, 66] The

principal tenet of the selection explanation for inequalities in mortality by socio-economic status relevant to this analysis is the direction of the relationship between health and social position: that is, that health status influences social position rather than vice versa, leading to a concentration of people at higher risk of premature death in low status occupations or unemployed or permanently sick or disabled. If the propensity for an individual to retire early or leave the labour market on grounds of ill-health varies between occupations, this is likely to affect the comparison of mortality rates by NS-SEC, since such individuals are at increased risk of subsequent death. The linked records approach using data from the LS can adjust for health selection out of the labour market by allocating an occupied NS-SEC from the LS member's 1991 Census record if available.

While the linked records contained within the LS provide a number of methodological advantages described above, estimates of mortality based on the LS alone are subject to sampling variation, which limits the scope for detailed analysis by socio-economic status and cause of death. Furthermore, the potential for underestimation of loss to follow-up brought about by an unknown rate of unobserved embarkation can result in sample members continuing to accrue person years at risk when they are no longer resident in England and Wales, thereby reducing estimates of mortality.

To provide the most reliable comparison of mortality by NS-SEC for adult males, this article draws on both unlinked and linked records, explained in the Methods section below. Mortality rates are calculated using a combination of both approaches, including adjustments applied in each set of calculations to compensate for known biases specific to the data sources. In particular, the analysis draws on linked records in two ways to improve the unlinked records analysis.

Firstly, it takes advantage of the fact that the LS is a representative sample; this means that results calculated from the LS should be broadly similar to those calculated from unlinked records, subject to sampling error and known differences in method of NS-SEC assignment.[1] Significant differences between the two sets of results are therefore suggestive of systematic bias in one or the other and can be investigated to improve the overall robustness of the findings. Secondly, the LS contains data on the same individuals collected at successive censuses and at death registration. This means that the relationships between (for example) the NS-SEC class allocated at the 2001 Census and that allocated to the same person at death can be compared and used to refine the methods for unlinked analysis.

Details of the adjustments made and the calculations at each intermediate stage in the process will be provided in a subsequent technical paper. Some additional tables and background material have been provided in a separate Appendix to this article; tables and boxes referred to below by an alphanumeric character (for example, Box A1) can be found in the Appendix.

Methods

National Statistics Socio-Economic Classification (NS-SEC)

Box One shows the analysis according to the nine class breakdown of NS-SEC and provides examples of the occupations included in each class. These analytical classes are based on a larger number of operational categories (and sub-categories) and can be further aggregated into broader divisions (5 and 3 analytic class versions), shown in Box A3 in the Appendix.

There are three principal methods of deriving NS-SEC, depending on the data available.[43] The **full** method requires occupational information coded to the Standard Occupational Classification 2000 (SOC 2000), details of employment status (for example supervisor, other employee, or self-employed) and the size of the organisation for which the individual works. The **reduced** method dispenses with organisational size and derives NS-SEC from the SOC 2000 code and employment status, while the **simplified** method derives NS-SEC from the SOC 2000 code only.

A study using the Labour Force Survey in 2000 found that compared with the full method, the reduced method allocated 98 per cent of individuals to the correct NS-SEC analytic class.[33] The main effect of using the reduced method was to increase the proportion of the study population working as **Large employers, higher managers** from 4.4 per cent to 5.9 per cent, and reduce the proportion working in **Lower managerial, professional** occupations from 25.0 per cent to 23.3 per cent. A comparison of the allocations to the NS-SEC analytic classes using the full and reduced methods of derivation, based on that study, is shown in Table A1 in the Appendix.

Full NS-SEC can be derived from the 2001 Census data, but not from death registrations, because size of organisation is not among the occupational details recorded on the death certificate. For consistency, therefore, reduced NS-SEC was used throughout this analysis. The census questions on occupation and employment status are shown in Box A1 and the rules for recording of the relevant information at death registration are set out in Box A2.

During the development of the NS-SEC, a version for use with data coded to the Standard Occupational Classification 1990 (SOC 90) was made available (referred to as NS-SEC90).[44] Although the categories and analytic classes of NS-SEC90 are identical to those of NS-SEC,

Box one

National Statistics Socio-Economic Classification – Analytic classes

Analytic class	Examples of occupations included
1.1 Large employers, higher managers	Senior officials in national and local government, directors and chief executives of major organisations, officers in the armed forces
1.2 Higher professionals	Civil engineers, medical practitioners, physicists, geologists, IT strategy and planning professionals, legal professionals, architects
2 Lower managerial, professional	Teachers in primary and secondary schools, quantity surveyors, public service administrative professionals, social workers, nurses, IT technicians
3 Intermediate	NCOs and other ranks in the Armed Forces, graphic designers, medical and dental technicians, Civil Service administrative officers and local government clerical officers, counter clerks, school and company secretaries
4 Small employers and own account workers	Hairdressing and beauty salon proprietors, shopkeepers, dispensing opticians in private practice, farmers, self-employed taxi drivers
5 Lower supervisory and technical occupations	Bakers and flour confectioners, screen-printers, plumbers, electricians and motor mechanics employed by others, gardeners, rail transport operatives
6 Semi-routine occupations	Pest control officers, clothing cutters, traffic wardens, scaffolders, assemblers of vehicles, farm workers, veterinary nurses and assistants, shelf fillers
7 Routine occupations	Hairdressing employees, floral arrangers, roundsmen and women, sewing machinists, van, bus and coach drivers, labourers, hotel porters, bar staff, cleaners and domestics, road sweepers, car park attendants
8 Never Worked, long-term unemployed	Defined at census as a person aged 16-74 who had never engaged in paid employment or had not worked since 1999

Source: NS-SEC User Manual

differences between the SOC 90 and SOC 2000 classifications mean that the two are not directly equivalent. A previous analysis of deaths registered in 2001, which were coded using both SOC 90 and SOC 2000, found that allocation to NS-SEC and NS-SEC90 classes agreed in 90 per cent of cases overall.[45]

Analysis period and study populations

Death registrations record information on the occupation and employment status of the deceased for men between the ages of 16 and 74. However, the completeness of these data deteriorates after the state retirement age of 65, reducing the reliability of analysis by NS-SEC from this source beyond the age of 64. The trend for an increasing proportion of young men to delay entry into the labour market, usually because of their continuation in full-time education beyond the age of 16, also reduces the proportion of men aged 16–24 who can be allocated an NS-SEC class based on their occupation. Consequently, this analysis focuses on men aged 25–64, to ensure the most complete and reliable allocation to NS-SEC classes.

Deriving population denominators by NS-SEC

Mid-year population estimates 2001–03 by NS-SEC

It is customary for a decennial analysis of mortality to focus on deaths in a period evenly spread before and after the census year. However, the introduction of NS-SEC for death registrations from January 2001 makes that impossible in this case. Consequently, deaths of men resident in England and Wales registered in the calendar years 2001 to 2003 were used. Because this means that the census-based population counts are not centrally positioned in the analysis period, and to allow for revisions to the 2001 Census populations which have subsequently been published by ONS, adjusted denominators were derived for use in the decennial analysis of unlinked records by applying the proportions of the male population in each NS-SEC class and five-year age group to the ONS revised mid-year population estimates for each of the three years. The adjusted total population denominator was 41,507,100 PYRs for 2001–03 combined, representing an increase of 1.7 per cent in the denominator compared to the census counts. Population numbers (rounded to thousands) by age group and NS-SEC class from the 2001 Census are shown in Table A2 in the Appendix, and the equivalent numbers using ONS mid-year population estimates are shown in Table A3.

Using linked data to refine population estimates

The analysis of linked records concentrated on male members of the LS, included if they were enumerated in England and Wales at the 2001 Census, were aged 25–64 years on the census date, and were traced at NHS Central Register (this ensures the inclusion of death records where appropriate). A total of 139,760 LS members were included in this sample. Person years at risk were calculated for the period 29 April 2001 (census day) to 31 December 2004, taking account of emigrations from and re-entries to England and Wales and ageing-out of the population at risk. These linked records were used to (a) reduce the proportion classified to the residual category **Not classifiable for other reasons** (artificially inflated by the application of the Filter X rule in the 2001 Census), (b) minimise the potential for health selection out of the labour market to disproportionately diminish occupied NS-SEC analytic class denominators. The age and NS-SEC class-specific proportions of PYRs were applied to the pooled mid-year population estimates for England and Wales for the years 2001–03 to produce synthetic unlinked records denominators optimised for mortality analysis. The rounded denominators by NS-SEC class and age group are presented in Table 1. The unrounded version of this table will be available on the National Statistics website.

The Longitudinal Study sample members were allocated to an NS-SEC class based on their 2001 Census record. To maximise the number of individuals available for analysis and to reduce the possible effect of health selection out of the labour market, those who had no occupied NS-SEC class in 2001, but were present and had an occupation coded to SOC90 at the 1991 Census, were then allocated to an NS-SEC class on the basis of their NS-SEC90 code. In linked records 95.9 per cent of the LS sample was allocated to an occupied NS-SEC class using NS-SEC in 2001 only, and 97.9 per cent using NS-SEC90 in addition. The PYRs providing the denominators for the linked records analysis are shown (by NS-SEC class, all ages combined) in Table 2.

Adjustments to the assignment of deaths (numerator) to NS-SEC

A total of 150,201 deaths were included in the unlinked records analysis; 89.3 per cent of these could be allocated to an occupied NS-SEC class. Preliminary investigation of linked records using the LS revealed a systematic bias in the unlinked records analysis caused by an apparent misallocation of one NS-SEC operational category at death registration. Certain occupations are assigned to NS-SEC operational category L6 (Higher Supervisory occupations), which is part of the analytic class **Lower professional, managerial**, if they supervise other employees and have an employment status of supervisor, and operational category L7 (Intermediate occupations), which is part of the **Intermediate**

Table 1 **Optimised population estimates[1] (person years at risk) by NS-SEC[2] and age, males aged 25–64, 2001–03**

England and Wales — Thousands

	NS-SEC analytic class									
Age (years)	1.1	1.2	2	3	4	5	6	7	FTS[3]	Other[4]
25–29	249	575	1,185	439	336	691	645	720	34	193
30–34	412	649	1,385	431	567	882	655	829	15	161
35–39	536	588	1,377	351	829	857	639	846	6	139
40–44	508	495	1,263	299	861	769	579	753	3	109
45–49	462	444	1,116	251	792	668	500	676	5	84
50–54	427	446	1,153	261	863	654	504	717	3	73
55–59	374	407	1,012	230	853	612	491	743	1	54
60–64	210	297	722	177	682	528	431	682	1	46
Total[5]	3,178	3,901	9,213	2,439	5,783	5,661	4,444	5,966	68	859
Percentages	*7.7*	*9.4*	*22.2*	*5.9*	*13.9*	*13.6*	*10.7*	*14.4*	*0.2*	*2.1*

1 Adjusted for 2001 Census 'Filter X' rule and health selection.
2 Reduced derivation.
3 Full-time students.
4 Other (including never worked and long-term unemployed, inadequately described, not classifiable for other reasons).
5 Totals in thousands rounded so do not sum to 41,507,100 reported in text.

Source: Office for National Statistics, 2001 Census (custom table provided by ONS Census Division); mid-year population estimates for 2001, 2002 and 2003; ONS Longitudinal Study

Table 2

Populations (person years at risk) by NS-SEC,[1] males aged 25–64 in the Office for National Statistics Longitudinal study sample, 2001–04[2]

England and Wales

NS-SEC analytic class	Based on NS-SEC in 2001 only		Based on NS-SEC in 2001 and NS-SEC90 in 1991	
	PYRs	Percentages	PYRs	Percentages
1.1 Large employers, higher managers	38,150	*7.8*	38,348	*7.8*
1.2 Higher professionals	44,567	*9.1*	45,251	*9.2*
2 Lower managerial, professional	106,673	*21.8*	108,224	*22.1*
3 Intermediate	26,940	*5.5*	27,747	*5.7*
4 Small employers, own account workers	70,254	*14.3*	71,258	*14.5*
5 Lower supervisory and technical	65,683	*13.4*	66,710	*13.6*
6 Semi-routine	49,794	*10.2*	51,854	*10.6*
7 Routine	68,063	*13.9*	70,711	*14.4*
Never worked, long-term unemployed	14,483	*3.0*	9,113	*1.9*
Full-time students	4,640	*1.0*	628	*0.1*
Inadequately described	115	*0.0*	52	*0.0*
Not classifiable for other reasons	863	*0.2*	330	*0.1*
Total[3]	490,226	*100*	490,226	*100*

1 Reduced derivation.
2 29 April 2001 to 31 December 2004.
3 Totals vary slightly due to rounding.

Source: Office for National Statistics Longitudinal Study

analytic class, if not; however their job titles typically make no mention of management or supervisory responsibilities in either case. Examples include draughtsmen, various categories of clerical workers, photographers, and electrical technicians. For those men assigned to NS-SEC operational category L6 at census and L7 at death in the LS sample, equivalence was found in the occupation reported in their linked census and death record, and differed only in regard to the employment status reported. While this issue has no effect on the linked records analysis, which is based on NS-SEC allocated at census for both deaths and PYRs, it distorts the mortality rates produced from unlinked records for these analytic classes. The rule for coding employment status, a fundamental factor in the decision to allocate to either L6 or L7, in death registrations, when employment status information is missing or insufficiently detailed, is to default to the **employee** category. This rule increases the likelihood for deaths in these occupations to be classified to the operational category Intermediate occupations (L7) and hence the **Intermediate** analytic class.

To adjust for this bias, while ensuring that the total number of deaths remains consistent, age-specific adjustment factors were calculated from the LS sample and applied to the numbers of deaths in the **Lower professional, managerial** and **Intermediate** analytic classes in the deaths registrations data. The resulting per cent change in deaths in each class and the adjustment factors are shown in Table A4 in the Appendix. This reduced the number of deaths allocated to the **Intermediate** analytic class by 23 per cent and increased the number of deaths allocated to the **Lower managerial, professional** analytic class by 9 per cent in death registration records.

The information collected at death registration does not allow reliable identification of men who had **Never worked** or were **Long-term unemployed**, or differentiation between those categories and men who could not be allocated to an NS-SEC class due to inadequate information or for other reasons. Full-time students are identified, but deaths in this group are uncommon. Consequently, mortality rates based on the unlinked records approach are presented for occupied NS-SEC analytic classes only.

A total of 1,678 deaths occurring between census day 29 April 2001 and 31 December 2004 were included in the analysis of linked records using the LS. The NS-SEC distribution of deaths found in the LS sample enumerated in 2001 takes account of potential health selection bias by allocating the sample member's NS-SEC90 class from their 1991 Census record, if available, to assign NS-SEC in 2001. Linked records include the reliable capture of the NS-SEC operational category **Never worked, long-term unemployed**, enabling the calculation of mortality estimates for this group, in addition to occupied NS-SEC analytic classes.

Outcome measures

To compare the mortality experience of NS-SEC analytic classes, two measures of mortality were calculated: firstly, age-specific mortality rates for five-year age groups and secondly, directly age-standardised mortality rates for all men aged 25–64 standardised to the European standard population (see Table A5). Age-standardised rates are a summary measure allowing populations with differing age structures to be reliably compared.

Table 3

Number and percentage distribution of deaths by NS-SEC, males aged 25–64, death registrations 2001–03 and LS sample 2001–04

England and Wales

NS-SEC analytic class	Death registrations				LS sample			
	Unadjusted		Adjusted[1]		Unadjusted		Adjusted[2]	
	Number	Percentages	Number	Percentages	Number	Percentages	Number	Percentages
1.1 Large employers, higher managers	5,304	*3.5*	5,304	*3.5*	85	*5.1*[3]	85	*5.1*[3]
1.2 Higher professionals	7,153	*4.8*	7,153	*4.8*	92	*5.5*	94	*5.6*
2 Lower managerial, professional	20,334	*13.5*	22,116	*14.7*	268	*15.9*[3]	275	*16.5*
3 Intermediate	7,711	*5.1*	5,929	*4.0*	64	*3.8*[4]	66	*3.9*
4 Small employers, own account workers	20,493	*13.6*	20,493	*13.6*	242	*14.4*	249	*14.8*
5 Lower supervisory and technical	20,377	*13.6*	20,377	*13.6*	241	*14.4*	246	*14.7*
6 Semi-routine	20,442	*13.6*	20,442	*13.6*	215	*12.8*	225	*13.4*
7 Routine	32,347	*21.5*	32,347	*21.5*	345	*20.6*	362	*21.6*
Never worked, long-term unemployed	646	*0.4*	646	*0.4*	116	*6.9*[3]	>70	—
Full-time students	419	*0.3*	419	*0.3*	< 5	—	< 5	—
Inadequately described	14,672	*9.8*	14,672	*9.8*	< 5	—	< 5	—
Not classifiable for other reasons	303	*0.2*	303	*0.2*	< 5	—	< 5	—
Total	150,201	*100*	150,201	*100*	1,678	*100*	1,678	*100*

1 Applies adjustment factors to classes 2 and 3.
2 Adjusts for health selection out of the labour market for unoccupied LS sample enumerated in 2001.
3 Significantly higher proportion in LS sample than in death registrations ($p<0.05$).
4 Significantly lower proportion in LS sample than in death registrations ($p<0.05$).

— Cell per cent suppressed due to disclosure control.

Source: Death registrations 2001-03 and Office for National Statistics Longitudinal Study

Table 4 **Comparison of NS-SEC[1] allocation at 2001 Census and death registration: LS sample members who died 2001–04[2]**

England and Wales

NS-SEC at Census	NS-SEC at death registration										
	1.1	1.2	2	3	4	5	6	7	NWLTU, FTS, NC	Total at census	Percentages at census
1.1	**33**	5	23	4	—	4	5	—	4	85	*5.1*
1.2	3	**47**	14	8	3	4	7	3	5	94	*5.6*
2	17	11	**125**	32	25	19	11	19	16	275	*16.4*
3	—	—	16	**25**	—	3	9	—	7	66	*3.9*
4	4	7	23	7	**137**	18	17	22	14	249	*14.8*
5	5	4	13	4	12	**110**	41	42	15	246	*14.7*
6	—	—	11	6	8	28	**104**	49	16	225	*13.4*
7	—	—	12	4	31	29	34	**214**	33	362	*21.6*
NWLTU, FTS, NC	—	—	3	3	3	4	8	13	**39**	76	*4.5*
Total at death registration	67	82	240	93	226	219	236	366	149	1,678	*100*
Percentages at death registration	*4.0*	*4.9*	*14.3*	*5.5*	*13.5*	*13.1*	*14.1*	*21.8*	*8.9*	*100*	

1 Reduced derivation.

2 29 April 2001 to 31 December 2004.

— Cell per cent suppressed due to disclosure control.

Source: Office for National Statistics Longitudinal Study

Results

Distribution of deaths by NS-SEC and data source

Table 3 shows the number and per cent of deaths by NS-SEC class, by data source and method of assignment. The class distribution of deaths from death registrations takes account of the application of age-specific adjustment factors to the NS-SEC analytic classes **Lower managerial, professional** and **Intermediate**, explained earlier. The largest number of deaths was allocated to men working in **Routine** occupations, who made up 21.5 per cent of all deaths in the unlinked data and 21.6 per cent in the LS sample after adjustment for health selection.

The unlinked and linked records differed noticeably in the proportions of deaths assigned to the **Lower managerial, professional** and **Intermediate** analytic classes before the adjustment for misallocation described earlier. Specifically, the **Intermediate** analytic class had a statistically significant lower proportion of deaths and the **Lower managerial, professional** analytic class a significantly higher proportion in linked records compared with death registrations. This significant difference disappeared following adjustment for misallocation of certain occupations in death registrations.

The proportion of deaths allocated to the **Large employers, higher managers** analytic class was significantly higher in the LS at 5.1 per cent after adjustment for health selection, compared with 3.5 per cent of death registrations, but in other occupied classes differences were within the range of sampling variation.

Table 4 compares the NS-SEC assignment at census and death registration of the members of the LS sample who died in the study period. Overall, 53.3 per cent of those in occupied NS-SEC analytic classes were allocated to the same class at death as was reported in the census (range 40.7 per cent in the **Large employers, higher managers** analytic class to 65.0 per cent in the **Routine** analytic class), while 20.0 per cent were reported at death in a more advantaged class than at census, and 26.7 per cent in a less advantaged class.

The discrepancy in designation to NS-SEC **Large employers, higher managers** analytic class at census and death registration is apparent in Table 4. Only two-fifths of deaths assigned to the **Large employers, higher managers** analytic class at census were also assigned at death registration, with the majority not assigned, allocated to the **Lower managerial, professional** analytic class. A similar, although smaller, discrepancy was found in assignment to **Large employers, higher managers** at death registration compared with assignment at census. The greater likelihood for **Large employers, higher managers** to be allocated to the **Lower managerial, professional** analytic class at death registration partly explains the higher proportion of deaths found in assignment to **Large employers, higher managers** in linked records compared with unlinked death registrations.

The inadequacy of allocations to the NS-SEC operational category **Never worked, long-term unemployed** at death registration is verified in the examination of linked records. While more than 70 deaths were allocated to this NS-SEC operational category on LS members' census records, fewer than five were allocated at death registration. This finding shows that valid estimates of mortality for the **Never worked, long-term unemployed** cannot be calculated from the unlinked records.

Age-specific mortality rates by NS-SEC

Age-specific mortality rates by NS-SEC, calculated using the unlinked records approach, are presented in Table 5. The well-established increase in risk of death with increasing age is illustrated for each class separately in Figure 1. The class-specific relative increase with age is greatest in the **Higher professional** analytic class with a 33-fold increase in rate of death in 60–64 year olds compared to ages 25–29, while the men working as **Small employers, own account workers** had only an 11-fold increase between these ages. The inequality in relative risk of death between men working in **Routine** occupations and men working as **Large employers, higher managers** falls with increasing age. At ages 25–29, men in **Routine** occupations are more than four times more likely to die than men working as **Large employers, higher managers**, while at ages 60–64 the disparity in the rate of death falls to two and a quarter times greater. The contrast in mortality is further emphasised when comparing the mortality rate of the **Routine** analytic class at ages 25–29 with the mortality rate among men working as **Large employers, higher managers** fifteen years their senior. At ages 40–44 and 45–49, **Large employers, higher managers** have a lower rate than men working in **Routine** occupations fifteen years their junior.

The relative ranking of analytic classes in the mortality of men at the youngest ages (see Figure 2), shows men working as **Small employers, own account workers** had a raised rate of death compared with men working in **Lower supervisory and technical** occupations at ages 25–29, and a similar rate to men working in **Semi-routine** occupations. The **Lower supervisory and technical** analytic class experience lower

Table 5 Age-specific mortality rates[1] by NS-SEC:[2] men aged 25–64, 2001–03, death registrations[3]

England and Wales — Rate per 100,000

NS-SEC analytic class	Age (years) 25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64
1.1 Large employers, higher managers	26.9	31.3	44.0	71.3	127.8	237.7	360.2	742.7
1.2 Higher professionals	21.7	38.5	53.6	105.8	177.6	267.4	442.6	726.6
2 Lower managerial, professional	34.1	45.1	70.2	128.1	200.2	323.7	566.6	942.4
3 Intermediate	60.1	79.6	89.3	98.5	242.4	396.3	564.3	1,006.2
4 Small employers, own account workers	85.9	97.8	103.8	137.7	251.9	387.2	633.7	1,005.6
5 Lower supervisory and technical	55.4	64.6	94.0	155.1	280.1	473.4	823.4	1,405.8
6 Semi-routine	85.5	124.6	166.6	257.1	383.4	602.6	964.6	1,585.4
7 Routine	110.2	140.2	181.1	265.8	439.4	676.2	1,004.0	1,699.2

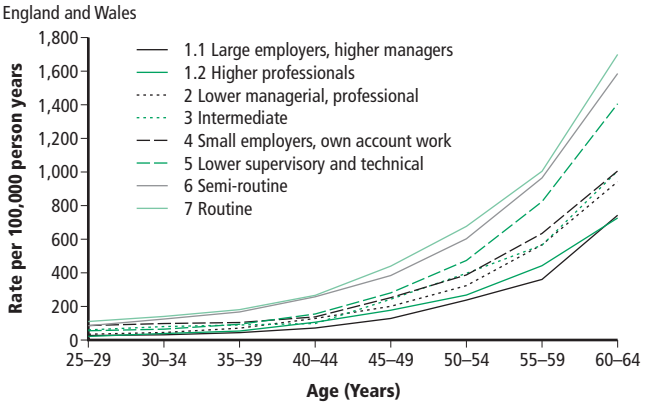
1 Age-specific rate per 100,000.

2 Reduced derivation.

3 Incorporating adjustment to death counts in classes 2 and 3 for misallocation of certain occupations.

Source: Death occurrences 2001–03; Census 2001, Mid-year population estimates 2001–03; Office for National Statistics Longitudinal Study

Figure 1 Age-specific mortality rates by five year age group and NS-SEC:[1,2] men aged 25–64, 2001–03: death registrations



1 Reduced derivation; occupied NS-SEC classes only.

2 Incorporating adjustment to death counts in classes 2 and 3 for misallocation of certain occupations.

Source: Death registrations 2001-03 and optimised population estimates (see Methods)

mortality than **Small employers, own account workers** at ages 30–39, but this pattern reverses at ages 45–64 (see Figure 3), demonstrating that the lower age-standardised rate of death to men working as **Small employers, own account workers** compared with men in the **Lower supervisory and technical** analytic class is predominantly a function of their lower mortality risk at older ages.

Age-standardised mortality rates by NS-SEC and data source

Table 6 presents age-standardised mortality rates per 100,000 PYRs, with 95 per cent confidence intervals, by NS-SEC using the unlinked and linked approaches.

In the analysis of unlinked records, the mortality rate of men working in **Routine** occupations was 513 per 100,000 PYRs, nearly three times the rate of 182 per 100,000 in men working as **Large employers, higher managers**. Mortality rates differed significantly between each NS-SEC analytic class, with the gap between NS-SEC-specific rates most pronounced between men working as **Small employers, own account workers** and men working in **Lower supervisory and technical** occupations, and between men in **Lower supervisory and technical** occupations and **Semi-routine** occupations.

Table 6 Age-standardised mortality rates[1] by NS-SEC,[2] men aged 25–64, death registrations 2001–03[3] and LS sample 2001–04[4]

England and Wales — Rate per 100,000

NS-SEC analytic class	Death registrations			LS sample		
	Mortality rate	Lower 95 per cent confidence limit	Higher 95 per cent confidence limit	Mortality rate	Lower 95 per cent confidence limit	Higher 95 per cent confidence limit
1.1 Large employers, higher managers	182	177	187	219	176	272
1.2 Higher professionals	206	202	211	210	171	257
2 Lower managerial, professional	259	256	262	249	221	280
3 Intermediate	286	279	294	251	197	320
4 Small employers, own account workers	307	303	312	285	250	324
5 Lower supervisory and technical	374	369	379	348	307	395
6 Semi-routine	473	466	479	409	359	467
7 Routine	513	508	519	443	399	492
Never worked, long-term unemployed				989	784	1,248
Inadequately described and not classified for other reasons				442	62	3,134
England and Wales	369	367	371	320	305	336
Ratio 7:1.1	2.8			2.0		
Ratio 7:1.2	2.5			2.1		

1 Directly age-standardised rate using the European standard population.

2 Reduced derivation.

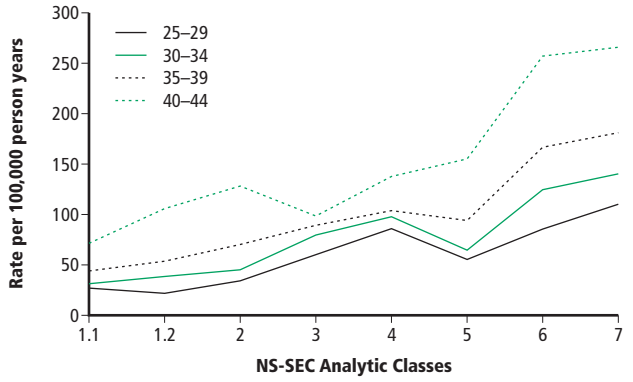
3 Incorporating adjustment to death counts in classes 2 and 3 for misallocation of certain occupations.

4 29 April 2001 to 31 December 2004.

Source: Death registrations 2001–03; optimised population estimates (see Methods); Office for National Statistics Longitudinal Study

Figure 2 Age-specific mortality rates by NS-SEC1,2 and five year age group, men aged 25–44, 2001–03: death registrations

England and Wales

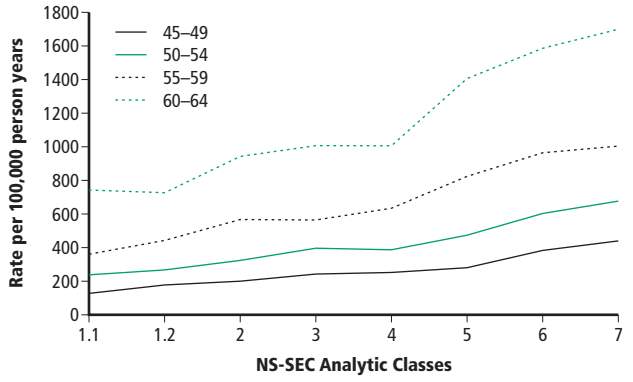


1 Reduced derivation; occupied NS-SEC classes only.
2 Incorporating adjustment to death counts in classes 2 and 3 for misallocation of certain occupations.

Source: Death registrations 2001–03 and optimised population estimates (see Methods)

Figure 3 Age-specific mortality rates by NS-SEC[1,2] and five year age group, men aged 45–64, 2001–03: death registrations

England and Wales



1 Reduced derivation; occupied NS-SEC classes only.
2 Incorporating adjustment to death counts in classes 2 and 3 for misallocation of certain occupations.

Source: Death registrations 2001–03 and optimised population estimates (see Methods)

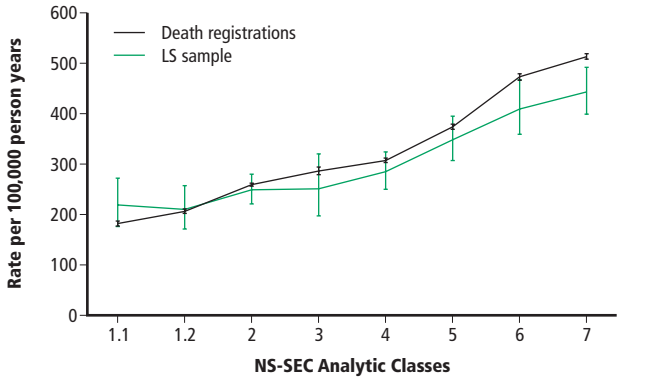
In the linked records analysis, age-standardised mortality rates were lower than or the same as the unlinked records rates in all analytic classes except the **Large employers, higher managers** analytic class (see Figure 4). However, only the difference for the **Routine** analytic class lay outside the 95 per cent confidence interval. A weaker gradient between **Large employers, higher managers** and men working in **Routine** occupations is found for the linked compared to the unlinked analysis, partly as a result of a higher rate of death in the **Large employers, higher managers** and partly due to a lower rate in the **Routine** analytic class.

The three NS-SEC analytic classes with a predominant service relationship form of employment regulation (that is, analytic classes 1.1, 1.2 and 2) have statistically significant lower rates of death compared with the three classes regulated by a labour contract (that is, classes 5, 6 and 7).

Men in the LS sample classified as **Never worked, long-term unemployed** had a rate of death of 989 per 100,000 PYRs, four and a half times higher than that of men working as **Large employers, higher managers**, and two and a quarter times higher than men working in **Routine** occupations.

Figure 4 Age-standardised mortality rate[1] by NS-SEC[2], men aged 25–64: death registrations 2001–03[3] and LS sample 2001–04[4]

England and Wales



1 Directly age-standardised rate using the European standard population.
2 Reduced derivation.
3 Incorporating adjustment to death counts in classes 2 and 3 for misallocation of certain occupations.
4 29 April 2001 to 31 December 2004.Source: Death registrations 2001–03 and optimised population estimates (see Methods).

Source: Death registrations 2001–03; optimised population estimates (see Methods); ONS Longitudinal Study

Table 7 Age-standardised mortality rates[1] by five class NS-SEC,[2] men aged 25–64, death registrations 2001–03[3]

England and Wales — Rate per 100,000

NS-SEC five class schema[4]	Mortality rate	Lower 95 per cent confidence limit	Higher 95 per cent confidence limit
1 Managerial and Professional (1.1, 1.2 & 2)	231	229	234
2 Intermediate (3)	286	279	294
3 Small employers and own account workers (4)	307	303	312
4 Lower supervisory and technical (5)	374	369	379
5 Semi-Routine and Routine (6, 7)	497	492	501

1 Directly age-standardised rate using the European standard population.
2 Reduced derivation.
3 Incorporating adjustment to death counts in classes 2 and 3 for misallocation of certain occupations.
4 Encompassed nine class schema included in parenthesis.

Source: Death registrations 2001-03; optimised population estimates (see Methods)

For comparison, the rates of death from the unlinked records analysis with and without the adjustment to operational categories L6-**Higher supervisory occupations** and L7-**Intermediate** occupations described earlier are shown in Figure A1 in the Appendix.

Mortality in condensed versions of NS-SEC

Table 7 presents age-standardised mortality rates per 100,000 PYRs, with 95 per cent confidence intervals, by NS-SEC analytic five class breakdown using the unlinked records method. The rate of death among men in the **Semi-routine and Routine** class is 2.2 times greater than that observed among men in the **Managerial and Professional** class, and a progressive, statistically significant pattern of increasing mortality with more disadvantaged socio-economic status is discernable between the intervening adjacent classes.

The corresponding mortality rates for the three class NS-SEC scale are presented in Table 8. The rate of death in men working in **Routine and Manual** occupations is twice as high as that in the **Managerial and Professional** analytic class, demonstrating the capability of the NS-SEC to discriminate mortality risk in its most condensed form.

Table 8 **Age-standardised mortality rates[1] by three class NS-SEC,[2] men aged 25–64, death registrations 2001–03[3]**

England and Wales — Rate per 100,000

NS-SEC three class schema[4]	Mortality rate	Lower 95 per cent confidence limit	Higher 95 per cent confidence limit
1 Managerial and Professional (1.1, 1.2 & 2)	231	229	234
2 Intermediate (3, 4)	301	297	304
3 Routine and Manual (5, 6 & 7)	454	451	457

1 Directly age-standardised rate using the European standard population.
2 Reduced derivation.
3 Incorporating adjustment to death counts in classes 2 and 3 for misallocation of certain occupations.
4 Encompassed nine class schema included in parenthesis.

Source: Death registrations 2001–03; optimised population estimates (see Methods)

Comparison with previous time periods

While direct comparison with earlier decennial analyses is difficult because of the change in socio-economic classifications, an indication of the scale of social inequalities over a thirty year period is presented in Table 9, based on a comparison of rates for the extremes of the RGSC and NS-SEC. Rates of death among men working in the most advantaged occupational group have fallen by more than 60 per cent since 1970–72, compared with only 40 per cent for those in the least advantaged group.

Table 9 **Comparison of age-standardised mortality rates in men aged 20-64 by RGSC for 1970–72, 1979–83 and 1991–93 and men aged 25–64 by NS-SEC for 2001–03**

England and Wales — Rate per 100,000

Socio-economic classification	1970–72	1979–83	1991–93	2001–03
RGSC class I	500	373	280	—
RGSC class V	897	910	806	—
Ratio class V to class I	1.8	2.4	2.9	
NS-SEC class 1.1				182
NS SEC class 7				513
Ratio class 7 to class 1.1				2.8

Source: Health Inequalities Decennial Supplement, Series DS No. 15, TSO: London for RGSC; death registrations for 2001-03 and optimised population estimates (see Methods)

The lower rate of death found in men working as **Large employers, higher managers** in 2001–03 compared with men working as professionals in 1991–93 is of a similar order of magnitude to the lower rate of death in men working in **Routine** occupations compared with men working in unskilled manual occupations. Consequently, the gradient in mortality persists despite the lower rates of death reported for NS-SEC analytic classes 1.1 and 7 compared with RGSC I and V.

Discussion

The age-standardised mortality rates by NS-SEC, calculated from death registrations and optimised class denominators and reported in Table 6, set a benchmark against which future analyses of mortality in men of working age can be compared. These rates represent the most valid and reliable estimates achievable from the design limitations imposed by the use of unlinked data sources. The concurrent use of the LS in this decennial analysis has shown its value by uncovering the presence of occupational data weaknesses in unlinked deaths and population records, which are capable of producing distortions in mortality estimates by NS-SEC.

This analysis shows a clear social gradient in mortality for men of working age in the early years of the 21st century. Although NS-SEC was not designed as a hierarchy of occupations,[33] each analytic class has a distinct and (in the unlinked records analysis) significantly different age-standardised all-cause mortality rate, showing a clear gradient from low mortality among men working as **Large employers, higher managers** or as **Higher professionals** through to high mortality in men working in **Routine** occupations. This suggests that the NS-SEC, which is based on employment relations, discriminates well between social groups with differing opportunities and experiences. The overall pattern between classes and the magnitude of the difference in mortality risk between the most advantaged and least advantaged occupational groups is similar to that found in previous analyses using RGSC.[3,7,9] The broad equivalence of most of the NS-SEC analytic classes to the RGSC classes occupying similar positions in the scale is apparent.

Even within the larger confidence intervals in the analysis using linked records, NS-SEC classes encompassing large employers, managers and professionals showed significantly lower mortality rates than the **Lower supervisory and technical, Semi-routine** and **Routine** analytic classes. The former three analytic classes are characterised by a service relationship and the latter three by a labour contract relationship, with the **Intermediate** and **Small employers, own account workers** having an intermediate employment relations position.[33] The division into **Professional and Managerial, Intermediate** and **Routine and Manual** classes in the most condensed version of the NS-SEC analytic classification[35] is thus a potentially useful one for the summary description of inequalities in mortality, while recognising that this will conceal important differences within the broader groupings.

The gradients in mortality by RGSC have been explained in the literature in terms of a clustering of attributes of advantage among professionals and disadvantage among unskilled manual workers,[46] and their accumulation and intensity over the life course.[47] Circumstances of disadvantage such as poor quality housing, exposure to environmental pollution in area of residence, occupational hazards, poor diet, smoking, risk of unemployment, and low income[48] were found to be finely graded between the social classes, most concentrated in social class V with diminishing levels of exposure for each step up the social hierarchy. The presence of a gradation of mortality risk across the hierarchy rather than coherence in mortality risk beyond a specific threshold has been used to justify the relevance of the materialist explanation for inequalities in health.[37] The mortality pattern by NS-SEC is also graded and may indicate a similar analytic class relationship to these domains of material disadvantage.

Explanations for inequalities in mortality related to employment relations concepts inherent to the NS-SEC such as work control and job strain (high demands in the presence of low control) have been addressed in previous research. The Whitehall II study showed an association between low job control, low employment grade and future development of heart disease,[49] while other studies have demonstrated a connection between high job strain and hypertension.[50,51] In addition to job strain, psycho-social work hazards such as effort-reward imbalance[52] (high effort and low rewards in terms of pay, security, recognition and career progression opportunities) and its influence on cardiovascular health has been investigated. The link between high blood pressure, harmful levels of blood lipids, and future development of cardiovascular disease was found in people experiencing effort-reward imbalance.[53,54,55] Further analyses reporting mortality patterns by NS-SEC in major causes of death will

provide more relevant evidence of the impact of employment relations on premature mortality from specific causes of death. Generally, the literature suggests that occupations with greater autonomy and control experience better health,[3,56] and the differences in mortality rates reported here support this conclusion.

The higher rate of premature death found among the **Never worked, long-term unemployed** compared to all men aged 25–64 in 2001 in the Longitudinal Study is consistent with previous analyses and demonstrates the persistent mortality disadvantage associated with this economic position.[7, 9, 17, 57, 58, 59, 60, 61] Men of working age found to be seeking work at both the 1971 and 1981 censuses had rates of death twice the average for England and Wales during the period 1981–92, while the current analysis reports a three-fold raised rate compared to all men aged 25–64 enumerated in 2001. The larger excess mortality found may be partly explained by the different definitions of unemployed in the censuses of 1971 and 1981 and at 2001. The latter indicates a period of unemployment lasting more than a year and encompasses the never worked, whereas the former is defined by an economic position of seeking work in the past week. The 2001 Census definition of long-term unemployed, used in the NS-SEC schema, represents a more marginalised population with apparent difficulty in securing a place in the labour market.

Previous research has challenged the confounding influence of pre-existing ill-health,[32, 57, 59] educational attainment,[60] housing tenure,[17] occupational class,[17, 57] or health-damaging behaviour[61] as adequate explanations for the higher rate of mortality found among those exposed to unemployment, suggesting a distinct, independent influence. The importance of unemployment for future mortality risk necessitates regular monitoring. We emphasise that mortality rates for the **Never worked, long-term unemployed** can only be reliably estimated using the linked records approach. The contrast between proportions of deaths classified to the **Never worked, long-term unemployed** at census and at death registration is marked, confirming death registrations do not capture the true population of unemployed individuals.

The age-specific mortality rates reported show that, with some exceptions, the patterns of mortality by NS-SEC class are consistent throughout the age range examined. Relative differences between classes are greater at younger ages, while absolute differences are greater at older ages. The pattern of age-specific rates among **Small employers, own-account workers** is unusual. Men in this analytic class had higher mortality than men in the **Lower supervisory and technical** analytic class at ages 25–34, but lower mortality than the **Intermediate** analytic class at ages 50–54. These findings merit further investigation, and the reasons may become clearer when the data are analysed by cause of death.

Differences between linked and unlinked results

Although the pattern of age-standardised mortality rates by NS-SEC is broadly similar whether the unlinked or linked record approach is used, there are three main differences, which are distinct but connected. The first difference relates to source of assignment of NS-SEC. The linked records approach allocates deaths to the NS-SEC class from the 2001 Census record, while the unlinked records approach allocates deaths from the death registrations records. The large discrepancy found between the death registrations and the LS sample in allocation to the 'inadequately described' suggests that the occupational information elicited at census is substantially more detailed and complete than that recorded at death registration. This is likely to reflect both the specific questions and coding rules, and the fact that reporting at death relies on the knowledge the informant has about the deceased.

A second difference between the census and death registrations in the designation of NS-SEC is particularly relevant for the capture of the **Long-term unemployed**. The 2001 Census defines the NS-SEC category of **Long-term unemployed** as having not worked since 1999 and seeking work, enabling derivation of this class from the last year worked indicator and economic activity. Consequently, the probability of recording completely and accurately this NS-SEC class is greater at census than at death registration. Death registration data for the period 2001–03 indicate some (0.4 per cent) men were designated to an NS-SEC of **Long-term unemployed**, but the rules for recording of occupation at death registration state the last gainful occupation should take precedence for persons currently unemployed (see Box A2).

The influence of differential capture of the **Long-term unemployed** on the resultant occupied class gradient in each approach may function through disproportionate risk of exposure to unemployment in some social groups more than others in the study period. A key component of employment relations, entrenched in the NS-SEC, is security of employment, with greater security in occupations regulated by a service relationship and less security in occupations regulated by a labour contract, with the strongest form of the labour contract found in the **Routine** analytic class.[33] It is plausible that the mortality rate in occupations regulated by a labour contract could be reduced in the linked records analysis by the exclusion of the **Long-term unemployed** from the relevant occupied NS-SEC classes.

The differences in both the rules of assignment of NS-SEC by source and the capture of the **Long-term unemployed** are possible explanations for the somewhat higher mortality rate found among **Large employers, higher managers** and the lower rates for all other analytic classes in the linked records analysis. However, the difference between the class-specific rates produced by the two approaches is statistically significantly lower only for the **Routine** analytic class. The narrower gradient found in this analysis of linked records compared with that found using unlinked records is consistent with previous analysis of linked records in the four years immediately following the assignment of RGSC at the 1971 Census.[6]

Increasing the length of follow-up of men in the LS has been the traditional approach to mitigating the distorting impact of health selection out of the labour market, producing social gradients of mortality similar to decennial analyses.[36, 62, 66] The approach adopted here of assigning the NS-SEC class from census records in 1991 for men allocated to an unoccupied NS-SEC in 2001 leaves a 40 per cent narrower gradient than that found in unlinked records. Comparison of allocations to the **Routine** analytic class at death showed 38 per cent were assigned to a higher NS-SEC at census, while allocations at census showed 32 per cent were assigned to a higher class at death. Consequently, there is a 20 per cent greater likelihood of demotion to the **Routine** analytic class at death than promotion from it, which may partly explain the lower rate found when assigning the death to the **Routine** analytic class at census, and hence the lower gradient.

Thirdly, the all-class mortality rate produced by the linked records analysis is lower than the unlinked records all-class mortality rate. Since the latter is based on all deaths registered to residents of England and Wales, it is assumed to be accurate. The observed difference does not appear to be due to sample variation, but may be influenced by loss to follow-up due to an unknown rate of unobserved emigration out of England and Wales, and the known under-enumeration at the 2001 Census.[63] Because of the greater concentration of that under-enumeration in disadvantaged sections of the population, it is possible that the effect would again be to reduce the mortality gradient found across NS-SEC classes.

Comparison with previous findings

The results reported here are largely consistent with an unlinked records analysis of mortality in 1991–93,[3] which used an early version of NS-SEC90 (not identical to the version of NS-SEC90 used above to adjust for health selection). However, that analysis found a lower standardised mortality ratio among **Small employers, own-account**

workers compared with men working in **Intermediate** occupations. A separate analysis of mortality in 1991–95 of men in the LS who were present at the 1991 Census (not reported here) shows a similar though non-significant pattern. Neither of these analyses was able to make any allowance for health selection. This difference may therefore be due to the limited comparability of the classifications used, health selection effects, and/or changes over the intervening decade in the age and class distribution of the population. The latter possibility is supported by the fact that the proportion of men aged 60–64 in the LS sample who were allocated to the **Small employers, own account workers** analytic class increased from 11 per cent in 1991–95 to 18 per cent in 2001–04, while the proportion allocated to the **Intermediate** analytic class fell from 7 per cent to 5 per cent in the same period.

A reliable comparison with findings on social inequalities in mortality for previous time periods is difficult because of the change in socio-economic classification. The ratio of the mortality rates of the most advantaged and least advantaged NS-SEC analytic classes is of a similar magnitude to that found between the broadly equivalent RGSC classes in the preceding decade. The similarity of the ratio of 2.8 in 2001–03 to that of 2.9 in 1991–93 reinforces the strength of each classification to discriminate mortality risk by socio-economic status. The measurement of inequalities in mortality by RGSC was criticised for comparing the relatively small populations at each end of the socio-economic spectrum, which had limited relevance to the vast majority of the population assigned to the intervening classes. This NS-SEC analysis has demonstrated that the scale of inequality holds when comparison is extended to a larger group of occupations designated to the **Routine** analytic class, and suggests the gradient by RGSC found earlier is not simply an artefact of an ever diminishing, more disadvantaged population of men concentrated in social class V. The restriction of the study population to men aged 25–64 in 2001–03 together with the larger populations of men within the **Large employers, higher managers** and **Routine** analytic classes may be consistent with increasing social inequalities in adult male mortality; however, further analysis is needed to produce reliable comparisons over time between figures based on RGSC and those using NS-SEC.

Limitations of the analysis

The age range of the study population ensured that the majority of men included would be in permanent employment in 2001, and could therefore be assigned to an occupied NS-SEC class. Because some of the steepest socio-economic gradients in adult mortality are those from accidents and violence in younger men,[64,65] the lower age limit of 25 years may lead these results to understate the extent of inequalities in the adult male population as a whole.

The methods used were designed to reduce the artefactual effect of health selection out of the labour market. The possible substantive impact of health-related social mobility on social inequalities in mortality is a separate though related question, and can only be addressed through longitudinal analysis. Previous research using the LS data has indicated that selection in the latter sense was not a major cause of the well-established patterns in mortality by RGSC, but is likely to be a constraining factor.[39, 40, 66] There is no apparent reason why such effects should have greater influence in analysis by NS-SEC, but future research will address this possibility.

This analysis has not addressed trends over time, except through the comparison of overall mortality gradient. Further analysis is required to provide a reliable basis for the comparison of mortality before and after the introduction of NS-SEC in 2001. Reporting of trends in life expectancy from the 1970s to date using RGSC, based on the LS only, will therefore continue to be of key importance for some time. The most recent update of the time series in life expectancy by RGSC covers the period 2002–05.[67] Future research will also test the feasibility of producing an inter-censal time series of mortality estimates by NS-SEC, using denominators based on national survey data.

Conclusions

This analysis of adult male mortality by NS-SEC provides an indication of the health impact of different social and occupational circumstances in England and Wales during the early 21st century. The age-standardised mortality rate among men aged 25–64 in routine occupations in 2001–03 was found to be 2.8 times the rate among men working as **Large employers, higher managers**. While direct comparisons cannot be made with previous time periods because of the change in socio-economic classification, it is clear from these results that a substantial and consistent social gradient in mortality continues to be in evidence.

The methods used in this analysis involved detailed consideration of the sources of bias and other weaknesses in the individual data sources, and their likely impact on the calculation of mortality rates by socio-economic status. The methodological advantages of record linkage in the LS were used to adjust the unlinked records measurement, allowing greater confidence in the validity of the resulting estimates. The combination of unlinked and linked records approaches provides robust, statistically significant estimates of mortality for men in occupied NS-SEC classes.

The figures presented here based on the unlinked records approach are recommended for overall description of social inequalities in mortality in England and Wales and further disaggregation by cause of death and geographical area. The linked records approach, drawing on more complete and accurate assignment of individuals to NS-SEC classes, allows mortality in non-occupied groups to be estimated but is likely to underestimate the mortality of the least advantaged occupied men.

This analysis confirms the value of NS-SEC for the examination of mortality inequalities in men of working age. A clear social gradient in mortality can be distinguished whether using the nine, five, or three analytic class version of NS-SEC. Each class had a significantly different age-standardised mortality rate from the others within each version. The more condensed versions give a smaller, but still substantial, difference between the most advantaged and least advantaged groups.

Key findings

- In 2001–03, the age-standardised mortality rate of men aged 25–64 in routine occupations was 513 per 100,000 population, 2.8 times the rate of 182 per 100,000 among men in higher managerial occupations
- The National Statistics Socio-Economic Classification (NS-SEC), which was introduced in 2001 to replace Registrar General's Social Classification (RGSC), provides a clear and consistent basis for the analysis of mortality in adult men
- There were statistically significant differences in mortality rates between all NS-SEC classes in a clear socio-economic gradient, whether using the full (nine class) or condensed (five or three class) version
- The mortality gradient found in this analysis is similar to the ratio of 2.9 times reported between men in unskilled manual occupations and professional men in 1991–93, based on RGSC
- Cross-sectional (unlinked records) analysis using death registrations and synthetic populations based on the 2001 Census and ONS annual population estimates, adjusted for biases identified in linked records in the ONS Longitudinal Study, can provide precise and robust estimates of mortality

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Box A1 Questions on occupation and employment in the 2001 Census

Answer the remaining questions for the *main* job you were doing last week, or if not working last week, your last *main* job.

- Your *main* job is the job in which you usually work the most hours

25 Do (did) you work as an employee or are (were) you self-employed?

☐ Employee

☐ Self-employed with employees

☐ Self-employed/freelance without employees

26 How many people work (worked) for your employer at the place where you work (worked)?

- If you are (were) *self-employed*, tick to show how many people you employ (employed)

☐ 1 - 9

☐ 10 - 24

☐ 25 - 499

☐ 500 or more

27 What is (was) the full title of your *main* job?

- For example, PRIMARY SCHOOL TEACHER, STATE REGISTERED NURSE, CAR MECHANIC, TELEVISION SERVICE ENGINEER, BENEFITS ASSISTANT
- Civil Servants, Local Government Officers - give job title not grade or pay band

28 Describe what you do (did) in your *main* job.

29 Do (did) you supervise any other employees?

- A supervisor or foreman is responsible for overseeing the work of other employees on a day-to-day basis

☐ Yes

☐ No

30 What is (was) the business of your employer at the place where you work (worked)?

- For example, MAKING SHOES, REPAIRING CARS, SECONDARY EDUCATION, FOOD WHOLESALE, CLOTHING RETAIL, DOCTOR'S SURGERY.
- If you are (were) self-employed/freelance or have (had) your own business, what is (was) the nature of your business?
- Civil Servants, Local Government Officers - please specify your Department

Box A2 Recording of occupation and employment status at death registration

Occupation refers to the latest gainful employment followed by the person concerned up to the date of the birth, still-birth, death or marriage. This includes any job regularly engaged in, for whatever hours are regarded as normal, permanent or temporary in the particular occupation. Regular paid employment for a few hours a day is thus included. Unemployed persons should have their last gainful occupation recorded. If they have never worked, a line should be drawn through the space or column. Where the informant or person(s) to be married have a non-gainful occupation (e.g. Home duties) this may be recorded if requested. Retired persons should be described by reference to their last full-time occupation followed by the word 'retired' in brackets, e.g. 'Railway engine driver (retired)', 'Staff nurse (retired)'. Persons unable to work through ill-health or disability, should be described by their last gainful occupation; it is immaterial how long ago this was or whether incapacity is temporary or permanent. Where an informant to a death entry wishes an occupation to be recorded as 'Housewife/Househusband', 'Home Duties' or similar, this may be recorded. However, where the person in question was previously in gainful occupation, details of that occupation, with the informant's agreement, should be recorded.

Employment status is also elicited from the informant. Registrars ask whether the deceased was:

1. Employee not supervising others
2. Employee supervising others
3. Self-employed without employees
4. Self-employed with employees
5. No gainful occupation

These categories are then used to determine employment status in combination with the occupational details provided, in the following categories:

A. Employers (derived from occupation and category 4 above)
B. Self-employed, no employees (derived from category 3 above)
C. Manager (derived from occupation if SOC2000 code has prefix of 1 and category 2 reported above)
D. Supervisor (derived from occupation if SOC2000 code has prefix other than 1 and category 2 reported above)
E. Other employees (if category 1 reported above)
F. Pseudo-employment status code (if no gainful employment reported)

Categories 1 and 2 include directors, managers, foremen, gaffers, family workers, apprentices, trainees, etc, as well as all other persons employed by any person or company.

With regard to the identification of categories 1 and 2 as described above, descriptions such as manager, foreman, etc, may already be included in the occupation details supplied by the informant. There may be instances however where this will not be the case and in addition it will not be possible to deduce the applicable category from the stated occupation. In such circumstances an enquiry of the informant as to whether the occupation also carried responsibility for overseeing the work of other employees on a day-to-day basis, may enable the appropriate category to be established. Where information is not available and therefore the precise category cannot be determined, category 1 should be used.

Category 3 includes out-workers (persons working in their own homes for an employer), members of a partnership without paid employees, all parochial clergy, and all other self-employed persons, without paid employees.

Category 4 includes proprietors of businesses, medical and dental practitioners in general practice, and other self-employed persons provided they have paid employees or paid assistants.

Category 5 includes persons who have never had any occupations and are without private means.

Where 'housewife', 'househusband' or similar has been recorded in the register, completed with details of the person's last gainful occupation, the employment status applicable should reflect the last gainful occupation. The same applies where the person is unemployed or retired and the last gainful occupation is recorded in the register.

Box A3 National Statistics Socio-Economic Classification – Operational categories and analytic classes

Operational categories	Analytic classes			
	Nine class version	Eight class version	Five class version	Three class version
L1 Employers in large organisations	1.1 Large employers and higher managerial occupations	1 Higher managerial and professional occupations	1 Professional and managerial occupations	1 Professional and managerial occupations
L2 Higher managerial occupations				
L3 Higher professional occupations	1.2 Higher professional occupations			
L4 Lower professional and higher technical occupations	2 Lower managerial and professional occupations	2 Lower managerial and professional occupations		
L5 Lower managerial occupations				
L6 Higher supervisory occupations				
L7 Intermediate occupations	3 Intermediate occupations	3 Intermediate occupations	2 Intermediate occupations	2 Intermediate occupations
L8 Employers in small establishments	4 Small employers and own account workers	4 Small employers and own account workers	3 Small employers and own account workers	
L9 Own account workers				
L10 Lower supervisory occupations	5 Lower supervisory and technical occupations	5 Lower supervisory and technical occupations	4 Lower supervisory and technical occupations	3 Routine and manual occupations
L11 Lower technical occupations				
L12 Semi-routine occupations	6 Semi-routine occupations	6 Semi-routine occupations	5 Semi-routine and Routine occupations	
L13 Routine occupations	7 Routine occupations	7 Routine occupations		
L14 Never worked and Long-term unemployed	8 Never worked and Long-term unemployed	8 Never worked and Long term unemployed	6 Never worked and long-term unemployed	4 Never worked and Long-term unemployed

Source: NS-SEC User Manual