Living in the 21st century: older people in England THE 2006 ENGLISH LONGITUDINAL STUDY OF AGEING (Wave 3), edited by James Banks, Elizabeth Breeze, Carli Lessof and James Nazroo, Institute for Fiscal Studies, July 2008, ISBN13: 978-1-903274-54-5

NOTE: This is an updated version of Chapter 8, correcting errors found in the data originally used. [December 2008]

8. Mortality and healthy life expectancy

James Nazroo *The University of Manchester*

Paola Zaninotto *University College London*

Edlira Gjonça *University College London*

This chapter examines the incidence of mortality in the English population aged 50 and over living in private households. It explores demographic, socio-economic and lifestyle factors associated with increased risk of mortality and how mortality is patterned across the year (excess winter mortality), and estimates the proportion of remaining life that will be spent in good health. Key points arising from this chapter are:

- Risk of death was higher for men than women for all ages studied here. In a multivariate analysis adjusting for demographic, behavioural and socio-economic factors, men aged 50 and over had on average an 86% higher risk of dying (hazard ratio 1.86, 95% confidence interval [CI] 1.64–2.12).
- Risk of death was lower for those living with a partner (married or not) than for those living without a partner, and for those who were married compared with those who were not. In a multivariate analysis those who were widowed had an 18% greater risk, those who were separated or divorced a 39% greater risk and those who had never married a 49% greater risk, compared with those currently married.
- The incidence of mortality was strongly patterned by the three socio-economic indicators examined here: level of qualifications, occupational class and wealth. In bivariate analyses stratified by age and sex:
    - There were generally more deaths among those without qualifications and fewer among those with a degree or higher qualification, compared with those with an ‘intermediate’ level of qualification.
    - Those in routine and manual occupations had a higher risk of death than those in intermediate occupations, while those in managerial and professional occupations had a lower risk, generally.
    - Risk of mortality by wealth was similarly graded, with those in the richest wealth quintile having the lowest risk and those in the poorest wealth quintile having the highest risk.

- In multivariate analyses, where all three socio-economic measures (qualifications, occupational class and wealth) were included in a joint model, together with demographic and lifestyle measures, wealth was the only socio-economic measure that predicted risk of mortality. This may be because wealth is a more accurate marker of socio-economic position at older ages than the other measures, or because the effects of education and occupational class operate through wealth.
- The three lifestyle factors examined (physical activity, smoking and drinking alcohol) were all associated with risk of mortality in multivariate analyses accounting for demographic and socio-economic effects:
  - Those who were physically inactive had more than twice the risk of death compared with those who had the highest level of physical activity (hazard ratio 2.30, 95% CI 1.80–2.93).
  - Compared with those who had never smoked, ex-smokers had a 22% greater risk of mortality and current smokers had a 78% greater risk of mortality.
  - Compared with those who never drink alcohol and those who drink daily, occasional drinkers had a reduced risk of mortality (hazard ratio 0.80, 95% CI 0.69–0.92, in comparison with those who never drink alcohol).
  - Although these analyses are longitudinal, the interpretation of the strength of these associations should be made cautiously, because behaviours may change after the onset of disease but before death.
- Analysis of deaths by the month of year in which they occur shows the expected excess occurring in the winter months of December to March compared with other months (11.8% of deaths in those months were excess winter deaths). An unusual peak of deaths occurred in the month of October and if these deaths are excluded from the analysis, the estimate of excess winter mortality increases to 17.2% of deaths occurring in the period December to March, which is 7.0% of all deaths.
- The excess of deaths in winter months was not clearly patterned by age, cohabiting status, central heating, quality of accommodation or socio-economic position. However, the risk was higher for women.
- Three estimates of life spent in good health were used: life expectancy with excellent or good health (rather than fair or poor health); life expectancy without a limiting illness; and healthy life expectancy, estimated using measures of mobility, activities of daily living and instrumental activities of daily living:
  - For all three measures, at older ages an increasing proportion of life expectancy is spent without good health. For example, men aged 50–54 are estimated to spend 21% of their remaining life with a disability, compared with 36% for men aged 75–79, while for women in the same age groups the figures are 27% and 46%, respectively.
  - The three measures used give different estimates of the proportion of life to be spent unwell or disabled. For example, men aged 50–54 are

estimated to spend 8.2 years with fair or poor self-rated health, 10.3 years with a limiting long-standing illness and 6 years with a disability. This is not surprising, because they represent different dimensions of health, but this sensitivity to the measure used is important for policy.

8.1 Introduction

The patterning and predictors of mortality at older ages is of increasing relevance to policy and has been an increasing focus of research. In developed countries mortality at young ages is very low, so improvements in mortality come mainly from declines in mortality rates at older ages. In fact, the further ageing of the already older populations of developed countries, which have been characterised by both low fertility and low mortality, is now largely driven by declines in mortality rather than declines in fertility (Preston, Himes and Eggers, 1989). In addition, governments are concerned with socio-economic differences in mortality, but research on socio-economic inequalities in health and mortality has traditionally focused on the working-age population, so there is a need for more data on the socio-economic patterning of mortality at older age, as well as health and disability. There is more research on one of the central areas of policy concern, the excess of deaths that occur in the winter months. Nevertheless, there remains uncertainty about the primary causes of this excess and, therefore, appropriate policy responses. Finally, while it is known that there have been large improvements in mortality, less is known about how much time is spent unwell, or in disability, prior to mortality, something that is clearly of relevance to health, social care and economic policy. Recent evidence suggests that the prevalence of chronic disability has declined alongside increases in life expectancy, and has declined faster in recent periods than previously (Manton, Corder and Stallard, 1997; Manton and Gu, 2001; Bobak et al., 2004; ONS, 2008). If this is the case, increases in life expectancy may not be associated with increases in levels of dependency and the associated increases in health and social welfare costs.

ELSA allows us to explore the patterning of mortality at older ages in relation to a number of determinants. The analyses presented in this chapter examine demographic and socio-economic factors associated with mortality at older ages and how mortality varies across the months and seasons of the year and the factors that might relate to seasonal variation, and estimate the proportions of life that people at older ages spend in poor health or disabled.

8.2 Descriptive analysis of mortality rates

In this section we describe the patterning of mortality of the ELSA population by sex, age, socio-economic and behavioural factors. We study deaths that occurred from wave 1 of ELSA (2002–03) up to early January 2008. We only include in these analyses deaths occurring to core wave 1 ELSA respondents who agreed to have their data linked to mortality records and did not withdraw that consent. Such consent was given by 10,799 (96% of those eligible) ELSA respondents, with the majority of the remaining respondents not consenting to have their data linked to mortality records when first asked, and a very small

Table 8.1. Deaths occurring after wave 1, by age and sex at wave 1

Respondents in 2002–03 who gave consent for mortality record

	50–64	65–74	75–84	85+	All
	%	%	%	%	%
Men	4.1	14.4	32.0	60.6	12.9
Women	2.5	7.8	21.8	53.5	10.6
Unweighted N					
Men	*2,572*	*1,414*	*769*	*165*	*4,920*
Women	*2,993*	*1,617*	*1,013*	*256*	*5,879*

number withdrawing their consent at a subsequent interview (11 respondents). As almost all ELSA wave 1 respondents are included in the sample used here, the analyses in this section use the wave 1 weight, which adjusts for non-response to the wave 1 interview.

Over the period studied (from wave 1 (2002–03) to early January 2008) 1,222 deaths occurred, equating to 11.3% of the sample. Table 8.1 shows the patterning of mortality during this period by sex and age, and shows the expected higher mortality rate for men (at all ages) and for older people.

The first block of Table 8.2 shows death rates by partnership status (living with a partner, including a spouse, compared with not living with a partner), while the second block of Table 8.2 shows death rates by marital status.

Table 8.2. Deaths occurring after wave 1, by age, sex, and cohabiting and marital status at wave 1

Respondents in 2002–03 who gave consent for mortality record

	Partnership status		**Marital status**			
	Living with partner	Not living with partner	Married	Separated or divorced	Widowed	Never married
	%	%	%	%	%	%
Men						
50–59	2.2	7.3	2.3	6.1	[2.3]	6.1
60–74	10.4	15.7	10.1	15.5	18.3	14.8
75+	32.1	46.5	32.1	–	46.7	[38.7]
Women						
50–59	1.8	2.9	1.8	3.0	0.0	5.1
60–74	4.9	9.1	4.9	7.1	9.5	9.9
75+	22.7	32.7	23.2	[31.8]	32.3	35.3
Unweighted N						
Men						
50–59	*1,497*	*312*	*1,393*	*238*	*38*	*139*
60–74	*1,740*	*437*	*1,711*	*182*	*156*	*128*
75+	*596*	*338*	*607*	*28*	*266*	*33*
Women						
50–59	*1,657*	*497*	*1,569*	*371*	*113*	*101*
60–74	*1,580*	*876*	*1,550*	*277*	*538*	*90*
75+	*381*	*888*	*385*	*43*	*752*	*89*

Table 8.3. Deaths occurring after wave 1, by age, sex and socio-economic position at wave 1

Respondents in 2002–03 who gave consent for mortality record

	Men			Women		
	50–59	60–74	75+	50–59	60–74	75+
	%	%	%	%	%	%
Qualifications						
Degree or higher	2.0	6.6	35.0	2.7	3.5	[15.0]
Intermediate	2.9	10.4	33.0	1.6	5.1	24.4
No qualification	4.7	13.8	40.1	2.3	7.8	31.0
NSSEC occupational class						
Managerial and professional	1.7	8.0	33.5	1.7	4.8	23.8
Intermediate	4.0	11.2	35.5	2.1	4.8	25.2
Routine and manual	4.0	13.9	40.7	2.1	8.0	33.6
Total wealth quintile						
Richest	1.4	6.3	30.5	2.2	2.6	22.3
4th	1.4	8.1	31.6	0.7	4.6	25.4
3rd	1.0	12.5	28.2	2.3	5.9	23.2
2nd	5.3	15.4	41.8	2.2	6.4	30.7
Poorest	9.0	16.5	49.8	3.0	12.8	37.2
Unweighted N						
Qualifications						
Degree or higher	*360*	*275*	*94*	*252*	*148*	*40*
Intermediate	*991*	*992*	*341*	*1,161*	*1,033*	*356*
No qualification	*423*	*862*	*478*	*654*	*1,187*	*752*
NSSEC occupational class						
Managerial and professional	*739*	*704*	*348*	*614*	*534*	*209*
Intermediate	*374*	*408*	*161*	*566*	*690*	*348*
Routine and manual	*689*	*1,057*	*424*	*942*	*1,180*	*624*
Total wealth quintile						
Richest	*406*	*484*	*172*	*503*	*487*	*151*
4th	*432*	*447*	*165*	*431*	*495*	*198*
3rd	*356*	*430*	*176*	*434*	*520*	*224*
2nd	*339*	*442*	*188*	*413*	*488*	*271*
Poorest	*260*	*362*	*228*	*328*	*451*	*424*

The analysis of mortality by partnership status shows the clear advantage of those living with a partner for all ages and both men and women. This pattern is repeated for the analysis by marital status, with men and women who are married having lower mortality rates than others. With the exception of widowed women aged 50–59, both men and women who are separated or divorced, widowed or never married have a similar level of higher risk of mortality.

Table 8.3 examines mortality rates by three markers of socio-economic position: qualifications, occupational class and wealth. For qualifications the sample is divided into three groups: ‘degree or higher’, ‘intermediate qualifications’ and ‘without qualification’. The analyses show that for both males and females and at all ages (except women aged 50–59) there are more deaths among those without qualification and, with the additional exception of men aged 75 or older, fewer deaths among those with a degree or higher qualification.

NSSEC is used for the analysis by occupational class, and the sample is divided into three groups: managerial and professional, intermediate, and routine and manual occupations. For both sexes there is a clear ascending trend in deaths by occupational class, with more deaths occurring to people in the routine and manual class and fewer deaths for those in the managerial and professional class. This pattern is repeated for all age groups.

Finally, Table 8.3 also shows the distribution of deaths by age and total wealth quintile. Again, the distribution of deaths for all groups, except women aged 50 to 59, shows a very clear descending pattern of deaths from the poorest to the richest groups. For example, among the poorest wealth group 49.8% of males aged 75 and over and 37.2% of females aged 75 and over have died since wave 1 compared with only 30.5% of males and 22.3% of females of the same age from the richest wealth group. Focusing on absolute differences in rates between wealth groups suggests that the pattern is accentuated by age, but this is, of course, related to higher mortality rates at older ages. In relative terms inequalities in mortality rates across wealth groups reduce with age.

8.3 Factors predicting mortality

This section of the chapter aims to examine the contribution of different determinants to mortality for the population aged 50 and older, many of which feature in the list of targets for interventions to reduce health inequality (Department of Health, 2005). Building on the descriptive analysis shown in Section 8.2, we examine three categories of explanation:

- *Demographic:* age, sex, marital status, living arrangements;
- *Socio-economic:* education, occupational class (NSSEC), wealth;
- *Behaviour:* smoking, drinking pattern, physical exercise.

These factors are thought to affect health and mortality through interactive mechanisms. As Hummer, Rogers and Eberstein (1998) state, mortality should be conceptualised as a process that is influenced by direct and indirect variables. For example, socio-economic determinants could, and perhaps should, be conceptualised as working through psychosocial, behavioural, psychological, health care and biological factors.

Research on socio-economic mortality differentials is an established field of study. A range of socio-economic factors has been examined in relation to mortality, such as: income, wealth, social class, employment, education, etc. Duncan (1961) describes the connection between some of these elements as follows: ‘Education qualifies the individual for participation in occupational life, and pursuit of an occupation yields him a return in the form of income’ (p. 783). Socio-economic status is thought to be one of the strongest predictors of mortality. Factors such as occupational class, educational attainment, wealth and housing quality have been shown to affect mortality through a number of pathways (Kitagawa and Hauser, 1973; Smith, 1998; Brunner et al., 1999; Elo and Preston, 1996; Marmot et al., 2000). However, much of the research in this field has typically concentrated on the middle-aged, working population, and men, and has neglected the older population. This is in part because the indicators of socio-economic status commonly used in the UK have been based on occupation, which is less relevant and more difficult to measure for economically inactive people, such as those post-retirement, or women who are not in paid employment. Nevertheless, there is a growing body of evidence showing that the socio-economic differentials persist after retirement (Kitagawa and Hauser, 1973; Fingerhut, Wilson and Feldman, 1980; Marmot, Kogevinas and Elston, 1987; Williams, 1990; House, Kessler and Herzog, 1990; Breeze, Sloggett and Fletcher, 1999; Marmot, 2004; Gjonça, 2007), even if socio-economic differentials reduce, in relative terms, at older ages (Deaton and Paxson, 1998; Beckett, 2000; Mishra et al., 2004; House, Lantz and Herd, 2005; McMunn et al., under review).

In addition to examining socio-economic differentials by occupational class, there is value in exploring the impact of education and wealth. There is considerable evidence that an individual's educational attainment is strongly correlated with health and mortality (Preston and Taubman, 1994; Winkleby et al., 1992), and a measure of education is available for those who are not currently in the labour force. Compared with other socio-economic indicators, education is also a more consistent measure and one that is more easily collected (Preston and Elo, 1995). Importantly, its level is less likely than other measures of socio-economic position to be influenced by health problems that develop in adulthood. Indeed, Smith and Kington (1997) suggest that, because of its prior timing relative to current health, education is less likely to reflect 'reverse causation'. However, the fact that education is a distal measure also makes it less able to reflect accumulated socio-economic risks and benefits.

Wealth is a particularly useful measure of socio-economic position for people in older age, because it reflects both accumulated socio-economic position and potential for current consumption. Indeed, some have suggested that wealth is a more important measure of economic status than income, especially for people who are retired (Hurd, 1989; Smith and Kington, 1997). In part this is because an older person's current income largely reflects their pension, but resources to support consumption can be supplemented by spending down financial assets, or wealth. In such cases studying income alone may give a false impression of economic well-being.

Methods and data description

Data covering the period from wave 1 of ELSA (2002–03) to early January 2008 are used for a longitudinal modelling of mortality risk over a 70-month period. This means that the data are left truncated (that is, they do not capture mortality prior to the start of ELSA, so reflect the risks for 'survivors', which are particularly important at older ages). For the purpose of these analyses, we are interested in a particular event, the death of a member of the study. The period until that event is known as the risk period. The temporal sequencing of such data, known as time-to-event, or survival, data, is best approached using survival analysis. In survival analysis there is a *time of entry* and the *time of* *exit*. Time of entry is the time when the subjects start to be observed, which in our case corresponds to the time wave 1 interviews began (March 2002). The end point (or time of exit) is, for those who died, month and year of death and, for those who did not die, January 2008, which is the last date to which the cases are followed. At this point we censor in cases of people who are still alive by the end of study.

As described in Section 8.2, only deaths occurring to core wave 1 ELSA respondents who agreed to have their data linked to mortality records and did not withdraw that consent are included in this analysis. This gives a total of 10,799 respondents and 1,222 deaths. Survivor functions were estimated using the Kaplan Meier (KM) product-limit estimator method and the hazard function using Cox proportional hazards models (Cox, 1972). For estimating both the survivor function and the cumulative hazard function we have used STATA 10. All analyses use the ELSA wave 1 weight and are age adjusted (using a categorical measure to capture non-linear effects).

Results

Survival functions were constructed for a range of the factors that could be associated with mortality. A selected number of these analyses are shown for illustrative purposes in Figures 8.1 to 8.7. Figure 8.1 shows survival by marital status. Those who are married have the highest survival rates for both men and women, followed by those who are ‘separated’ (which includes those who are divorced). For men, those who are widowed are at a clear disadvantage.

Survival analysis by wealth, shown in Figure 8.2, shows a very clear gradient for both sexes. Those within the highest wealth quintile have the highest survival chances, followed by those who are in the fourth wealth quintile and so on. Similar findings are present for NSSEC occupational class (Figure 8.3), with those in ‘managerial’ (and professional) occupations having the highest chances of survival followed by those in ‘intermediate’ occupations, while those in ‘routine and manual’ occupations had the lowest chance of survival. Results for the more distal socio-economic measure, educational qualifications (Figure 8.4), also show a clear difference in survival for both sexes, with those who report having a degree having the highest chances of survival, followed by people who have an ‘intermediate’ level of educational attainment, and those with ‘no qualification’ having the lowest chance of survival.

Finally, we also built survival functions for three behavioural factors: drinking alcohol, smoking and physical activity. For both men and women, those who do not drink alcohol have a lower chance of survival than those who do (Figure 8.5). For men there is an overlap in the survival curves for those who report ‘drinking daily’ and ‘drinking occasionally’. The pattern is different for women, for whom those who drink alcohol ‘occasionally’ have a greater chance of survival than those who drink ‘daily’.

Analysis of survival by smoking pattern (Figure 8.6) shows the expected advantage for non-smokers, particularly for men, but does not show a clear difference between ex-smokers and current smokers. This failure to demonstrate the benefits of giving up smoking could, of course, reflect the fact that when people become ill they might stop smoking.

Figure 8.1. Survival after wave 1, by sex and marital status at wave 1

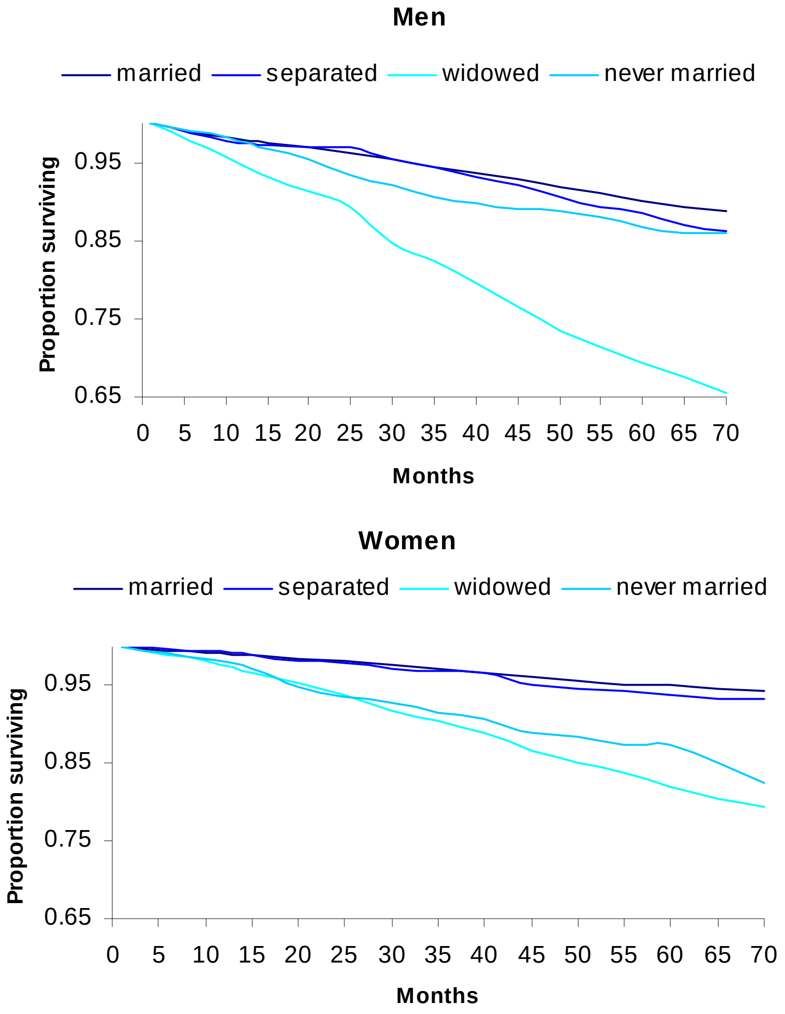


Figure 8.2. Survival after wave 1, by sex and total wealth at wave 1

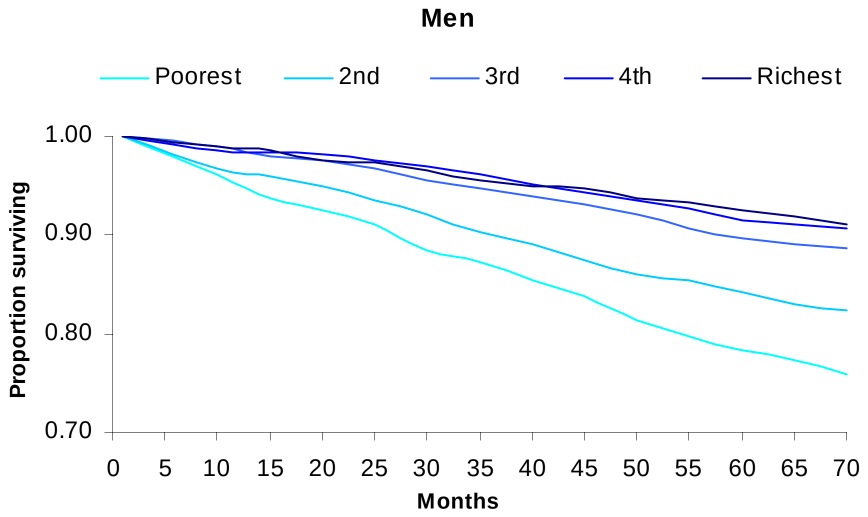


Figure 8.2 continued

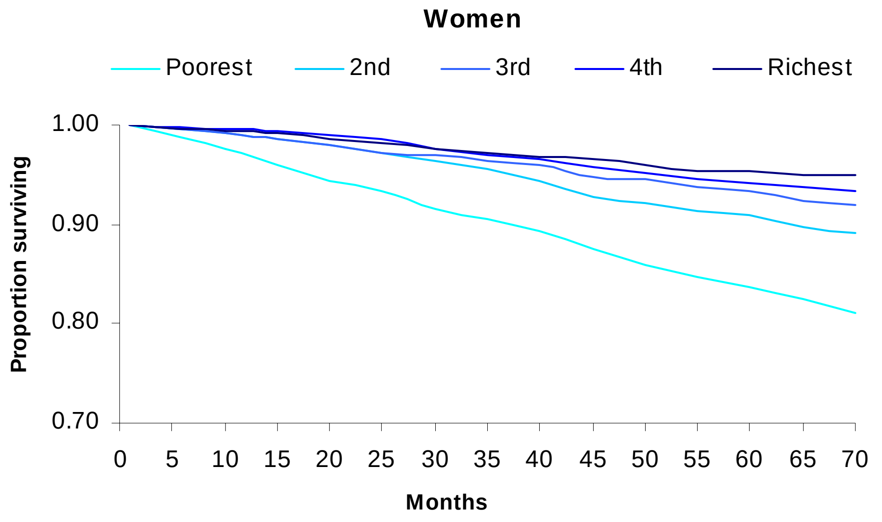
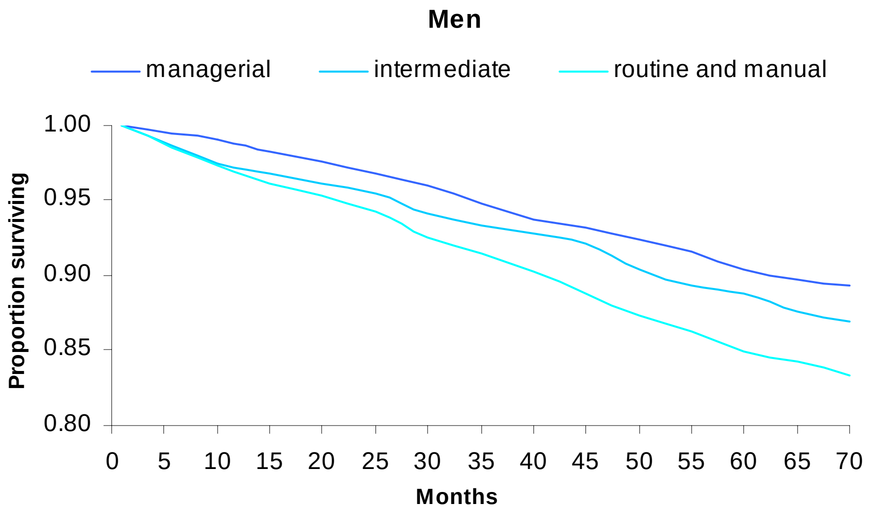


Figure 8.3. Survival after wave 1, by sex and NSSEC occupational class at wave 1



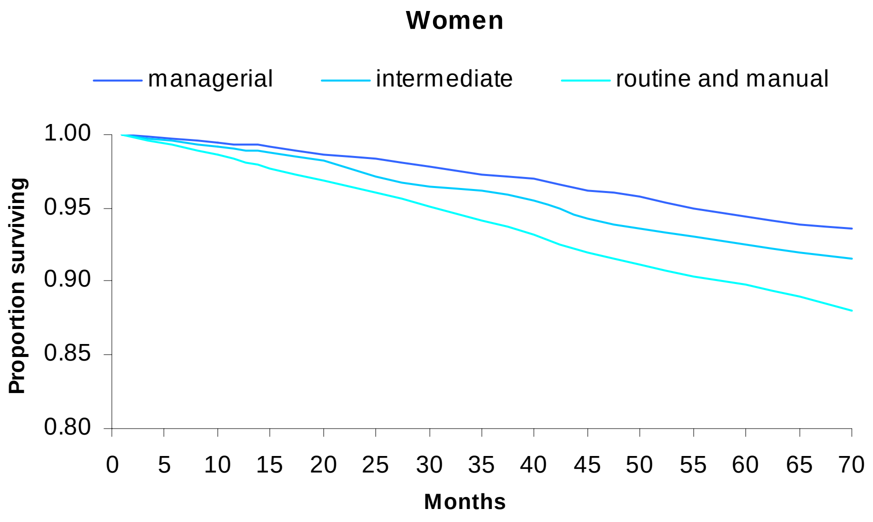


Figure 8.4. Survival after wave 1, by sex and educational qualifications at wave 1

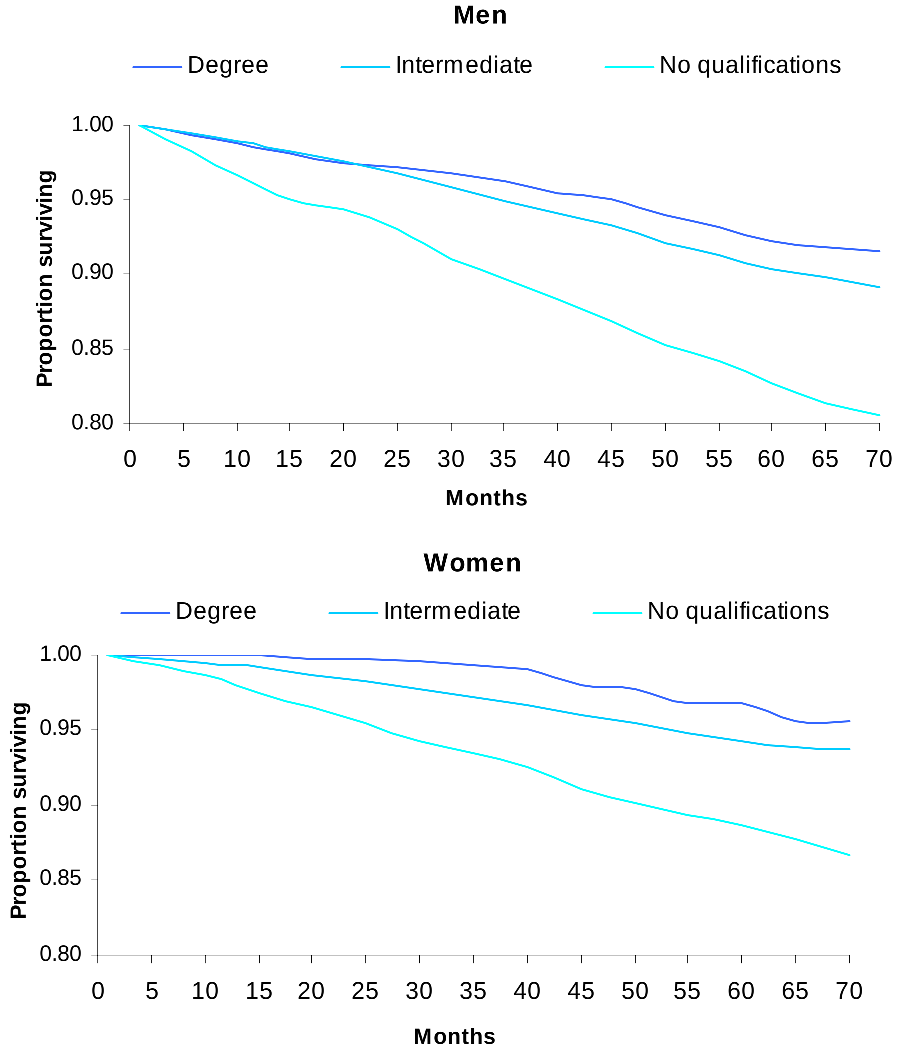


Figure 8.5. Survival after wave 1, by sex and alcohol consumption at wave 1

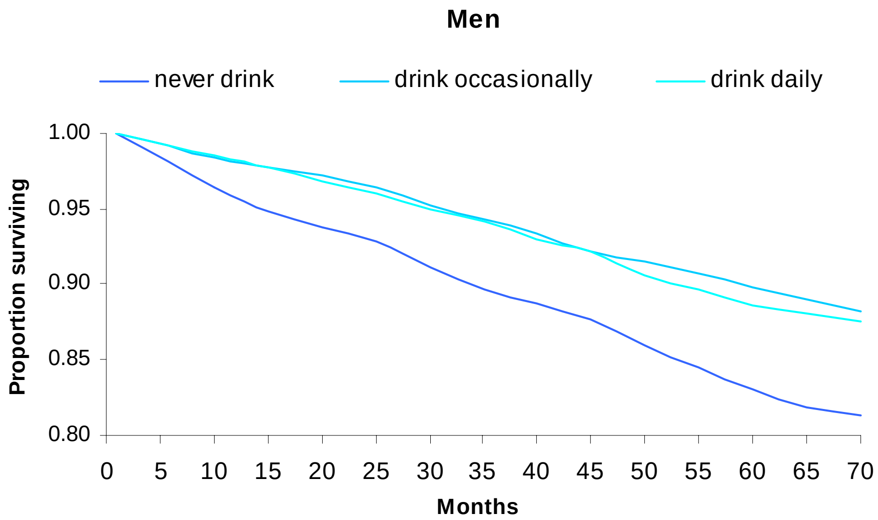


Figure 8.5 continued

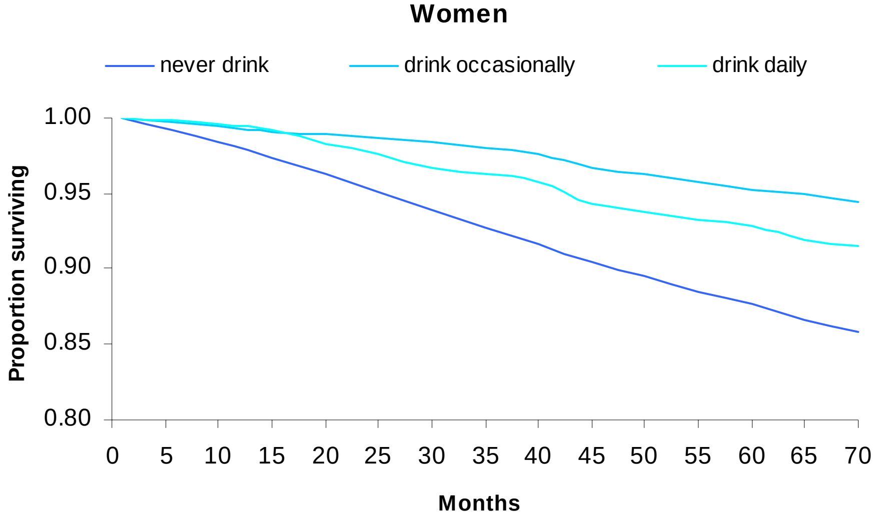
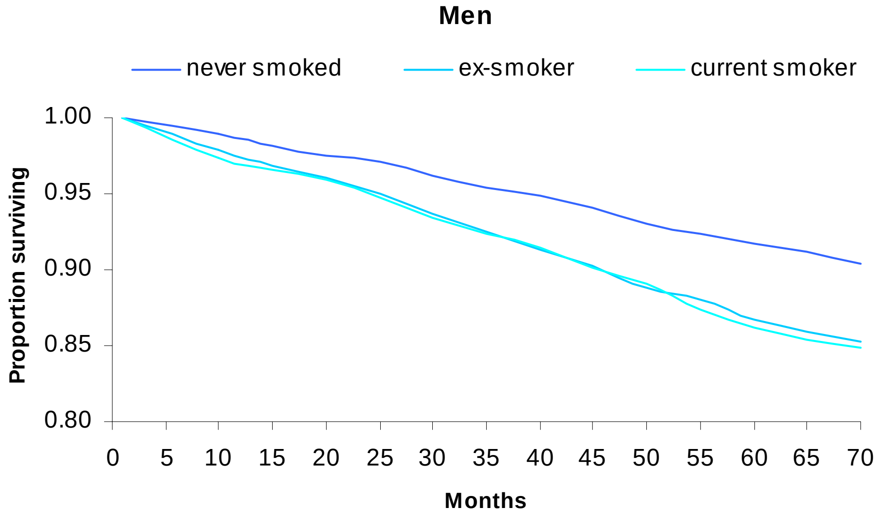


Figure 8.6. Survival after wave 1, by sex and smoking at wave 1



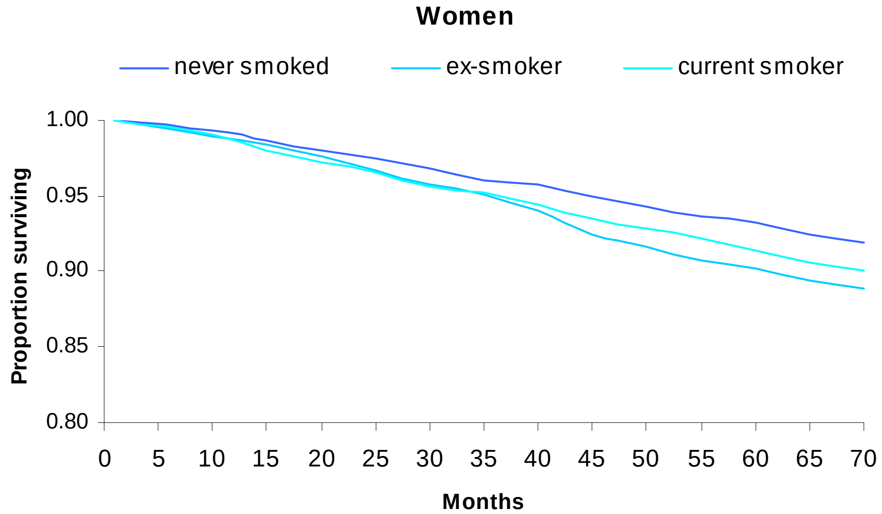
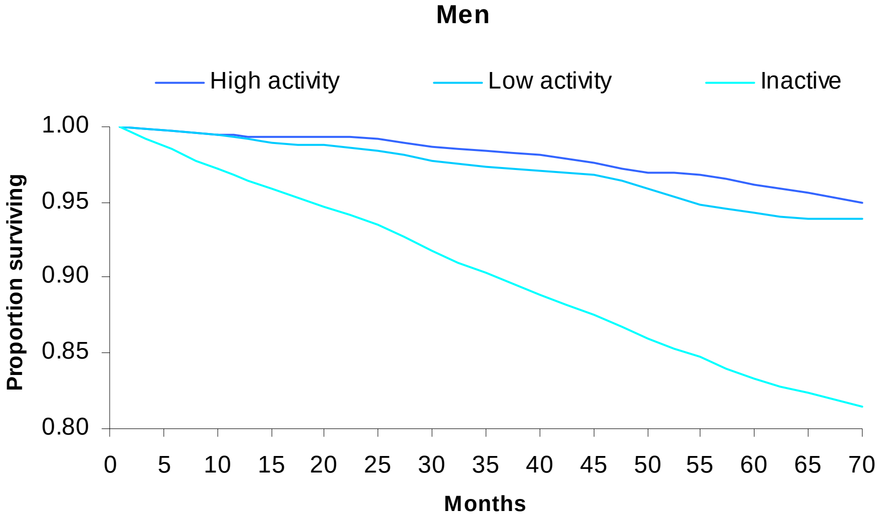
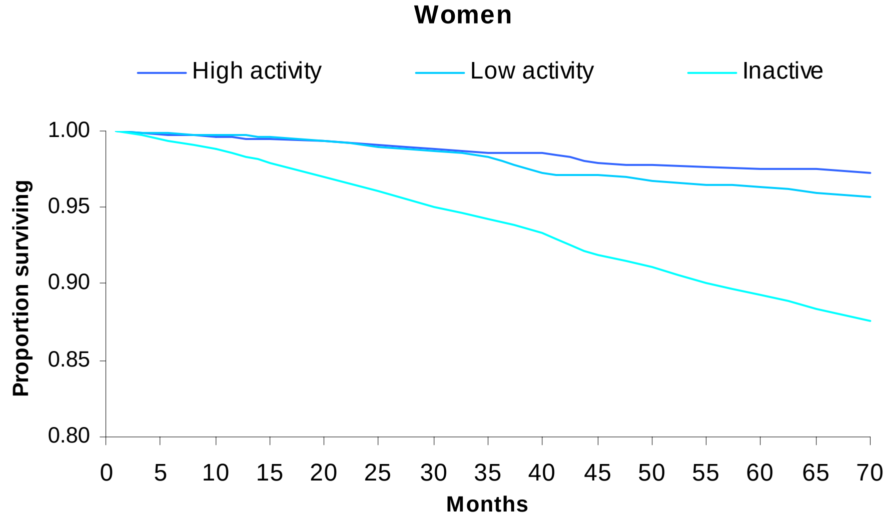


Figure 8.7. Survival after wave 1, by sex and level of physical activity at wave 1





Analysis of the survival pattern by level of physical exercise (Figure 8.7) shows a clear difference between those who perform a ‘high’ amount of exercise and those who perform a ‘low’ amount compared with those who are ‘inactive’. The last group is at a clear survival disadvantage in comparison with the other two, but, of course, they may have been physically inactive because of illness that commenced at, or prior to, ELSA wave 1.

As described earlier, the models shown in Figures 8.1 to 8.7 only adjust for age effects; none of the above analyses takes into account the possible associations between different factors. For example, socio-economic position is strongly related to smoking behaviour. A straightforward method for accounting for this is to include a range of competing explanations in a single analysis. To do this we constructed Cox proportional hazards models (Cox, 1972) to estimate the risk of mortality associated with each factor, while simultaneously adjusting for other factors. The model resulting from these analyses is shown in Table 8.4. In addition to the model shown here, sex-

Table 8.4. Odds for mortality after wave 1, by demographic, socio-economic and behavioural factors measured at wave 1: results from Cox proportional hazards model

Respondents in 2002–03 who gave consent for mortality record

	Hazard ratio	95% confidence interval	p-value
Sample size 10,393			
Females	1.00		
Males	1.86	1.64–2.12	<0.001
50–54	1.00		
55–59	2.18	1.41–3.36	<0.001
60–64	3.07	2.00–4.70	<0.001
65–69	4.95	3.30–7.44	<0.001
70–74	8.55	5.75–12.71	<0.001
75–79	14.14	9.52–21.01	<0.001
80–84	20.42	13.66–30.53	<0.001
85+	37.66	25.03–56.68	<0.001
Married	1.00		
Separated/Divorced	1.39	1.11–1.74	<0.010
Widowed	1.18	1.02–1.37	<0.010
Never married	1.49	1.18–1.89	<0.001
High physical activity	1.00		
Low physical activity	1.25	0.91–1.72	0.162
Inactive	2.30	1.80–2.93	<0.001
Never smoked	1.00		
Ex-smoker	1.22	1.06–1.41	<0.010
Current smoker	1.78	1.49–2.14	<0.001
Never drinks	1.00		
Drinks occasionally	0.80	0.69–0.92	<0.010
Drinks daily	0.93	0.80–1.08	0.358
5th quintile – highest wealth	1.00		
4th quintile	1.03	0.82–1.31	0.775
3rd quintile	1.15	0.92–1.45	0.223
2nd quintile	1.46	1.17–1.82	<0.001
1st quintile – lowest wealth	1.56	1.24–1.95	<0.001
Degree	1.00		
Intermediate	0.91	0.70–1.18	0.488
No qualifications	0.90	0.68–1.18	0.445
Managerial and professional	1.00		
Intermediate	1.06	0.88–1.28	0.559
Routine and manual	1.16	0.98–1.38	0.090

stratified models were constructed, but because the pattern of findings for variables other than sex was very similar for men and women, these models are not shown here.

Results show that men have a markedly higher chance of dying compared with women (hazard ratio 1.86, 95% confidence interval [CI] 1.64–2.12). As expected the older cohorts have higher chances of dying, with risk increasing for each increasing five-year age band. Regarding marital status, those who are married have the lowest chance of dying, with the never-married having the highest risk (a hazard ratio relative to the married of 1.49, 95% CI 1.18–1.89), followed by the 'separated and divorced' and then the widowed.

Those who reported engaging in low-level physical activity appear to have had a higher chance of dying than those who engage in a high level of physical activity, but this difference is not statistically significant. However, those who report being 'inactive' have a more than two times greater risk of dying (hazard ratio 2.30, 95% CI 1.80–2.93) than those who engage in a high level of physical activity. Both current smokers and ex-smokers have an increased risk of dying compared with non-smokers, although this risk is greater for current smokers (hazard ratio 1.78, 95% CI 1.49–2.14) than for ex-smokers (hazard ratio 1.22, 95% CI 1.06–1.41). The final behavioural factor considered in this model is drinking alcohol, and the analysis shows that drinking occasionally reduces the risk of mortality compared with never drinking alcohol (20% lower hazard), while drinking alcohol daily has a similar risk to never drinking.

The final three blocks of the table cover measures of socio-economic position. When these are included together in the model, only wealth has a significant relationship with mortality. There is an increasing risk of mortality with decreasing wealth, with those in the second wealth quintile having a 46% greater risk of mortality and those in the lowest wealth quintile having a 56% greater risk (hazard ratio of 1.56, 95% CI 1.24–1.95), both compared with the those in the richest wealth quintile. There are no differences in risk of mortality by educational qualifications, and the gradient is not statistically significant when looking at hazard of dying by occupational classification (NSSEC). However, those in the routine and manual class appear to have a 16% higher chance of dying than those in the managerial and professional class ($p < 0.1$).

Thus, analysis of socio-economic factors in a multivariate model suggests that wealth is the key predictor of survival. There are two important possible explanations for this. First, it may be that wealth is a more accurate marker of socio-economic position at older ages. As described previously, both education and occupation (for those who are retired) represent a position earlier in the life course, and wealth may reflect more accurately both accumulated socio-economic position and the level of resources available to support consumption. Second, in so far as wealth represents accumulated socio-economic position, it may be partially the distal product of the other socio-economic measures (education and occupation) included in the model. So, in these analyses wealth quintiles will reflect, in part, early occupation, which, in part, will reflect earlier education. That is, both education and occupation can be considered to be causally prior to wealth in later life.

8.4 Seasonality of death

Seasonal mortality, especially excess winter mortality, has been an area of public concern and government policy interest. Indeed, there have been prominent stories on this issue in the media, with headlines such as ‘Cold weather’s 25,000 deaths toll is scandal, say charities’ (Carvel, 2006), ‘Cold kills “thousands” in a week’ (BBC, 2003), ‘Britain is a rich nation; its old people should not be dying of the cold’ (*The Independent*, 2003) and ‘Eight older people every hour die during winter in Britain’ (Age Concern, 2005). Such headlines are, in part, reflected in official statistics. The Office for National Statistics (ONS) estimated that in the winter of 2004–05 (December–March) there were around 31,600 more deaths in England and Wales compared with the average number of deaths in the non-winter period (August–November 2004, April–July 2005) (ONS, 2005). This number was higher than levels seen in the previous four years, and has declined since – in the winter of 2006–07 the ONS estimated the figure at 23,900 more deaths (ONS, 2007). Although the 2004–05 figure represents a recent peak, it was less than was seen during the winters of 1998–99 and 1999–2000, when there were 46,840 and 48,440 more deaths, respectively, compared with levels in the non-winter period (ONS, 2005; ONS, 2007). Aylin et al. (2001) have noted that in the UK the excess winter mortality figure has been around 40,000 deaths annually. Paradoxically, countries with relatively cold winter temperatures (for example, Sweden, Canada, Finland and Norway) experience consistently lower excess winter mortality than countries with warm or moderate climate (for example, Portugal, Spain, Italy and the UK) (Rau, 2007).

Explanations proposed for excess winter deaths are predominantly concerned with the effect of cold temperature on the human body, for example the possible effect of cold on the sympathetic nervous system leading to greater vulnerability to cardiac failure, or to increased risk of death from influenza. Interestingly, some have estimated that the influence of influenza on cold-related mortality in recent decades has been small. For example, Donaldson and Keatinge (2002) estimate that only 2.4% of all excess winter deaths during the 1990s occurred either directly or indirectly from influenza, although others have suggested that its role as an indirect cause has been underestimated, and have noted the correspondence between the 1998–2000 peaks in winter mortality and influenza epidemics (ONS, 2007). In fact, the direct causes of deaths that appear to be of importance in explaining the mortality increase in winter are cardiovascular, cerebrovascular and respiratory diseases. The latter group has the strongest seasonal pattern among all major groups of causes of death (Feinstein, 2002; Rau, 2007), but respiratory diseases are not a leading cause of death in Western developed countries (NCHS, 2002). About half of the cold-related mortality can be attributed to ischaemic heart disease and cerebrovascular disease (Van Rossum et al., 2001; Eurowinter Group, 1997).

Another explanation for excess winter mortality is the concentration of air pollutants that are emitted when heating homes during exceptionally cold spells. On the other hand, it is suggested that the spread of central heating is the main cause for the decline in winter mortality during recent decades (Aylin et al., 2001; Donaldson and Keatinge, 1997; McDowall, 1981; Keatinge, Coleshaw and Holmes, 1989).

Other factors influencing seasonal mortality are outdoor, as well as indoor, cold. It has been argued that 'warm housing is not enough' (Keatinge and Donaldson, 2001, p. 166) and that it is equally important to avoid exposure to outdoor cold, which has an impact that is independent of indoor cold (Eurowinter Group, 1997). While the most influential factor in this respect is adequate clothing worn outdoors (Donaldson, Rintamäki and Näyhä, 2001), increased car ownership has also probably influenced the decrease in winter mortality over time (Donaldson and Keatinge, 1997; Keatinge, Coleshaw and Holmes, 1989).

Surprisingly, there is not much literature on socio-economic determinants in the field of seasonal mortality when compared with more general studies of mortality. Factors such as income, deprivation, wealth, marital status, education and occupation could impact specifically on excess winter deaths, as could behavioural factors such as lack of exercise and smoking, but these have not been much investigated. Literature on the influence of nutrition on seasonal mortality is also sparse. It has been suggested that low vitamin C intake during winter may increase cardiovascular risk by raising fibrinogen levels in the blood (Khaw and Woodhouse, 1995). Similarly, there has been only limited investigation of the association between winter mortality and marital status and household structure, with the only published study not finding any significant association (Wilkinson et al., 2004).

Methods and data description

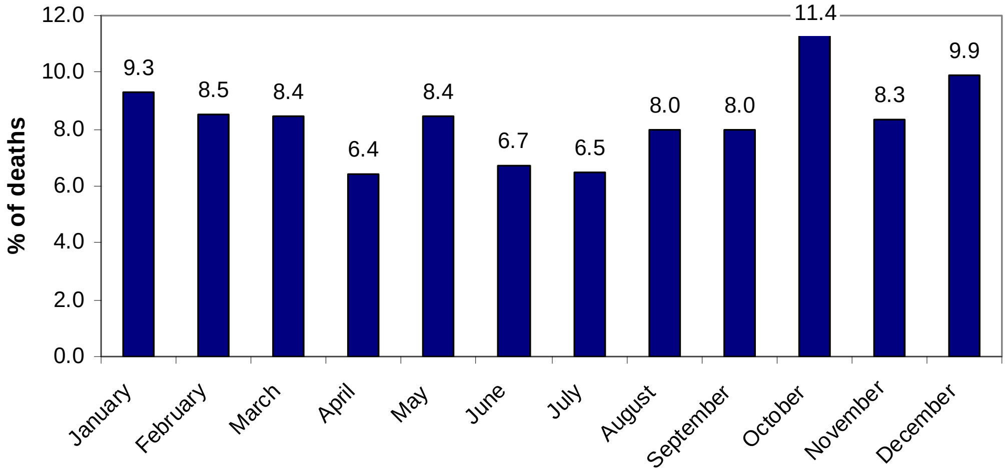
Data are used from those years where the whole sample is observed for the complete year. This means that 2002 and 2003 were not included, because wave 1 of ELSA was ongoing and respondents were still being recruited during these years, and 2008 was not included because we only have data for the very beginning of that year. So we include only deaths covering the period January 2004 to December 2007. We initially describe the incidence of death across the months of the year (aggregated across years). We then follow the generally accepted method of dividing deaths into those occurring in the 'winter' months of December to March and those occurring in April to November, to estimate excess winter mortality. Finally, data collected at wave 1 of ELSA are used to examine factors that may be associated with the excess winter mortality.

As described in Section 8.2, only deaths occurring to core wave 1 ELSA respondents who agreed to have their data linked to mortality records and did not withdraw that consent are included in this analysis. This gives a total of 937 deaths to analyse.

Results

Figure 8.8 shows the distribution of deaths by month of the year, for both men and women and covering the period 2004–07. For an even distribution of deaths, 8.3% would occur in each month, with values above this indicating that the month has a greater-than-expected number of deaths. The figure suggests a lower-than-average number of deaths in April, June, July, August and September, with an increase in deaths for the months October, December, and January. There are a surprisingly high number of deaths in October (11.4% of the total, or 107 actual deaths), a finding which is consistently repeated across all four of the years observed and for which there is no obvious explanation – October is neither a cold month nor a particularly hot month.

Figure 8.8. Month of death over 2004–07



Estimates of the excess number of deaths occurring during the winter months (December to March) depend on whether October is included as a non-winter month. Including October – so comparing December to March with April to November – shows that 36.2% of deaths, rather than 33.3% of deaths to be expected from an even distribution, occurred during the winter months. This gives an excess of 40 deaths over the four years observed (that is, the excess over the number that would have happened if the death rate in the winter months were the same as what we observed over this period for the non-winter months), which is 4.3% of all deaths observed, or 11.8% of the deaths occurring in winter months. If deaths occurring in October are excluded from the analysis completely, there is an excess of 58 deaths occurring during the winter months of December to March in the four years observed, which is 7.0% of the total deaths observed, or 17.2% of the deaths occurring in winter months.

We then examined how the proportion of deaths occurring in the winter months of December to March varied by a range of factors: age, sex, cohabitation status, presence of central heating at home, housing conditions (the presence of one or more of cold, damp, water, decay or condensation in the house) and wealth quintile. Findings for this are shown in Table 8.5, again with the analysis including and excluding the unexpectedly large number of deaths occurring in October over the four years. The percentage of deaths is represented as an excess (or deficit) over (or below) the percentage of deaths in December to March that would be expected if deaths were evenly distributed throughout the year (which is 33.3% of deaths if October is included in the calculation and 36.4% if October is not included).

Table 8.5. Excess percentage of deaths occurring in the winter months December to March

Deaths in the period 2004–07, by selected wave 1 measures: respondents in 2002–03 who died after wave 1 and gave consent for mortality record

		October included in 'non-winter' months	
		Yes	No
Age	50–59	–1.7	0.4
	60–74	2.3	3.5
	75+	3.9	5.7
Sex	Male	0.3	1.2
	Female	5.8	8.3
Cohabiting status	Living with partner	0.7	2.1
	Not living with partner	4.8	6.7
Central heating	Yes	2.4	3.8
	No	6.5	9.5
Cold, damp, water, decay or condensation in the house	No	3.0	4.3
	Yes	1.8	5.6
Wealth quintile	Richest	4.1	3.8
	4th	–5.5	–1.8
	3rd	–0.4	–0.8
	2nd	3.8	4.8
	Poorest	7.2	10.0
Unweighted N			
Age	*50–59*	*79*	*68*
	60–74	*331*	*296*
	75+	*527*	*466*
Sex	*Male*	*497*	*445*
	Female	*440*	*385*
Cohabiting status	*Living with partner*	*455*	*403*
	Not living with partner	*482*	*427*
Central heating	*Yes*	*834*	*742*
	No	*98*	*85*
Cold, damp, water, decay or condensation in the house	*No*	*826*	*737*
	Yes	*111*	*93*
Wealth quintile	*Richest*	*115*	*107*
	4th	*133*	*107*
	3rd	*161*	*149*
	2nd	*226*	*204*
	Poorest	*301*	*263*

Table 8.5 suggests a deficit or no excess of winter deaths for the youngest age group, and an excess of deaths for the oldest. Women, but not men, seem to have a large excess of winter deaths. Those living with a partner show no, or a small, excess, while those not living with a partner show a clearer excess. Those without central heating show a greater excess of winter deaths than those with central heating, but housing conditions are not related to the excess of winter deaths. The pattern for wealth quintile is unclear. Those in the bottom two wealth quintiles have a greater excess of winter deaths than those in the third and fourth quintiles, with a particularly large excess for those in the poorest quintile, but so do those in the richest quintile.

It is worth noting the bases in Table 8.5, which indicate that the number of deaths is small, particularly for some categories (younger respondents, those without central heating or with housing problems, and the richest quintile). This limits statistical power when analysing the data. Multivariate analyses, using the variables included in the table to predict winter rather than non-winter deaths, suggest that the only finding described in Table 8.5 that is statistically significant is the greater risk of winter deaths for women. This could be a consequence of limited statistical power, or a result of the inadequacies of broad measures to capture phenomena such as fuel poverty.

8.5 Healthy life expectancy

Life expectancy at birth has seen an unprecedented increase in the last 30 years, mostly as a result of improvements in mortality at older age (Kannisto et al., 1994; Vaupel, 1997). However, these improvements in mortality at older age have raised concerns about levels of dependence and disability for those who are surviving longer. The key question is whether people are surviving longer in good health, or in poor health. How far is the extension of life associated with an extension of the period spent in poor health and physical dependency, or is the period in poor health reducing alongside reductions in mortality rates, leading to a so-called compression of morbidity (Fries, 1980; Manton, Corder and Stallard, 1997; Manton and Gu, 2001)? Data recently published by ONS (2008), contrasting 2004 with 2001, suggest that over this period there has been an increase in healthy life expectancy (that is, period spent in good health) and disability-free life expectancy (in this case, period spent without a limiting long-standing illness) for older people, which goes along with an increase in life expectancy, a finding that is consistent with the work of Manton and colleagues suggesting compression of morbidity is occurring (Manton, Corder and Stallard, 1997; Manton and Gu, 2001).

This section of the chapter provides three estimates of life expectancy: healthy life expectancy, life expectancy without limiting illness and disability-free life expectancy. These definitions extend those used elsewhere (ONS, 2008), in the expectation that the use of three measures will allow us to contrast three dimensions of well-being at older ages: general health, the presence of a limiting illness and direct measures of difficulty performing tasks necessary for everyday living. The analyses use official life table information to calculate life expectancy, and combine this with information from ELSA wave 1 on the three measures of health we use here. Measures of the prevalence of health outcomes at a given age, combined with survival rates, yield estimates of survival with and without excellent or good health, limiting long-standing illness and disability. This allows us to estimate how much of any remaining life expectancy for each age group is with and without the measured health condition.

Methods and data description

In order to estimate life table functions, aggregate data on mortality rates in England and Wales for the year 2002 were used. These data were used as they correspond with the timing of the ELSA wave 1 data collection. Life table functions were calculated based on the data taken from the Human Mortality Database.

ELSA wave 1 data were used to provide the three measures of health. The general health measure was simply dichotomised into those reporting that they had excellent, very good or good health, contrasted with those who reported that they had fair or poor health. The limiting long-standing illness measure consisted of combined responses to a question asking about the presence of a long-standing illness and then whether the illness limited the respondent in any way. The measure of disability used self-reported information on activities of daily living (ADLs), instrumental activities of daily living (IADLs) and mobility difficulties in order to build a dichotomous disability index. An examination of the relationship between variables allowed us to exclude those that were insensitive measures of disability, leaving us with the following items:

- difficulty bathing or showering;
- difficulty getting in and out of bed;
- difficulty dressing, including putting on shoes and socks;
- difficulty eating, such as cutting up food;
- difficulty doing work around house and garden;
- difficulty taking medications;
- difficulty managing money, for example paying bills, keeping track of expenses;
- difficulty preparing a hot meal;
- difficulty shopping for groceries;
- difficulty walking across a room;
- difficulty using the toilet, including getting up or down;
- difficulty climbing one flight of stairs without resting; and
- difficulty walking 100 yards.

The internal consistency of this scale was very good (Cronbach alpha = 0.88). Principal component analysis (PCA) was then used to construct a single underlying factor score (which explained about 44% of the variance) that was, not surprisingly, heavily skewed. This variable was then dichotomised at the mean score to provide a disability variable.

Finally, the measures of self-reported health, limiting long-standing illness and disability were applied to the life table functions, and then used to calculate three measures of healthy/disability-free life expectancy following the Sullivan method (Sullivan, 1971; see Imai and Soneji [2007] for a recent validation of this method).

All the analyses were done for men and women separately by five-year age group and were weighted using the ELSA wave 1 weights. It is worth noting that the estimates of life expectancy and of health are based on current profiles; they do not anticipate future changes in mortality and morbidity. This means, of course, that they do not account for either future increases in life expectancy (for example, that current 50-year-olds will, when they reach 60, have a longer life expectancy than current 60-year-olds), nor changes in health (for example, that current 50-year-olds may, when they reach 60, have better or worse health than current 60-year-olds). In order to account for such changes between age cohorts, we need longitudinal data covering a longer period than the four years currently available from ELSA.

Results

Figures 8.9 to 8.11 show life expectancy with and without the health condition for men and women and five-year age groups. All figures show the greater life expectancy of women at all ages, and that with advancing age an increasing proportion of life is spent with the health condition (the ratio of the pale to the dark part of each bar). For example, according to the self-rated health measure (Figure 8.9), men aged 50 to 54 are estimated to spend 28% of their remaining life with fair or poor health, compared with 38% for men aged 75 to 79; and for women aged 50 to 54 and 75 to 79 the figures are 27% and 35%, respectively. For limiting long-standing illness the figures are 35% and 48% for men and 36% and 48% for women; and for disability the figures are 21% and 36% for men and 27% and 46% for women.

These figures also show that while women have a longer life expectancy, for two of the measures the proportion of their life estimated to be spent in fair or poor health, or with a limiting long-standing illness, is similar to that for men; while for the disability measure the proportion of remaining life spent disability free is estimated to be lower for women compared with men.

The figures also show that the three measures give different estimates of the number of years spent unwell or disabled. For example, men aged 50 to 54 are estimated to spend 8.2 years with fair or poor self-rated health, 10.3 years with a limiting long-standing illness and 6 years with a disability, while the figures for women are 9.1 years with fair or poor self-rated health, 12.1 years with a limiting long-standing illness and 8.9 years with a disability. This is not surprising, because they represent different concepts, with the general health measure perhaps reflecting broader well-being, the limiting long-standing illness measure perhaps reflecting the presence of disease requiring treatment, and disability being based on a direct measure of difficulty carrying out certain tasks and activities. As such, the three measures have varying implications for policy, with the disability measure perhaps being a more accurate assessment of social care needs, and the long-standing illness measure a more accurate assessment of clinical need.

Figure 8.9. Life expectancy with excellent/good health (healthy life expectancy) and with fair/poor health

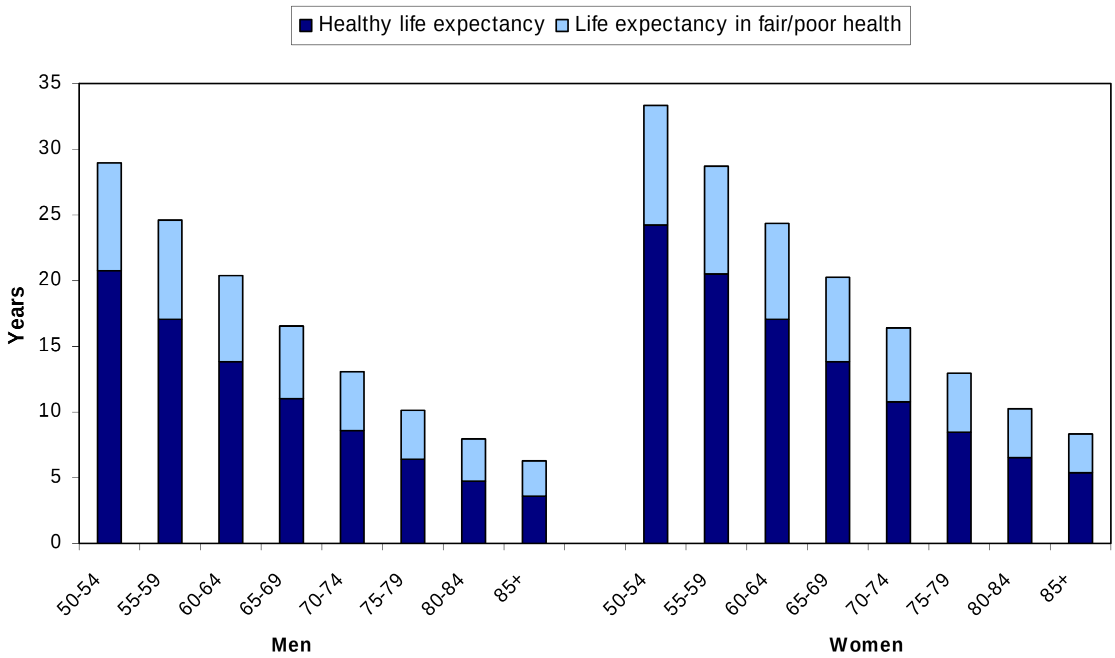


Figure 8.10. Life expectancy without and with limiting long-standing illness

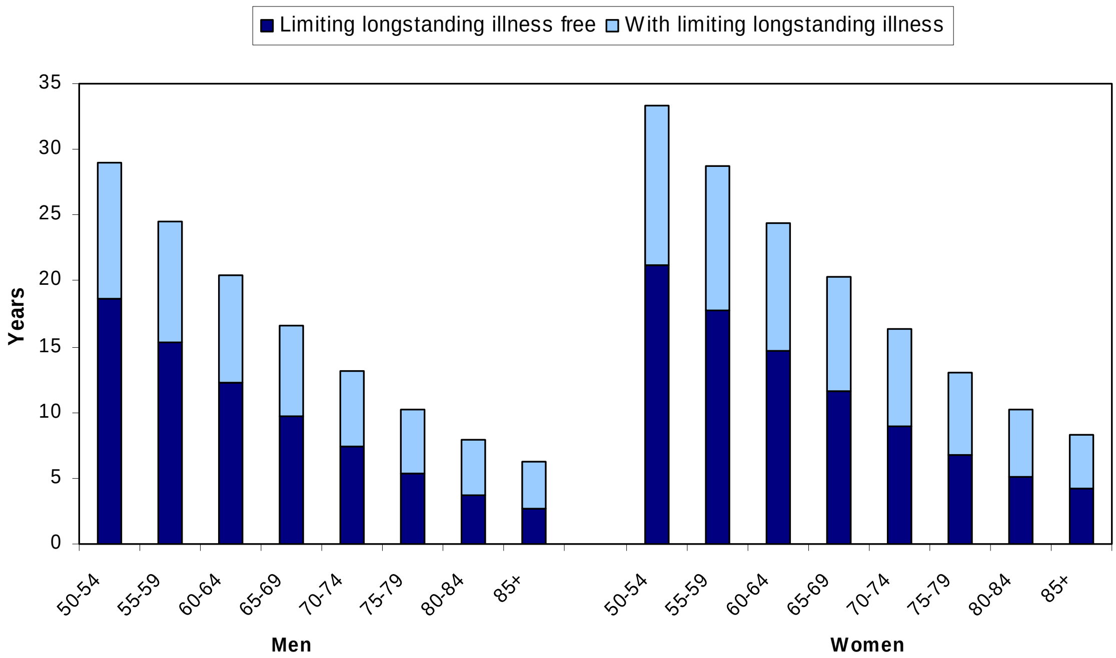
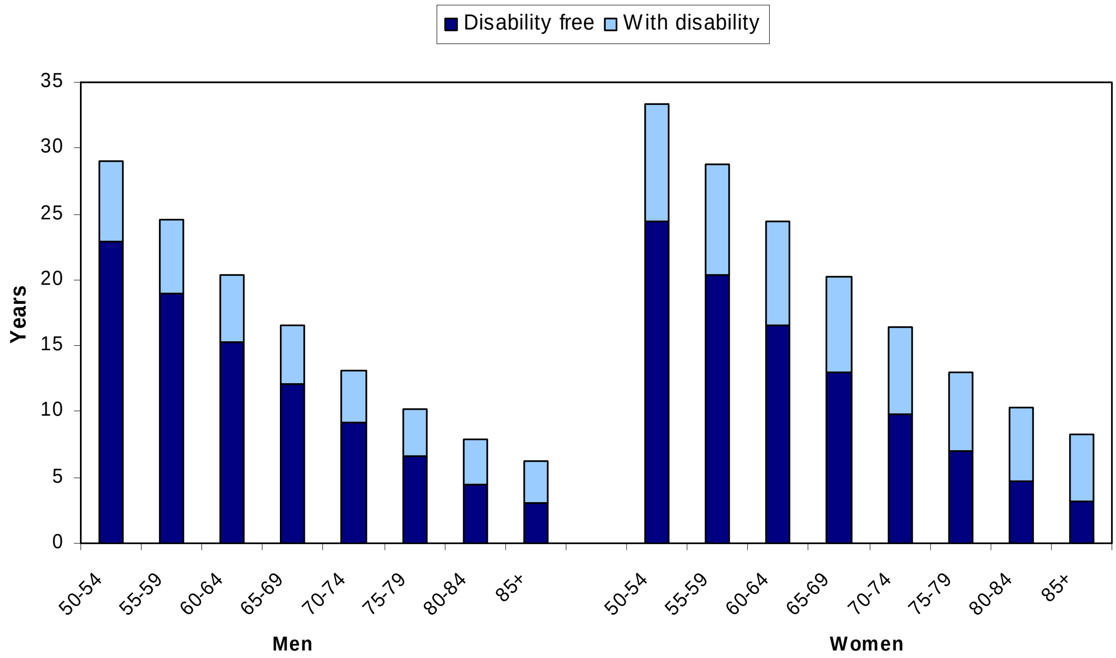


Figure 8.11. Life expectancy without and with disability



8.6 Conclusions

In this chapter we have exploited the short-term potential of ELSA to examine factors relating to mortality at older ages and to estimate healthy life expectancy. The analyses we have conducted show the importance of socio-economic position for future mortality, illustrating the importance of the current policy focus on health inequalities. They also show the importance of lifestyle, although we need to be cautious when drawing conclusions about the strength of the causal relationship between behaviour and mortality when preceding health may be a driver of both behaviour change and subsequent mortality. The analysis of 'winter' deaths, another area for policy concern, confirms that the proportion of deaths occurring in the months December to March is above average, with a significant proportion of deaths in these months attributable to a 'winter excess'. Analysis of the factors that might relate to this increased risk are no more than suggestive, because of limits to statistical power, but do raise the possibility that being female, increasing age, not living with a spouse or partner and a lack of central heating in the home may all be important. Future waves of ELSA will enable a more thorough and, given the depth of the questionnaire coverage, unique examination of risk factors, including level of fuel poverty.

Although there is considerable potential to explore factors related to risk of mortality in the ELSA data, the cautions attached to the interpretations of findings (such as the strength of the relationship between health behaviours and risk of mortality, or the importance of wealth in predicting mortality risk in comparison with other indicators of socio-economic position) indicate the need to unpick carefully the complex processes that result in differences in risk of mortality across the population. The analyses presented here illustrate the need to consider, for example, the relationships between socio-economic position, health, health behaviours and mortality risk, and how these might vary across age groups. We also need to consider the other mechanisms through which socio-economic position might increase risk of mortality, for example psychosocial factors such as status, control and autonomy. And, of course, we need to consider the complex relationships between trajectories in different dimensions of socio-economics (education, employment, income, wealth and consumption), health, health behaviours and social life, and how these ultimately relate to risk of mortality. The ELSA data will, over time, provide the opportunity for such analyses as the sample ages. Nevertheless, at the moment we are able to demonstrate the significance of socio-economic position to future mortality risk at even the oldest ages, with, for example, men and women aged 75 or older in the poorest wealth quintile having about a two-thirds greater risk of mortality compared with their counterparts in the richest wealth quintile (see Table 8.3) . This emphasises the need for policy around inequalities in health to consider such inequalities among the older population, as well as for children and adults of working age.

For the analysis of healthy life expectancy, we took advantage of the range of health markers available in the ELSA data. Most important here is that, in addition to measures based on self-rated general health and limiting long-standing illness, we were able to include an assessment of the respondent's ability to perform certain activities, giving a more direct assessment of level of disability. The three measures point to an increasing proportion of remaining life spent without good health with increasing age, but they also provide varying estimates of healthy, or disability-free, life expectancy, a finding that has important implications for the planning of health and social services. Again these analyses exploit the short-run potential of the ELSA data. The most important drawback of this short-run analysis is that estimates of life expectancy and health are treated as static across age cohorts. In the future, longitudinal data from ELSA will enable us to account for the possibility that levels of health, disability and (eventually) mortality will change across age cohorts – so, for example, that current 50-year-olds may not have the same level of health when they are 60 as current 60-year-olds. This will allow for much more accurate estimates of future healthy life expectancy.

Finally, it is worth noting that the analyses presented only cover those living in private households at the time of the wave 1 interview. Again, as the sample ages it will also become representative of those living in communal establishments, which is important for estimates of both mortality and healthy life expectancy.

Acknowledgements

James Nazroo's contribution to this chapter was supported by funding from the ESRC for the project 'Inequalities in health in an ageing population: patterns, causes and consequences' (RES-000-23-0590). We are grateful to our colleagues working on ELSA for their support when preparing this chapter and for useful comments on earlier drafts. We are also grateful for helpful suggestions provided by the consortium of government departments which part-funds ELSA.

References

Age Concern (2005), *Eight Older People every Hour Die during Winter in Britain* (http://www.ageconcern.org.uk/AgeConcern/6E014D9F8F0B4B569749D4035AC927A8.asp).

Aylin, P., Morris, S., Wakefield, J., Grossinho, A. Jarup, L. and Elliott, P. (2001), 'Temperature, housing, deprivation and their relationship to excess winter mortality in Great Britain, 1986–1996', *International Journal of Epidemiology*, vol. 30, pp. 1100–1108.

BBC (2003), *Cold Kills 'Thousands' in a Week* (http://news.bbc.co.uk/1/hi/uk/3342475.stm).

Beckett, M. (2000), 'Converging health inequalities in later life – an artifact of mortality selection?', *Journal of Health and Social Behaviour*, vol. 41, pp. 106–119

Bobak, M., Kristenson, H., Pikhart, H. and Marmot, M.G. (2004), 'The short life span in Russia is associated with high rates of disability. A comparison of Russian and Swedish community-based data', *British Medical Journal*, vol. 329, pp. 767–772.

Breeze, R., Sloggett, A. and Fletcher, A. (1999), 'Socioeconomic and demographic predictors of mortality and institutional residence among middle aged and older people: results from the longitudinal study', *Journal of Epidemiology and Community Health*, vol. 53, pp. 765–774.

Brunner, E.J., Shipley, M.J., Blane, D., Davey Smith, G. and Marmot, M.G. (1999), 'When does cardiovascular risk start? Past and present socioeconomic circumstances and risk factors in adulthood', *Journal of Epidemiology and Community Health*, vol. 53, pp. 757–764.

Carvel, J. (2006), 'Cold weather's 25,000 deaths toll is scandal, say charities', *The Guardian* (http://www.guardian.co.uk/society/2006/oct/28/health.medicineandhealth).

Cox, D.R. (1972), 'Regression models and life tables (with discussion)', *Journal of the Royal Statistical Society, Series B*, vol. 34, pp. 187–220.

Deaton, A.S. and Paxson, C.H. (1998), 'Aging and inequality in income and health', *American Economic Review*, vol. 88, pp. 248–253.

Department of Health (2005), *Tackling Health Inequalities: Status Report* (http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4117696).

Donaldson, G.C. and. Keatinge, W.R. (1997), 'Mortality related to cold weather in elderly people in southeast England, 1979–94', *British Medical Journal*, vol. 315, pp. 1055–1056.

Donaldson, G.C. and Keatinge, W.R. (2002), 'Excess winter mortality: influenza or cold stress? Observational study', *British Medical Journal*, vol. 324, pp. 89–90.

Donaldson, G.C., Rintamäki, H. and Näyhä, S. (2001), 'Outdoor clothing: its relationship to geography, climate, behaviour and cold-related mortality in Europe', *International Journal of Biometeorology*, vol. 45, pp. 45–51.

Duncan, D.O. (1961), 'Occupational components of educational differences in income', *Journal of American Statistical Association*, Dec., pp. 783–792.

Elo, I. and Preston, S. (1996), 'Educational differentials in mortality in the United States, 1979–1985', *Social Science and Medicine*, vol. 42, pp. 47–57.

Eurowinter Group (1997), 'Cold exposure and winter mortality from ischaemic heart disease, cerebrovascular disease, respiratory disease, and all causes in warm and cold regions of Europe', *Lancet*, vol. 349, pp. 1341–1346.

Feinstein, C.A. (2002), 'Seasonality of deaths in the US by age and cause', *Demographic Research*, vol. 6, pp. 469–486.

Fingerhut, L.A., Wilson, R.W. and Feldman, J.J. (1980), 'Health and disease in the United States', *Annual Review of Public Health*, vol. 1, pp. 1–36.

Fries, J.F. (1980), 'Ageing, natural death and the compression of morbidity', *New England Journal of Medicine*, vol. 303, pp. 130–135.

Gjonça, E. (2007), *Socioeconomic Determinants of Longevity in Denmark, England and Wales – A Comparative Study*, Odense: University Press of Southern Denmark.

House, J.S., Kessler, R.C. and Herzog, A.R. (1990), 'Age, socio-economic status and health', *The Milbank Quarterly*, vol. 68, pp. 383–411.

House, J.S., Lantz, P.M. and Herd, P. (2005), 'Continuity and change in the social stratification of aging and health over the life course: evidence from a nationally representative longitudinal study from 1986 to 2001/2002 (Americans' changing lives study)', *Journals of Gerontology*, vol. 60B, Special Issue II, pp. 15–26.

Hummer, R.A., Rogers, R.G. and Eberstein, I.W. (1998), 'Sociodemographic differentials in adult mortality: a review of analytic approaches', *Population and Development Review*, vol. 24, pp. 553–578.

Hurd, M.D. (1989), 'The economic status of the elderly', *Science*, vol. 244, pp. 659–664.

Imai, K. and Soneji, S. (2007), 'On the estimation of disability-free life expectancy: Sullivan's method and its extension', *Journal of the American Statistical Association*, vol. 102, pp. 1199–1211.

Independent (2003), 'Britain is a rich nation; its old people should not be dying of the cold', (http://www.independent.co.uk/opinion/leading-articles/britain-is-a-rich-nation-its-old-people-should-not-be-dying-of-the-cold-549145.html).

Kannisto, V., Lauritsen, J., Thatcher, R.A. and Vaupel, J.W. (1994), 'Reductions in mortality at advanced ages: several decades of evidence from 27 countries', *Population Development Review*, vol. 20, pp. 793–810.

Keatinge, W.R., Coleshaw, S.R.K. and Holmes, J. (1989), 'Changes in seasonal mortalities with improvement in home heating in England and Wales from 1964 to 1984', *International Journal of Biometeorology*, vol. 33, pp. 71–76.

Keatinge, W. and Donaldson, G. (2001), 'Winter deaths: warm housing is not enough', *British Medical Journal*, vol. 323, p. 166.

Khaw, K.T. and Woodhouse, P. (1995), 'Interrelation of vitamin C, infection, haemostatic factors, and cardiovascular disease', *British Medical Journal*, vol. 310, pp. 1559–1563.

Kitagawa, E. and Hauser, P. (1973), *Differential Mortality in the United States*: *A Study in Socioeconomic Epidemiology*, Cambridge, MA: Harvard University Press.

Manton, K., Corder, L. and Stallard, E. (1997), 'Chronic disability trends in elderly United States populations: 1982–1994', *Proceedings of National Academy of Sciences*, vol. 94, pp. 2593–2598.

Manton, K. and Gu, X. (2001), 'Changes in the prevalence of chronic disability in the United states black and non-black population above age 65 from 1982 to 1999', *Proceedings of National Academy of Sciences*, vol. 98, pp. 6354–6359.

Marmot, M. (2004), *Status Syndrome – How your Social Standing Directly Affects your Health and Life Expectancy*, London: Bloomsbury.

Marmot, M.G., Kogevinas, M. and Elston, M.A. (1987), 'Social/economic status and disease', *Annual Review of Public Health*, vol. 8, pp. 111–135.

Marmot, M.G., Shipley, M.J., Brunner, E.J. and Hemingway, H. (2000), 'Relative contribution of early life and adult socioeconomic factors to adult mortality in the Whitehall II study', *Journal of Epidemiology and Community Health*, vol. 55, pp. 301–307.

McDowall, M. (1981) 'Long term trends in seasonal mortality', *Population Trends*, vol. 26, pp. 16–19.

McMunn, A., Nazroo, J. and Breeze, E. (under review), 'Inequalities in health at older ages: a longitudinal investigation of onset of illness and survival effects in England'.

Mishra, G.D., Ball, K., Dobson, A.J. and Byles, J.E. (2004), 'Do socioeconomic gradients in women's health widen over time and with age?', *Social Science and Medicine*, vol. 58, pp. 1585–1595.

National Center for Health Statistics (NCHS) (2002), 'Table 1: deaths, percent of total deaths, and death rates for the 10 leading causes of death in selected age groups, by race and sex: United States, 2000', *National Vital Statistics Report*, vol. 50, pp. 13–48 (http://www.cdc.gov/nchs/fastats/pdf/nvsr50_16t1.pdf).

Office for National Statistics (ONS) (2005), *Excess Winter Deaths Highest for Five Years* (http://www.statistics.gov.uk/pdfdir/deaths1005.pdf).

Office for National Statistics (ONS) (2007), *Winter Mortality: Excess Winter Mortality Falls* (http://212.58.231.22/cci/nugget.asp?id=574).

Office for National Statistics (ONS) (2008), 'Health expectancies in the UK, 2004', *Health Statistics Quarterly*, vol. 37, pp. 48–51.

Preston, S.H. and Elo, I.T. (1995) 'Are educational differentials in mortality increasing in the United States?', *Journal of Aging and Health*, vol. 74, pp. 476–496.

Preston, S.H., Himes, C. and Eggers, M. (1989), 'Demographic conditions responsible for people ageing', *Demography*, vol. 26, pp. 691–704.

Preston, S.H. and Taubman, P. (1994), 'Socio-economic differences in adult mortality and health status', in L.G. Martin and J.H. Preston (eds), *Demography of Aging*, Washington DC: National Academy Press, pp. 279–318.

Rau, R. (2007), *Seasonality in Human Mortality. A Demographic Approach*, Heidelberg: Springer.

Smith, J.P. (1998), 'Socioeconomic status and health', *American Economic Review*, vol. 88, pp. 192–196.

Smith, J.P. and Kington, R. (1997), 'Demographic and economic correlates of health in old age', *Demography*, vol. 34, pp. 159–170.

Sullivan, D. (1971), 'A single index of mortality and morbidity', *Health Services and Mental Health Administration Health Reports*, vol. 86, pp. 347–354.

Van Rossum, C.T.M., Shipley, M.J., Hemingway, H., Diederick, G., Mackenbach, J.P. and Marmot, M.G. (2001), 'Seasonal variation in cause-specific mortality: are there high-risk groups? 25-year follow-up of civil servants from the first Whitehall study', *International Journal of Epidemiology*, vol. 30, pp. 1109–1116.

Vaupel, J.W. (1997), 'The remarkable improvements in survival at older ages', *Philosophical Transactions of the Royal Society of London – Series B: Biological Sciences*, vol. 352, pp. 1799–1804.

Wilkinson, P., Pattenden, S., Armstrong, B., Fletcher, A., Kovats, R.S., Mangtani, P. and McMichael, A.J. (2004), 'Vulnerability to winter mortality in elderly people in Britain: population based study', *British Medical Journal*, vol. 329, pp. 647–650.

Williams, D.R. (1990), 'Socio-economic differentials in health: a review and redirection', *Social Psychology Quarterly*, vol. 53, pp. 81–99.

Winkleby, M.A., Jatulis, D.A., Frank, E. and Fortmann, S.P. (1992), 'Socioeconomic status and health: how education, income and occupation contribute to risk factors for cardiovascular disease', *American Journal of Public Health*, vol. 82, pp. 816–820.