Social inequality in mortality among adults and elderly in northern Sweden 1851–2013*

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Abstract

A long-term perspective on the development of social inequalities in mortality in the adult and elderly population is taken. The area under investigation consists of the Skellefteå and Umeå regions in the north of Sweden, and the time period is 1851–2013.

The main findings are that the social gradient becomes evident in the later alf of the 20th century, with lower classes having the highest mortality.

1 Introduction

A long-term perspective on the development of social inequalities in mortality in the adult and elderly population is taken. The area under investigation consists of the Skellefteå and Umeå regions in the north of Sweden, and the time period is 1851–2013 for Skellefteå and 1901–2013 for Umeå.

This paper is a follow-up of an earlier paper (Edvinsson and Broström, 2016), presented at the ESHD Conference in Leuven, Belgium, 2016. Here we make quick look back in time for the Skellefteå region (1851–1900), and we also consider causes of death for the later part of the 20th century. The Lisa data allow us to study the effect of income and education on mortality in a more direct way.

2 Aims and questions

The aim of the paper is to investigate the development of social differences using HISCLASS in mortality for the adult and elderly population during the

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mortality transition and its relation to the development of income inequality. The analyses will be performed on data from the Skellefteå and Umeå regions 1901–2013. The questions are:

1. Has inequality in mortality between social classes increased among the adult and elderly population, primarily benefiting the highest social positions?

2. Are there any gender differences in the effect of social position?

3. Is social position equally important among the retired population as for those in working age?

3 The Skellefteå and Umeå regions

Figure 1 shows the study ares and thier position in Sweden.

[Figure 1 about here.]

Both regions are part of the county of Västerbotten in the north of Sweden, along the coast of the Gulf of Bothnia. The Skellefteå region in Poplink consists of a selection of parishes surrounding the town of Skellefteå, founded in 1845 but with a very small population in the 19th century. The data from the period after 1960 cover the Skellefteå and Malå municipalities, the same area as for the earlier period but with the addition of two more parishes. The majority of the population in the region lived in rural villages and hamlets, getting their livelihood from agricultural production. The region was vulnerable for harvest failures, one living long in memory was the famine of 1867–1868 (Edvinsson and Broström, 2014). Towards the end of the century, the re- gion became connected to the Swedish railway system, thus improving the communications and contacts with other parts of the country. During the 20th century, industrialisation took place, partly by the opening of mines in the inlands. This also led to a population increase both in the town and in the rural parts, and a much more diversified economy. Mortality was fairly low in comparison with other parts of the country and the fertility transition was late. The Skellefteå population size as defined in our datasets was 16 473 on January 1, 1850, 41 352 on January 1, 1900, 61 938 on January 1, 1950 and 76 723 at the end of the century.

The Umeå region in Poplink (from 1900 until 1950s) consists of Umeå urban and rural parish, and in the Linneus database from 1960 onwards of Umeå mu- nicipality where another three parishes are included. This region had a somewhat different character from that of Skellefteå, even though agricul- ture was dominating the economy for a long time. The town of Umeå had a small population but substantially larger than Skellefteå town during almost the whole studied period. It was the administrative centre in the county of Västerbotten and schools and military regiments was placed here. Officials, teachers and the military were much more common in Umeå. Agriculture dominated in the rural part, while and there were some foundries, some industries for example in forestry and small-scale production. Umeå had a much more diversified occupational structure than Skellefteå. The popula- tion size as defined in our datasets was 18 970 on January 1, 1900, 32 900 on January 1, 1950 and 103 970 when the century ended.

Figure 2 shows the distribution (per cent) of exposure time over hisclass for our selected time periods.

[Figure 2 about here.]

4 Previous research

For a detailed presentation we refer to Edvinsson and Broström (2016). Here is a short summary.

Several studies have shown how important access to economic and other resources are for health, but it is not clear how this has developed in history. Antonovsky (1967) and Smith (1983) suggest that social inequality in health has passed through different phases in history. According to them, social health differences were comparatively small during the pre-transitional phase when space was a strong determinant for the spread of disease. Differences then increased during the transitional phase when mortality declined and wealthy groups used their resources to gain better health. Finally, health differences decreased again in modern low-mortality settings when instead health-related behaviour became important, resulting in marginal differences. Omran (1982) state, in the third proposition in his theory of the epidemiological transition, that even if the class differential in mortality was maintained during the transition, the decline set in earlier and was faster among privileged groups.

The present state of knowledge about the development of social health inequalities (in Sweden but also in other European countries), no clear social hierarchy has been found before 1900 but substantial differences towards the late 20th and early 21st century. It appears as if a more consequent social health divide developed in the period in-between. This period has not been thoroughly studied on this issue, mainly because of lack of data to analyse. However, the extension of data at the Demographic Data Base, Umeå University (DDB) makes such studies possible. We are now able to analyse social differences in mortality with micro-data on a sufficiently large population and with substantial social diversity from the 20th century for the Skellefteå and Umeå regions (Westberg et al., 2016).

5 Data and variables

The data for the present study comes from two large population databases at the Demographic Data Base, Umeå University. The early period is covered by the database Poplink, the digitisation of historical parish registers for the Skellefteå and Umeå region (Westberg et al., 2016). The population in the two regions is large enough and socially diverse to enable studies of social mortality inequalities. Poplink is based on linked parish records, allowing us to reconstruct life biographies on people as long as they remained in the region. The records are linked within but not between the regions. Data from the regions are accessed for the period 1901–1950s.

The other large data-set comes from the Linnaeus database (Malmberg et al., 2010). It is based on different linked population registers from 1960 to 2013 and is used within the ageing program at CEDAR, Umeå University. The study period from 1960 to 2000 are constructed from censuses every fifth year 1965–1990, with additional information on deaths from National Board of Health and Welfare. For the period 2002–2013 we use the information from the yearly population registers (LISA) together with death information from National Board of Health and Welfare. The construction of these data-sets for analysis is presented below.

Information on individuals are anonymized and the two databases are not linked between each other. This stops us from following individuals present in both databases throughout their lives, thus they are treated separately. This also makes it impossible to add information on individuals in the Linnaeus database from what we potentially could find in Poplink, for example family background or occupations earlier in life.

In the data-set analysed here, all individuals 40 years and older and ever being resident in either of the regions are included. The data file contains the variables on sex, birth date, death date, first and last date of observation and type of entrance/exit.

The identification of presence periods as well as the time-dependent variables require some additional comments.

6 Models

The proportional hazards model in a survival analysis context is used, allowing for adjustment for civil status and rural/urban environment. Since the central explanatory variable, HISCLASS, do not follow the proportionality property, the analyses are stratified with respect to the variable, and the main results are presented graphically.

The analyses are performed in the **R** environment for statistical computing and graphics (R Core Team, 2016), especially using the package `eha` (Broström, 2012; Broström, 2015) The proportional hazards model allow us to scrutinise the differences and the development in more detail. We divide the analysis into two age groups, 40–64 and 65–99 years of age. The model controls for period, marital status and whether the individual resides in the urban or rural part. There are no serious signs of deviation from proportionality assumption, except regarding HISCLASS.

We analyse both regions together but perform separate analyses for men and women and for the age groups 40–64 and 65–89. The model in the analyses include social class, marital status and urban/rural residence. Each decade during the 20th century gets separate analyses, but we then combine results in order to show the development of the social patterning of mortality during the studied period. We present the results for the period 2001–2013 separately. We suggest a heterogeneity index in order to investigate a possible homogenisation of mortality between social classes.

The important explanatory variable, HISCLASS, is included in the proportional hazards models as a *stratification* variable. The main reason for this choice is that the effect of HISCLASS on survival is non-proportional, that is, it varies with age. Thus, the main results are presented *graphically.* Note further that `Hisclass` is a *time-varying* variable. This causes lack of information in the higher ages around 1960–1980, because that kind of information is simply missing to a large extent.

7 Results, all causes of death

Models are fitted separately for each ten-year time period, from 1901 to 2000, with the exception of the period 1951–1960. We stratify on HISCLASS and use the covariates `sex`, `civst`, and `urban` (Skellefteå/Umeå town or outside). The cumulative hazards at the end of the time period (65 if 40–64, 90 if 65–89) are the main target in our analysis: These numbers are used in the process of graphically illustrating the development over time.

7.1 Ages 40–64

We start by looking at cumulative hazards by HISCLASS over time periods. They are adjusted for `civil status`, and `urban/rural` residence. We present separate analyses for women and men. The two highest social classes, those we assume have more access to resources vital for health, are represented by blue lines, while the lower skilled workers have red lines.

[Figure 3 about here.]

[Figure 4 about here.]

From Figures 3 and 4 it is obvious that the idea of proportional hazards is not reasonable.The figures do however indicate substantial changes in the social pattern of mortality during the 19th century, something we will return to.

We will use as a summary measure the value of the cumulative hazards at duration 20 (age 60).

[Figure 5 about here.]

Figure 5 shows decadal mortality levels during the 19th century. Apart from the social pattern that will be commented on below, there are a couple of observations that can be made from the figure. Women had consistently better survival than men. This is a well-known phenomenon in Swedish demographic history. Male mortality has almost always been higher than female in all age groups (Willner, 1999; Sundin and Willner, 2007). We also observe a substantial decline in mortality for both sexes, resulting in smaller absolute differences between social classes. The compression that is visible for later decades is partly explained by the decreasing general mortality. This effect can be eliminated by showing these numbers on a log scale, showing the relative levels. Presented in that way, it is not obvious that differences between social classes have diminished. This conclusion has been confirmed by separate analyses (not shown). There is no clear indication of homogenisation of mortality levels between social classes.

In Figure 6 a "blow-up" of the last decades show clearly the upper hand of the upper classes.

[Figure 6 about here.]

The effect of income and education, 1990–2005

The analysis for the last period, is based on a separate analysis with income and education as explanatory variables.

The statistical significance of the covariates are shown in Table 7

[Table 1 about here.]

The estimated effect sizes are shown in Figure 7

[Figure 7 about here.]

And for men:

[Table 2 about here.]

[Figure 8 about here.]

The central question in this paper is however what classes are most advantaged when it comes to mortality, and if the social pattern changed during the 20th century. Notice that we have not analysed the 1950s due to the fact that we only have data for some parishes at that time, consequently having no corresponding population for that decade. Furthermore, the results for the 1960s should be considered with caution. The way the social class is defined leads to much missing information for that decade, something that have restricted the size of the population observed, making the results more shaky. The changing economy also have consequences for the analysis, particularly when it comes to the agricultural sector. While farmers were common occupations during the first half of the 20th century, these occupations has constantly decreased in numbers thereafter.

The social pattern among women are mixed, but in accordance with previous analyses from the present research group on other regions in northern Sweden and for other periods (Edvinsson and Lindkvist, 2011; Edvinsson and Broström, 2012, 2016) the highest social classes usually have comparatively low mortality, while working class women have high. This is especially the case during the latest decades of the century and especially for the period 2002–2013.

A different pattern appears among men. The groups we would expect to have the lowest mortality, if we assume that access to different resources and having a high status determines survival, instead have the highest during much of the century. This is also in accordance with our previous studies (Edvinsson and Lindkvist, 2011; Edvinsson and Broström, 2012, 2016). Workers on the other hand have comparatively low mortality. This changes however towards the end the 20th century. From the 1980s, there is a clear advantage when it comes to survival for higher managers and professionals. This is also what we usually find in analyses of social health inequalities in present-day Sweden as well as in most other countries. In the regions we are studying, this is however a quite recent phenomenon.The advantage for higher classes and disadvantage for low skilled workers is very clear for the period 2002–2013.

7.2 Ages 65–89

We now turn to the elderly, i.e. those that mostly have left the workforce. We start by looking at cumulative hazards by HISCLASS over time periods. In accordance with the analyses for the age group 40–64, the model adjusts for `civil status` and `urban/rural` residence and with separate analyses for women and men. We do not present any results concerning possible homogenisation of mortality levels, since the main results do not deviate from that of the younger group.

[Figure 9 about here.]

[Figure 10 about here.]

The cumulative hazards for the age group 65–89 in different decades are presented in Figures 9 and 10. Corresponding to what we find for the age group 40–64, it is obvious that the assumption of proportional hazards is not reasonable.

We will use as a summary measure the value of the cumulative hazards at duration 30 (age 90), starting from age 65. For the period 2002–2013, a separate analysis is presented.

The general pattern do not differ from the one of the younger age group. The levels are slightly more homogeneous, but we cannot establish that the elderly diverge to any degree from the working-age population. Mortality among women was, as expected, lower than among men. We also find a clear decline in mortality, but this decline did not set in until sometimes after the Second World War. This corresponds to the Swedish development where we find a turning point at this time with better survival among elderly, to a large extent caused by lower mortality in cardiovascular diseases. The results for the 1960s are however uncertain as discussed above, and should not be taken to seriously. The levels seem to be to low. This is something we need to control further.

Concerning the social pattern, we find results fairly similar to the ones for the age group 40–64. For women the results are mixed, even though women from the elite had comparatively low mortality and working class women high. For men we find the same intriguing change among elderly as for the adult population 40–64 years. Mortality was in fact substantially higher among men from the elite and the group of lower managers while it was lowest among workers. This did not change until the last decades of the 20th century. At that time, the highest social classes instead had the best survival while the opposite was the case for workers. The pattern had reversed, thus confirming the results from most studies of this topic concerning the present-day society. The advantage for the higher classes and the disadvantage for the workers are apparent also for this age group during the early 21st century.

[Figure 11 about here.]

A blow-up of the last years is shown in Figure 12.

[Figure 12 about here.]

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The analysis for the last period is based on a separate analysis with income and education as explanatory variables.

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[Table 3 about here.]

The estimated effect sizes are shown in Figure 7

[Figure 13 about here.]

And for men:

[Table 4 about here.]

[Figure 14 about here.]

8 Results, heart diseases ...

Models are fitted separately for each ten-year time period, from 1961 to 2000. We stratify on HISCLASS and use the covariates `sex`, `civst`, and `urban` (Skellefteå town or outside). The cumulative hazards at the end of the time period (60 if 40–64, 90 if 65–89) are the main target in our analysis: These numbers are used in the process of graphically illustrating the development over time.

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[Figure 15 about here.]

[Figure 16 about here.]

[Figure 17 about here.]

[Figure 18 about here.]

[Figure 19 about here.]

[Figure 20 about here.]

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And for men:

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[Figure 24 about here.]

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[Figure 25 about here.]

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[Figure 26 about here.]

The cumulative hazards for the age group 65–89 in different decades are presented in Figures 9 and 10. Corresponding to what we find for the age group 40–64, it is obvious that the assumption of proportional hazards is not reasonable.

We will use as a summary measure the value of the cumulative hazards at duration 30 (age 90), starting from age 65. For the period 2002–2013, a separate analysis is presented.

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[Figure 27 about here.]

A blow-up of the last years is shown in Figure 12.

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[Figure 28 about here.]

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[Table 7 about here.]

The estimated effect sizes are shown in Figure 7

[Figure 29 about here.]

And for men:

[Table 8 about here.]

[Figure 30 about here.]

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List of Figures

Figure 1: The Skellefteå and Umeå regions in Sweden.

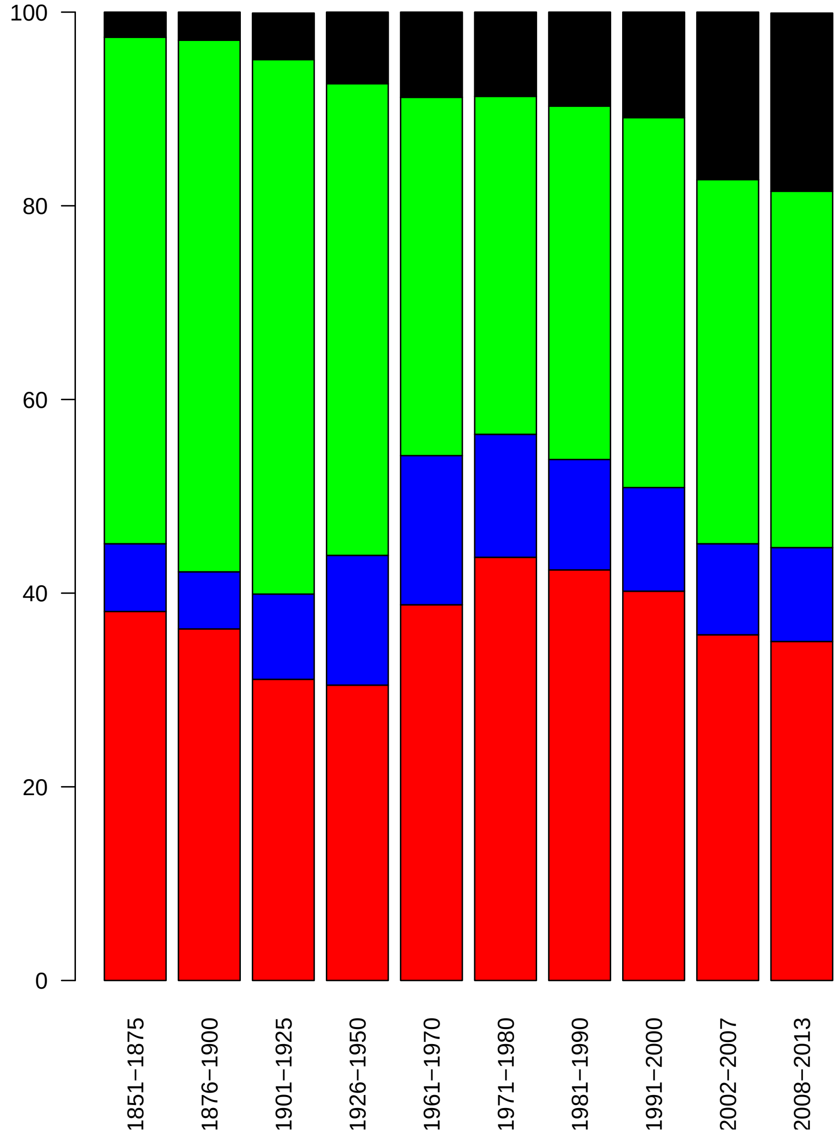


Figure 2: Exposure by hisclass (from the top: 1+2, 3+4, 5, 6+7) and time period

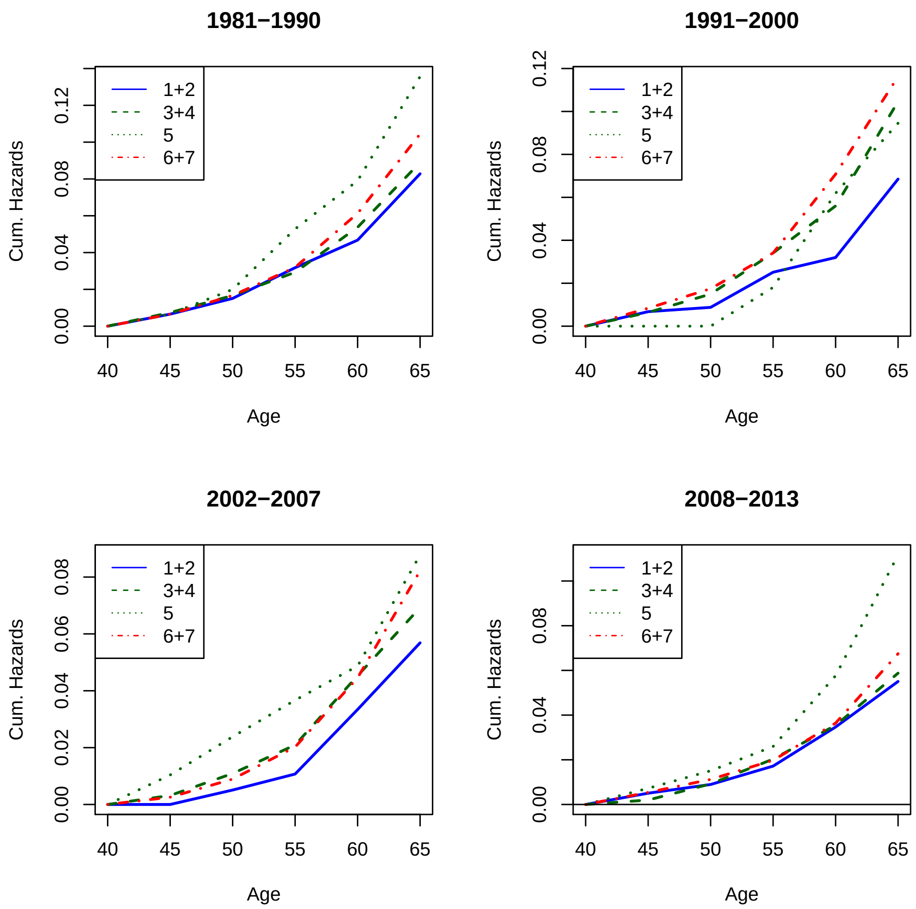


Figure 3: Cumulative hazards for HISCLASS by time period, ages 40–64, women.

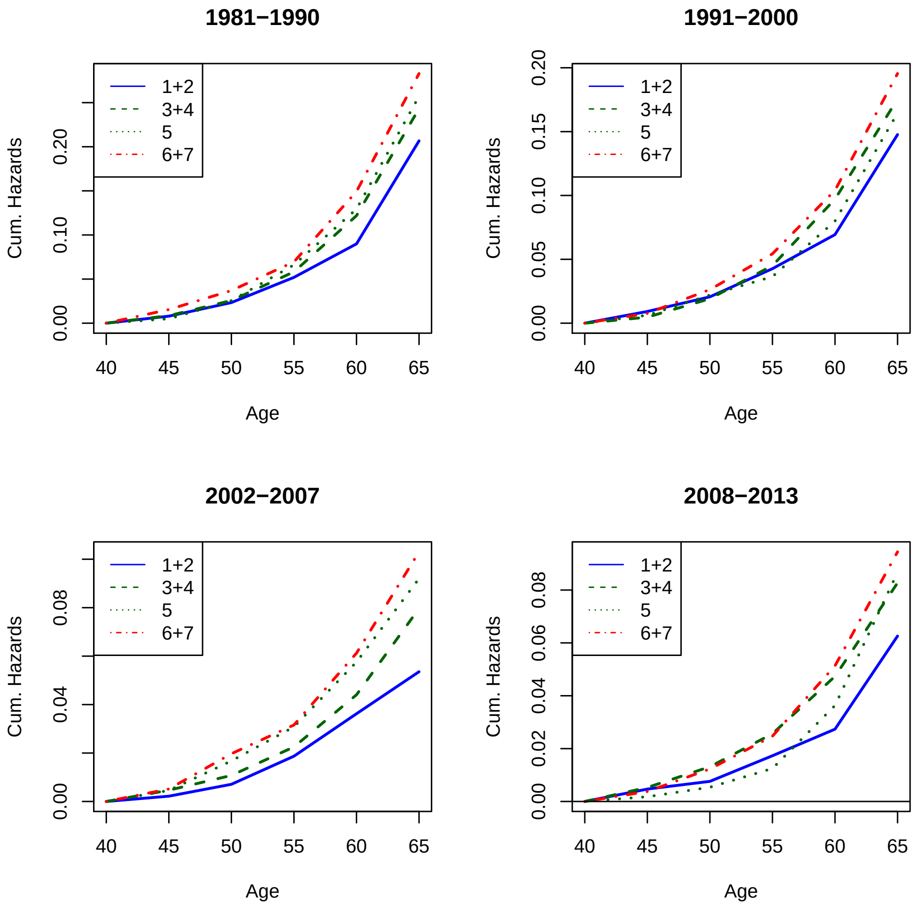


Figure 4: Cumulative hazards for HISCLASS by time period, ages 40–64, men.

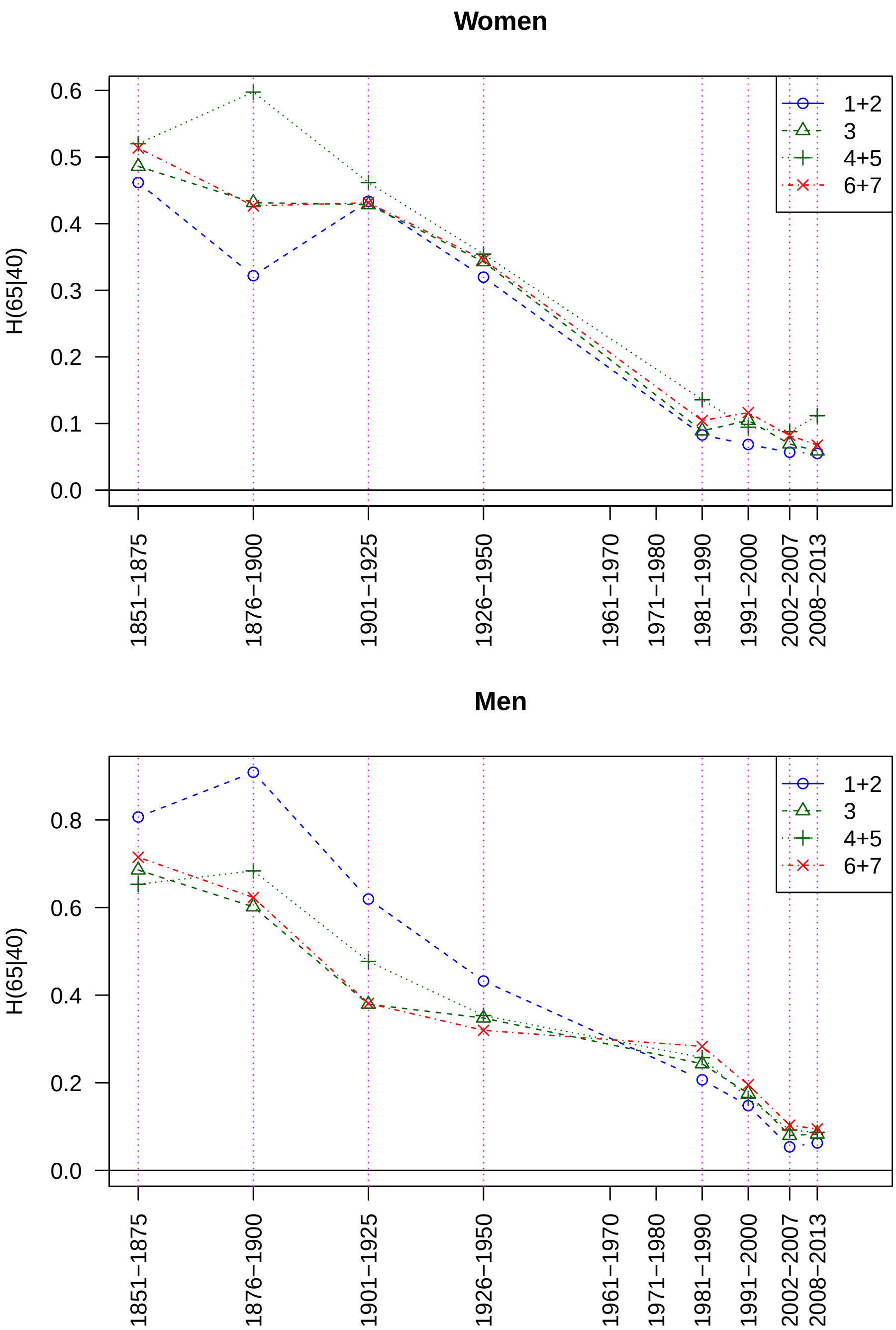


Figure 5: Total hazard of dying before age 65 for a 40 year old person by HISCLASS and decade, women (top) and men (bottom).

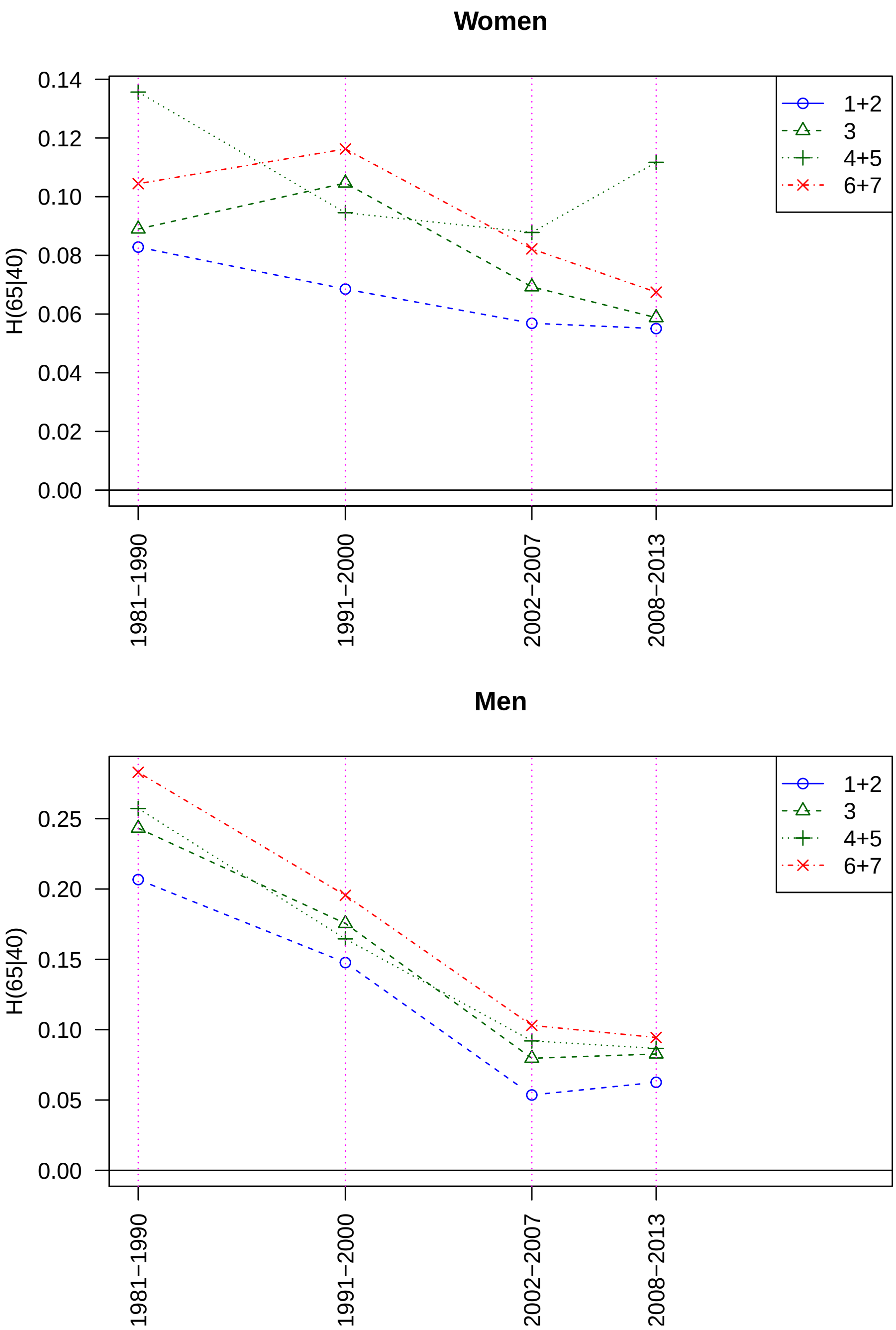


Figure 6: Total hazard of dying before age 65 for a 40 year old person by HISCLASS and decade, women (top) and men (bottom). The last decades.

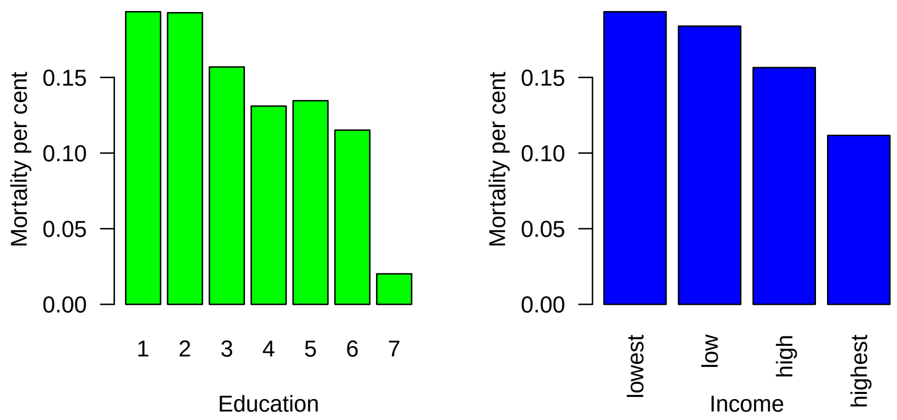


Figure 7: Effect sizes, women 40-64, 1990-2005.

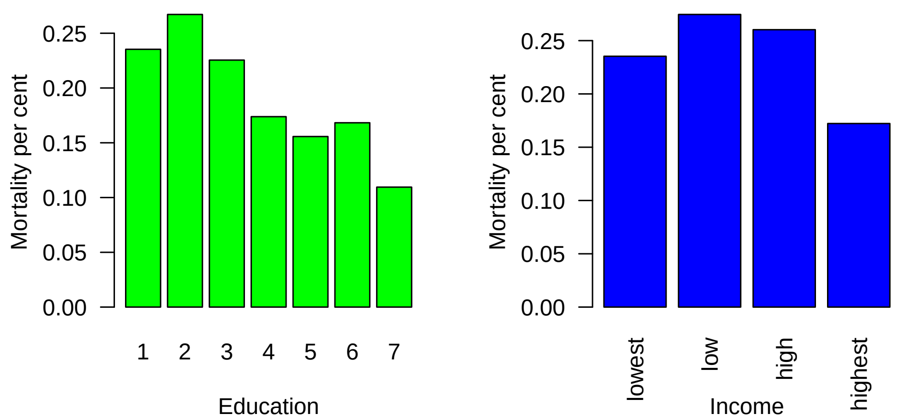


Figure 8: Effect sizes, men 40-64, 1990-2005.

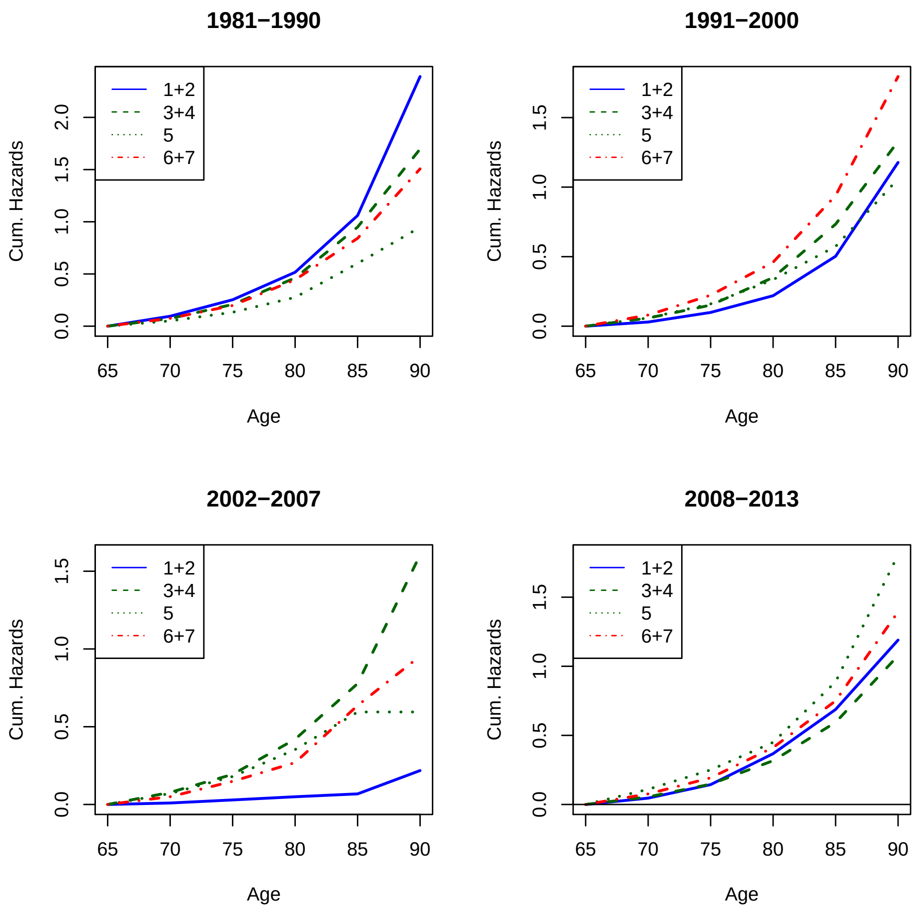


Figure 9: Cumulative hazards for HISCLASS by time period, ages 65–89, women.

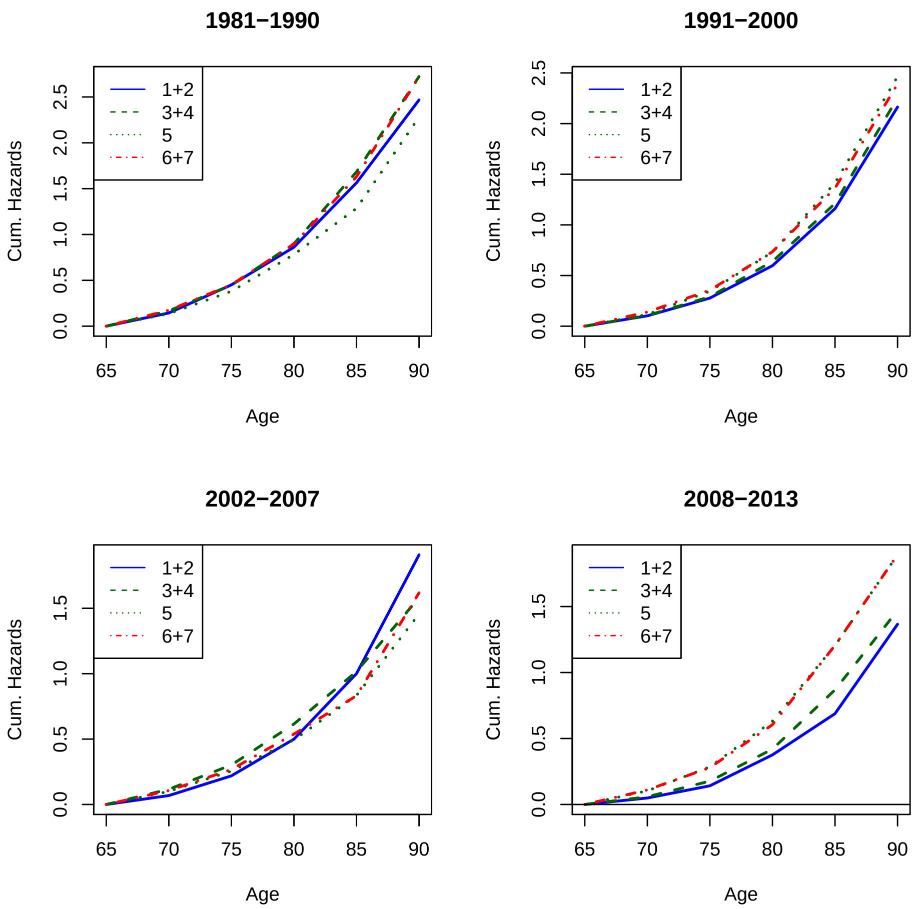


Figure 10: Cumulative hazards for HISCLASS by time period, ages 65–89, women.

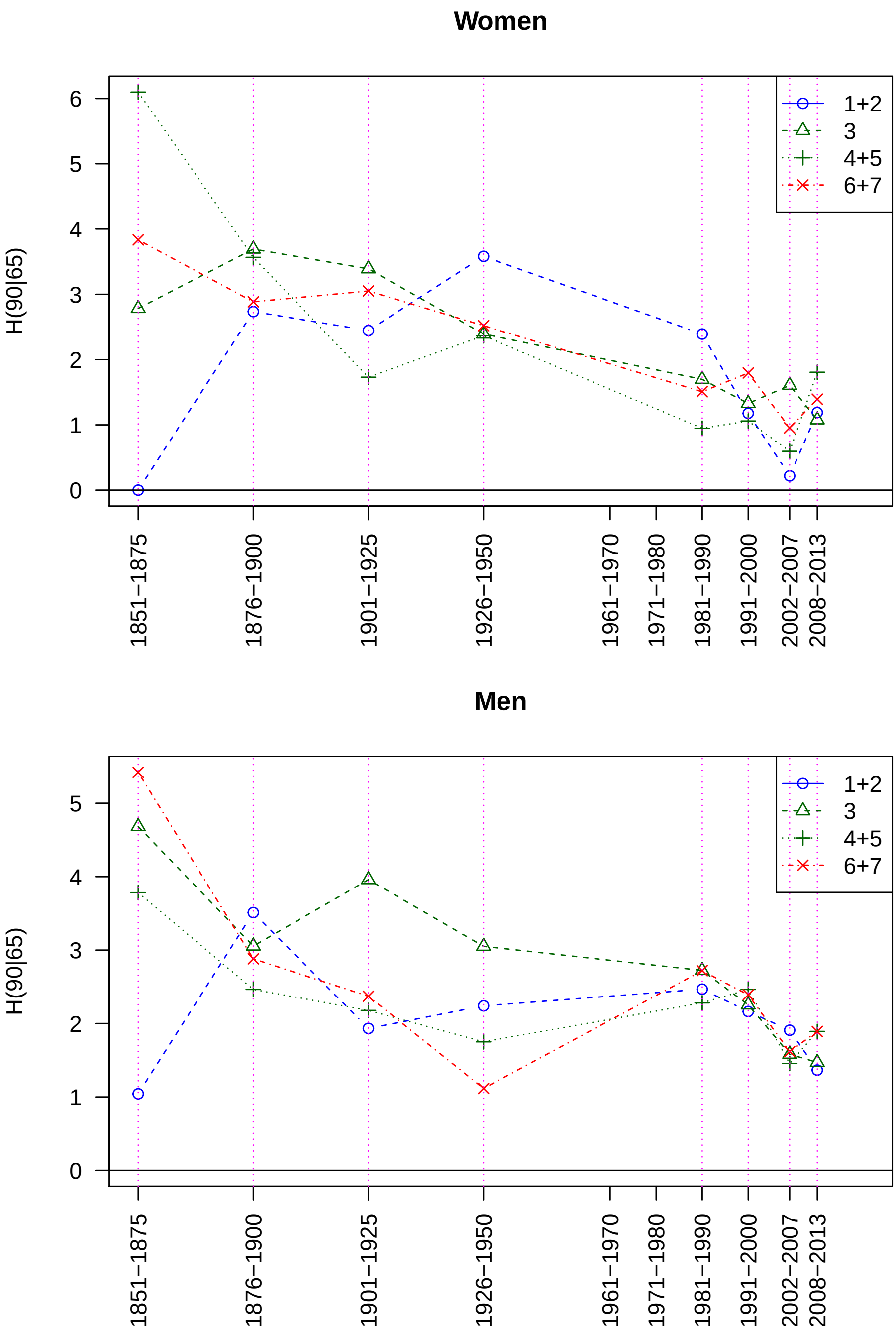
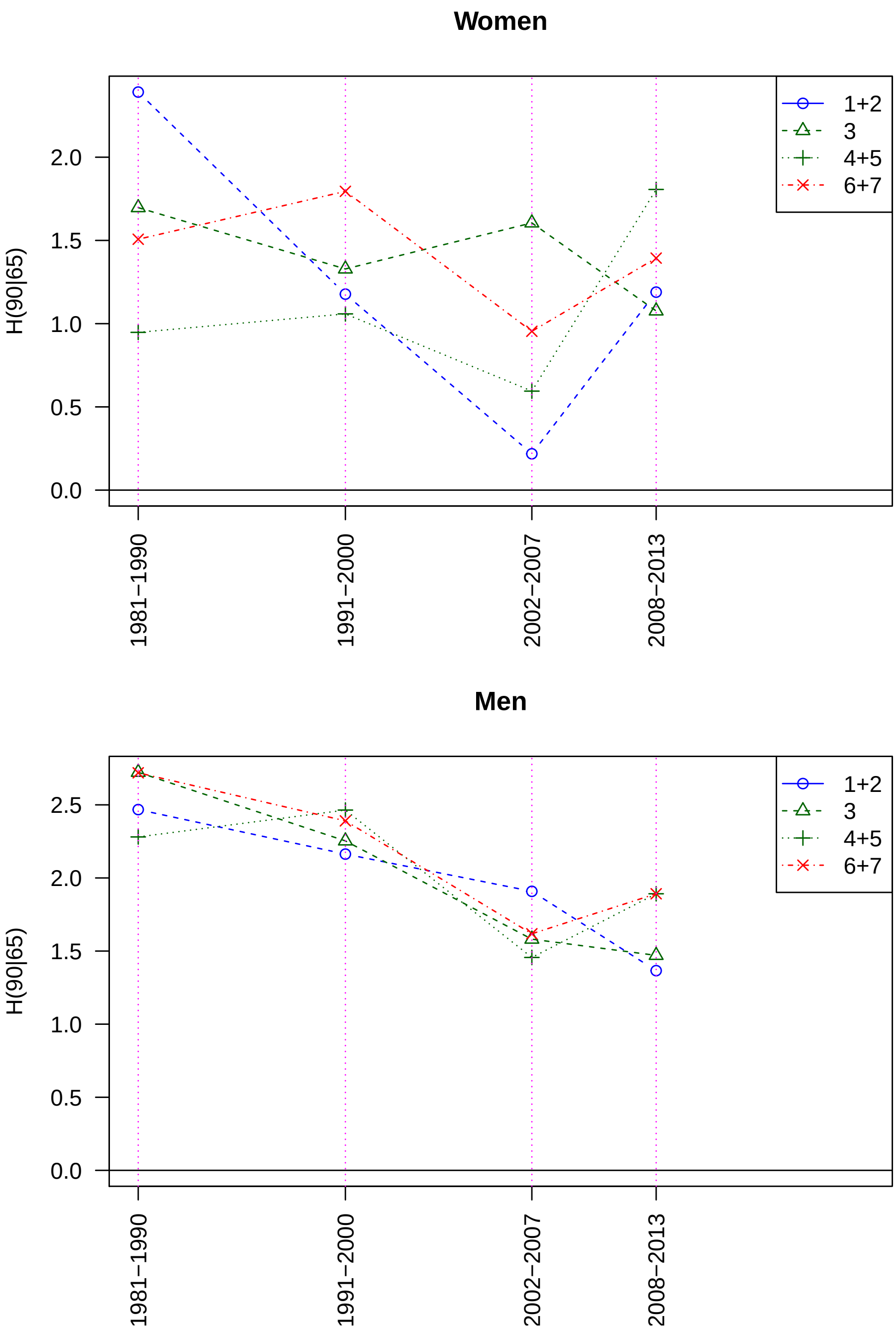


Figure 11: Total hazard of dying before age 90 for a 65 year old person by HISCLASS and decade, women (top) and men (bottom).



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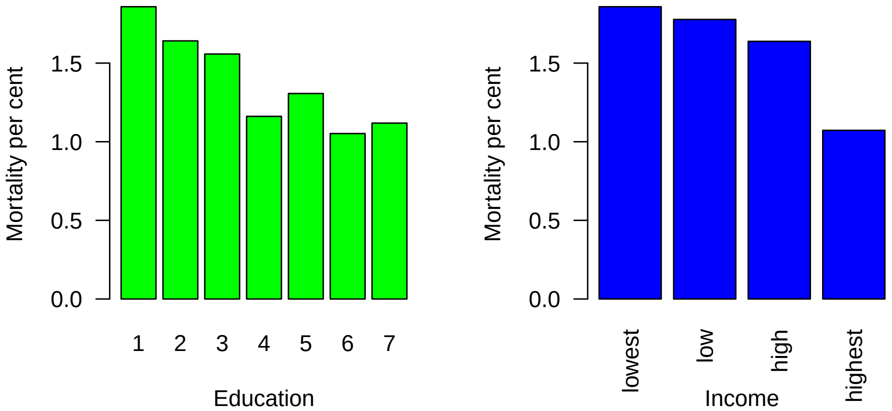

Figure 13: Effect sizes, women 65-89, 1990-2005.

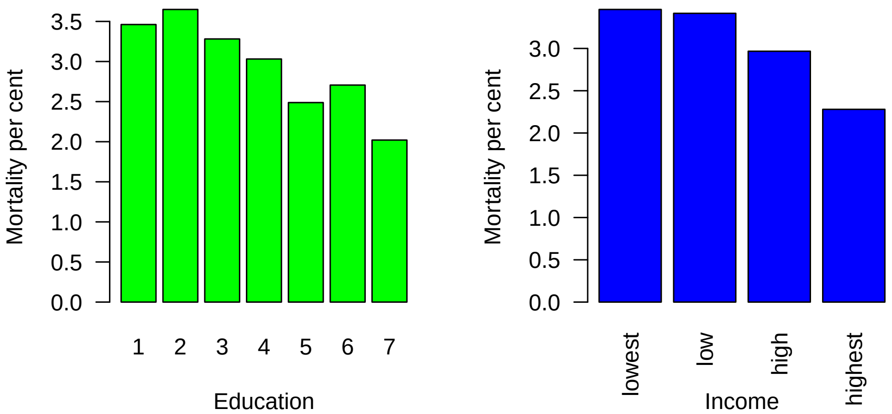

Figure 14: Effect sizes, men 65-89, 1990-2005.

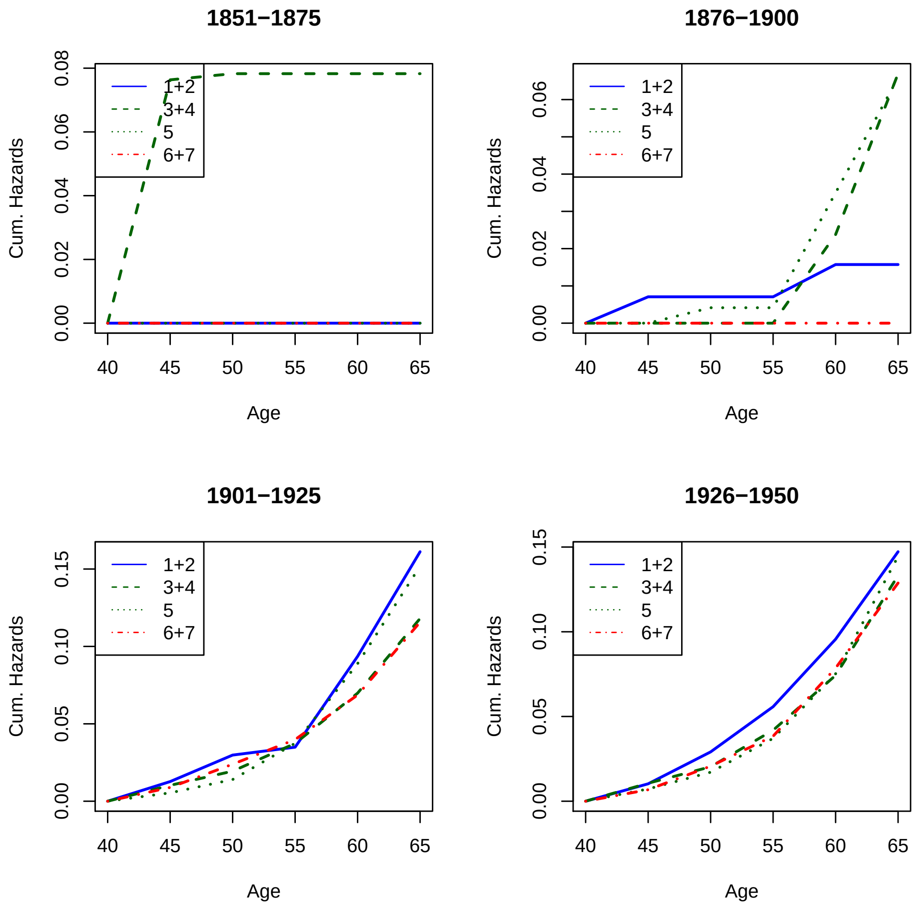

Figure 15: Cumulative hazards for HISCLASS by time period, ages 40–64, women, causes 19.

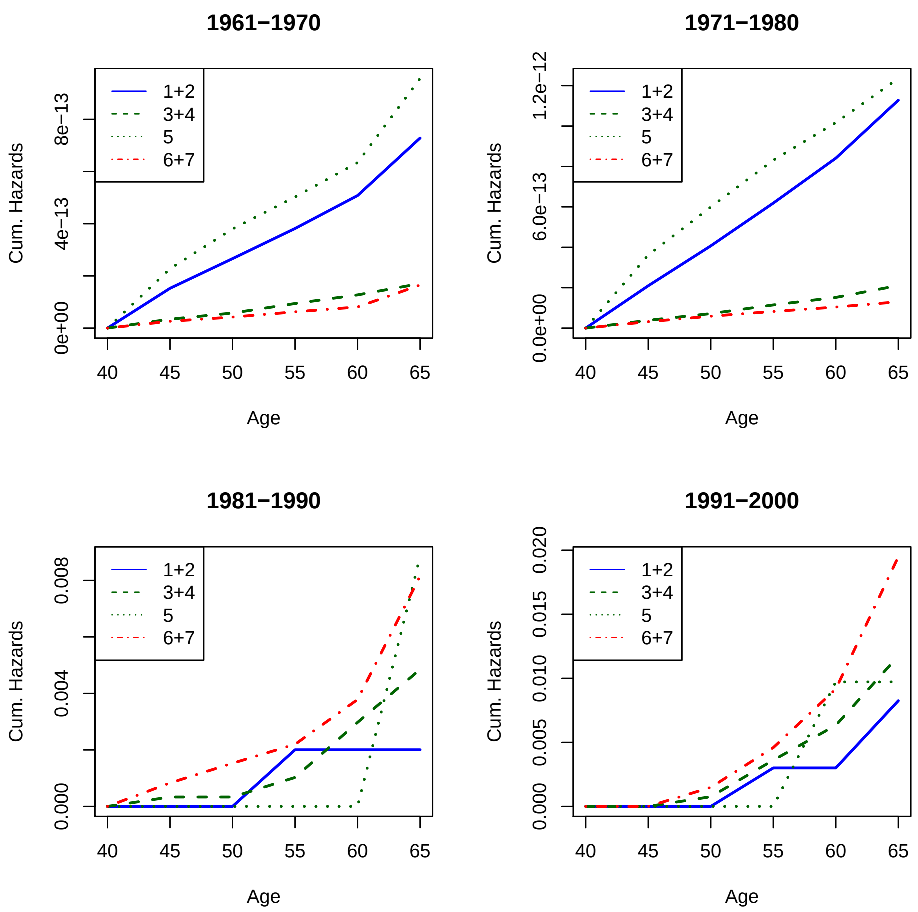

Figure 16: Cumulative hazards for HISCLASS by time period, ages 40–64, women, causes 19.

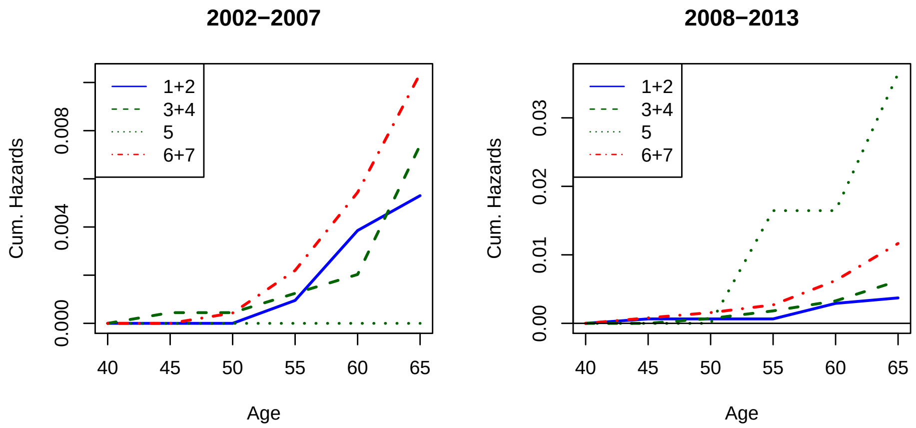

Figure 17: Cumulative hazards for HISCLASS by time period, ages 40–64, women, causes 19.

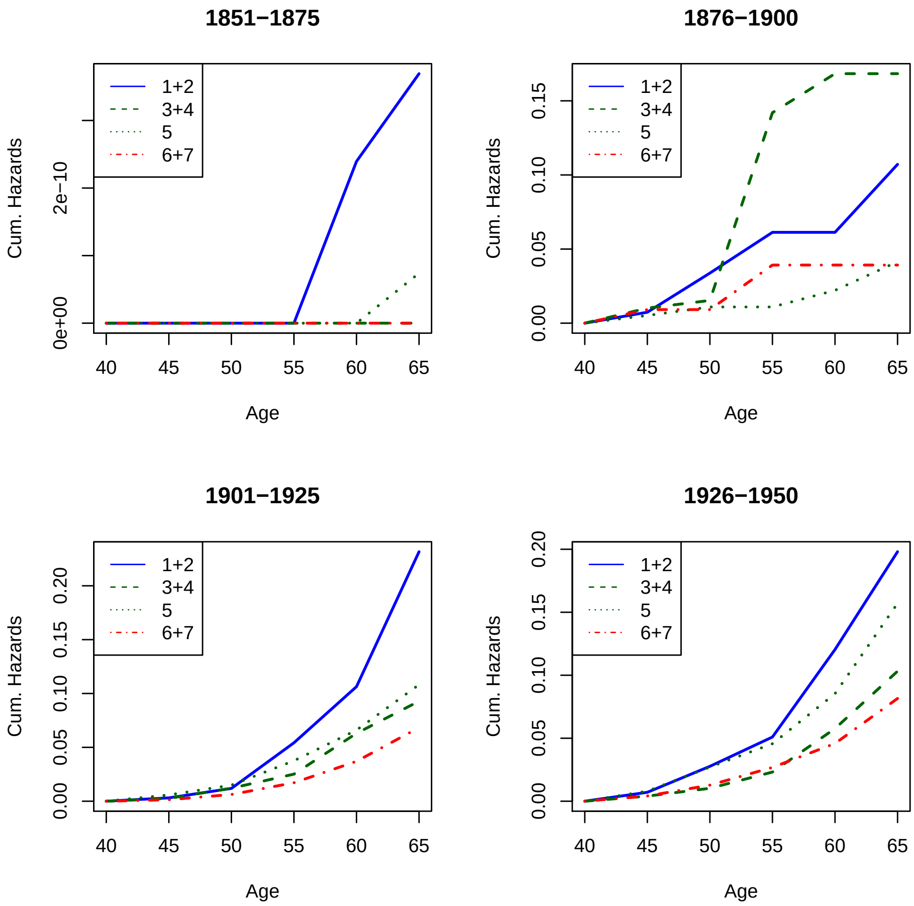

Figure 18: Cumulative hazards for HISCLASS by time period, ages 40–64, men, causes 19.

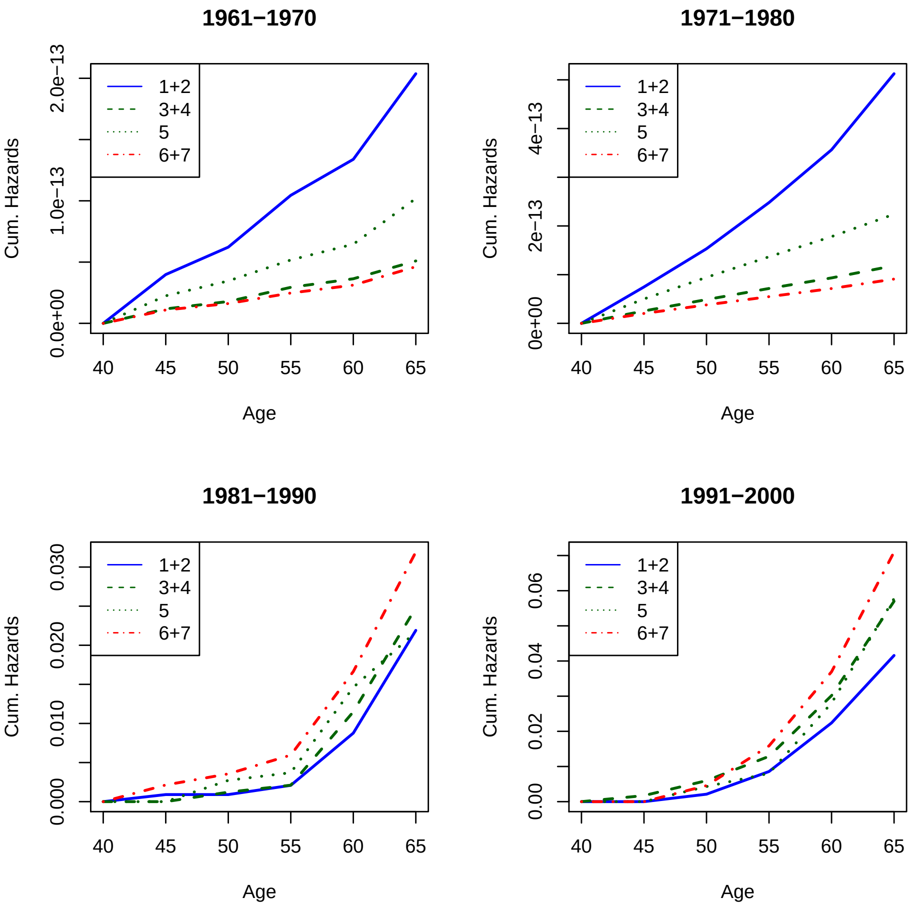

Figure 19: Cumulative hazards for HISCLASS by time period, ages 40–64, men, causes 19.

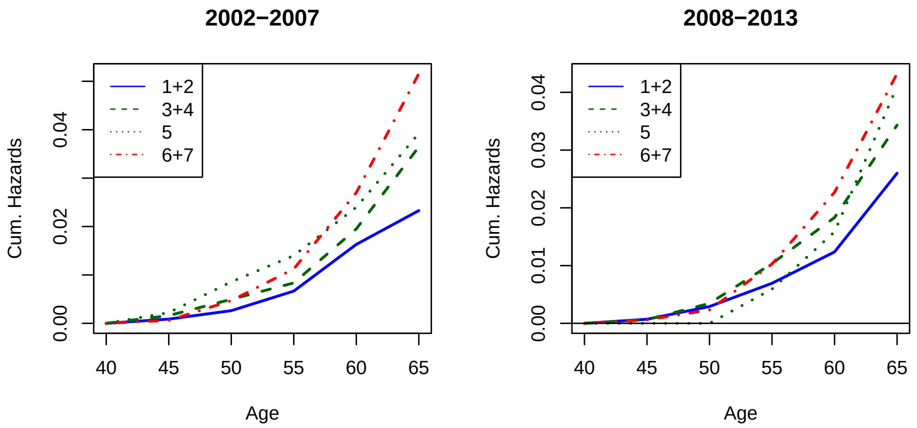

Figure 20: Cumulative hazards for HISCLASS by time period, ages 40–64, men, causes 19.

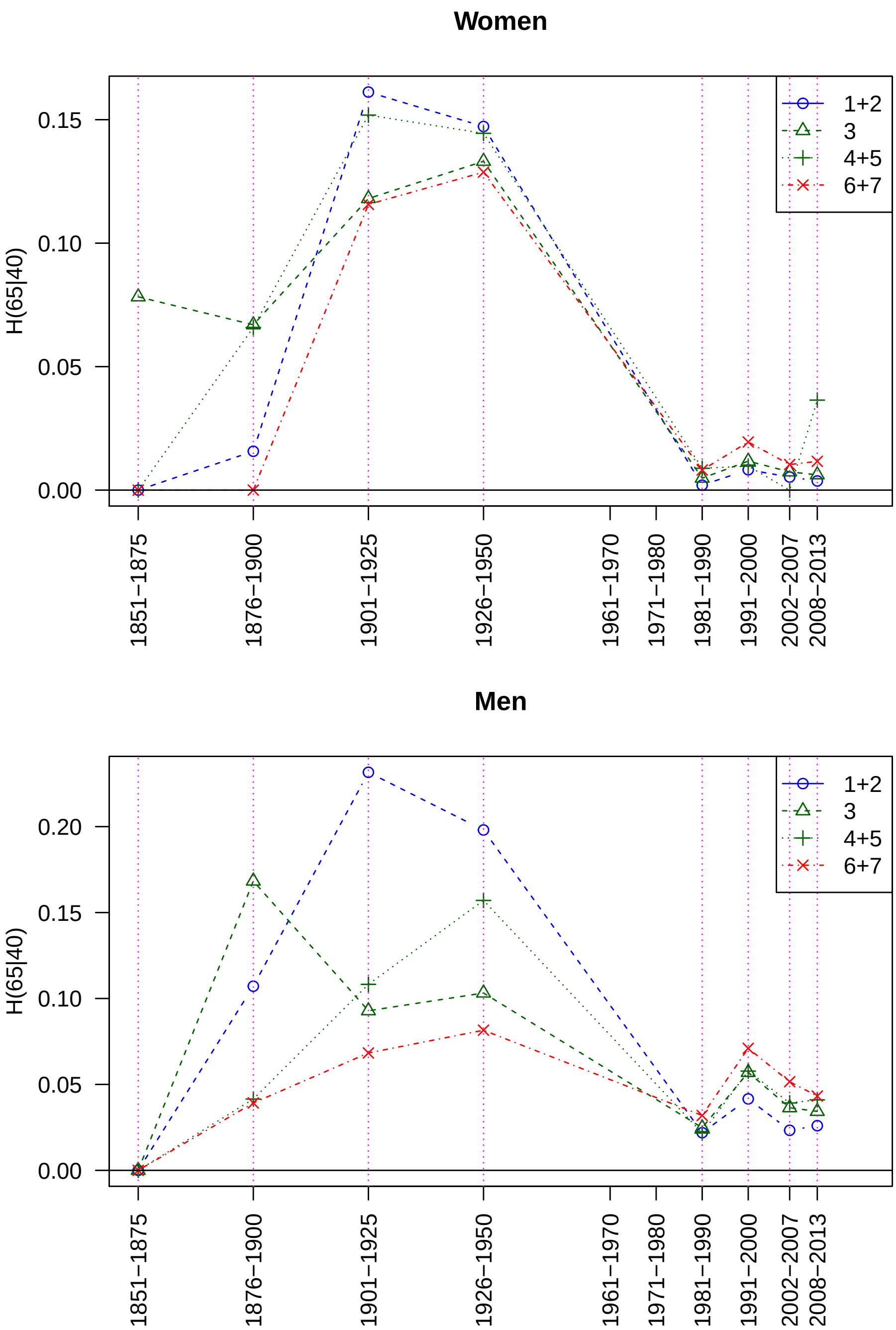

Figure 21: Total hazard of dying before age 60 for a 40 year old person by HISCLASS and decade, women (top) and men (bottom), causes 19.

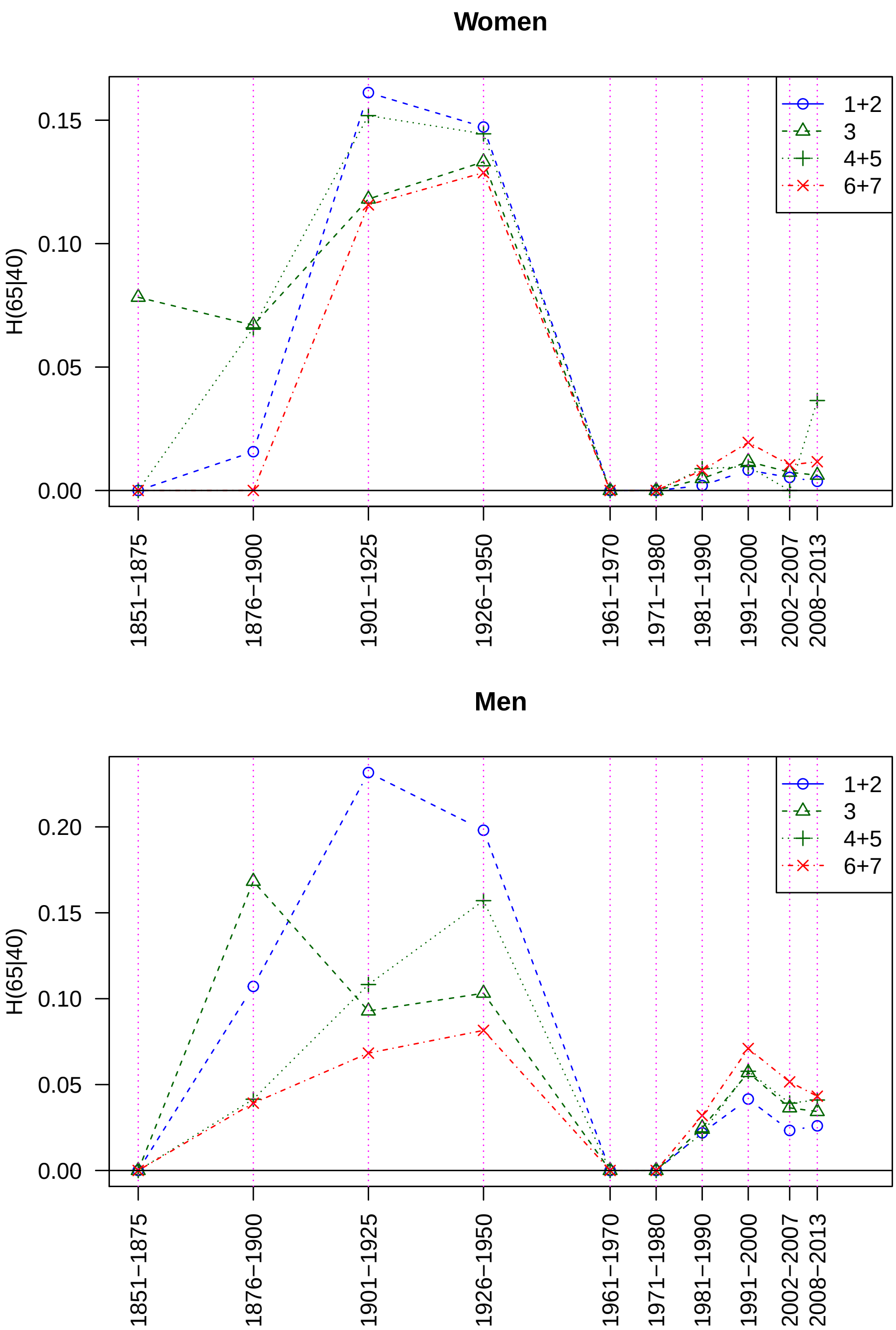

Figure 22: Total hazard of dying before age 60 for a 40 year old person by HISCLASS and decade, women (top) and men (bottom). The last decades, causes 19.

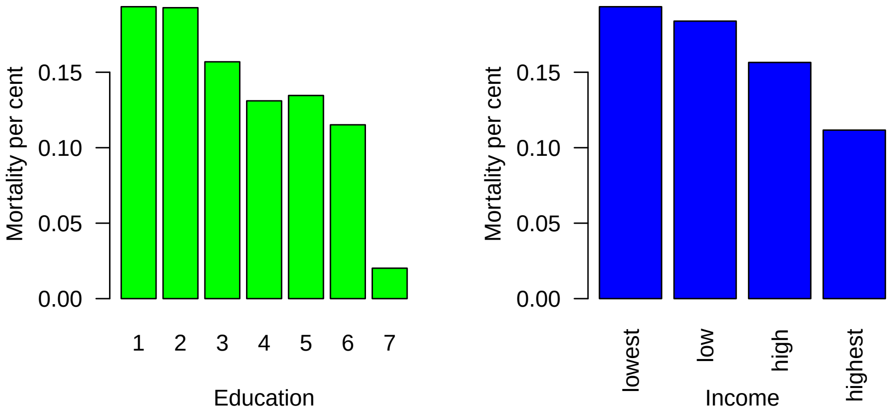

Figure 23: Effect sizes, women 40-64, 1990-2005, causes 19.

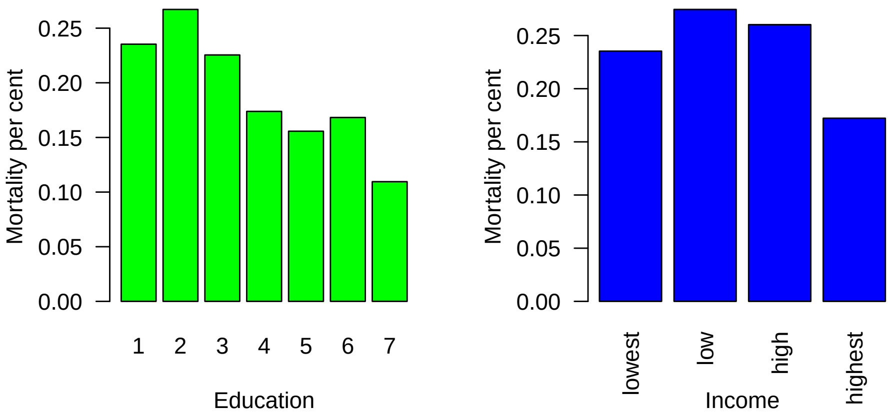

Figure 24: Effect sizes, men 40-64, 1990-2005, causes 19.

Figure 25: Cumulative hazards for HISCLASS by time period, ages 65–89, women, causes 19.

Figure 26: Cumulative hazards for HISCLASS by time period, ages 65–89, women, causes 19.

Figure 27: Total hazard of dying before age 90 for a 60 year old person by HISCLASS and decade, women (top) and men (bottom), causes 19.

Figure 28: Total hazard of dying before age 90 for a 60 year old person by HISCLASS and decade, women (top) and men (bottom). The last decades, causes 19.

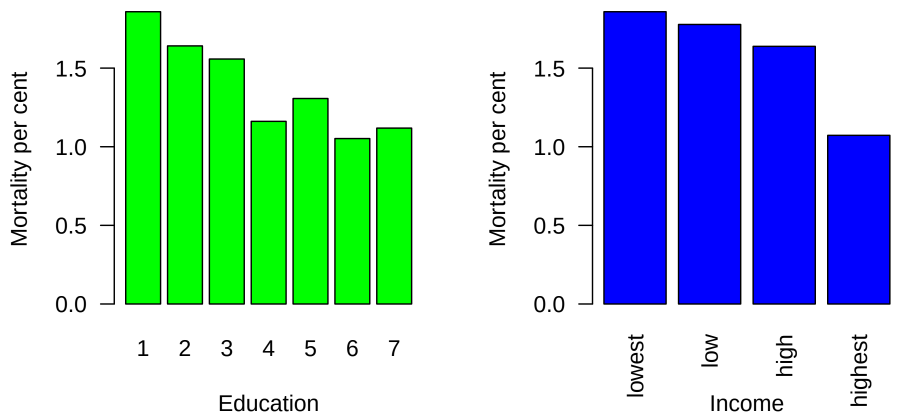

Figure 29: Effect sizes, women 65-89, 1990-2005, causes 19.

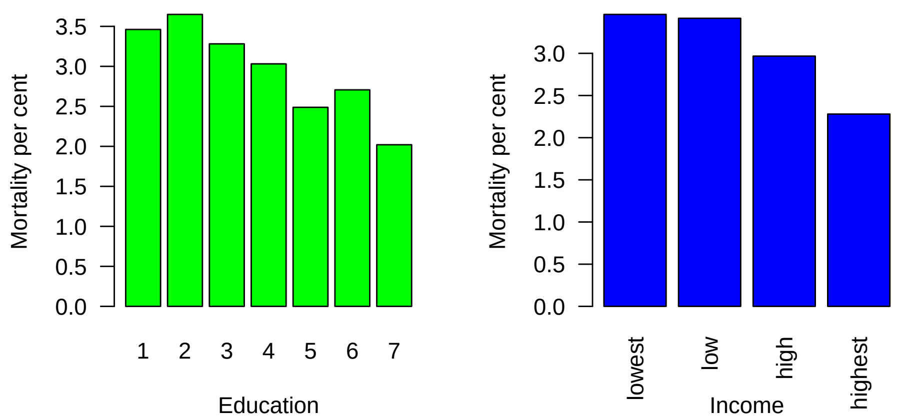

Figure 30: Effect sizes, men 65-89, 1990-2005, causes 19.

List of Tables

	Df	Deviance	AIC	LRT	Pr(>Chi)
<none>		2641.27	4435.92		
as.factor(age)	4	3040.96	4827.60	399.69	0.0000
urban	1	2641.71	4434.35	0.43	0.5099
period	7	2651.80	4432.45	10.53	0.1604
civst	2	2726.38	4517.03	85.11	0.0000
income	3	2680.12	4468.76	38.85	0.0000
educ	6	2677.43	4460.07	36.15	0.0000

Table 1: Effect of covariates for women 40-64, 1990-2005.

	Df	Deviance	AIC	LRT	Pr(>Chi)
<none>		3512.69	6239.93		
as.factor(age)	4	4307.07	7026.30	794.38	0.0000
urban	1	3516.09	6241.32	3.40	0.0653
period	7	3528.32	6241.55	15.62	0.0288
civst	2	3707.78	6431.01	195.09	0.0000
income	3	3577.95	6299.18	65.26	0.0000
educ	6	3566.58	6281.81	53.88	0.0000

Table 2: Effect of covariates for men 40-64, 1990-2005.

	Df	Deviance	AIC	LRT	Pr(>Chi)
<none>		1644.58	3518.27		
as.factor(age)	2	1778.63	3648.31	134.04	0.0000
urban	1	1645.99	3517.67	1.41	0.2351
period	7	1651.66	3511.35	7.08	0.4205
civst	2	1685.24	3554.93	40.66	0.0000
income	3	1685.13	3552.82	40.55	0.0000
educ	6	1673.08	3534.76	28.49	0.0001

Table 3: Effect of covariates for women 65-89, 1990-2005.

	Df	Deviance	AIC	LRT	Pr(>Chi)
<none>		2026.10	4707.72		
as.factor(age)	2	2207.76	4885.37	181.66	0.0000
urban	1	2029.98	4709.60	3.88	0.0488
period	7	2050.43	4718.04	24.33	0.0010
civst	2	2148.73	4826.35	122.63	0.0000
income	3	2075.63	4751.25	49.53	0.0000
educ	6	2047.56	4717.17	21.46	0.0015

Table 4: Effect of covariates for men 65-89, 1990-2005.

	Df	Deviance	AIC	LRT	Pr(>Chi)
<none>		2641.27	4435.92		
as.factor(age)	4	3040.96	4827.60	399.69	0.0000
urban	1	2641.71	4434.35	0.43	0.5099
period	7	2651.80	4432.45	10.53	0.1604
civst	2	2726.38	4517.03	85.11	0.0000
income	3	2680.12	4468.76	38.85	0.0000
educ	6	2677.43	4460.07	36.15	0.0000

Table 5: Effect of covariates for women 40-64, 1990-2005, causes 19.

	Df	Deviance	AIC	LRT	Pr(>Chi)
<none>		3512.69	6239.93		
as.factor(age)	4	4307.07	7026.30	794.38	0.0000
urban	1	3516.09	6241.32	3.40	0.0653
period	7	3528.32	6241.55	15.62	0.0288
civst	2	3707.78	6431.01	195.09	0.0000
income	3	3577.95	6299.18	65.26	0.0000
educ	6	3566.58	6281.81	53.88	0.0000

Table 6: Effect of covariates for men 40-64, 1990-2005, causes 19.

	Df	Deviance	AIC	LRT	Pr(>Chi)
<none>		1644.58	3518.27		
as.factor(age)	2	1778.63	3648.31	134.04	0.0000
urban	1	1645.99	3517.67	1.41	0.2351
period	7	1651.66	3511.35	7.08	0.4205
civst	2	1685.24	3554.93	40.66	0.0000
income	3	1685.13	3552.82	40.55	0.0000
educ	6	1673.08	3534.76	28.49	0.0001

Table 7: Effect of covariates for women 65-89, 1990-2005, causes 19.

	Df	Deviance	AIC	LRT	Pr(>Chi)
<none>		2026.10	4707.72		
as.factor(age)	2	2207.76	4885.37	181.66	0.0000
urban	1	2029.98	4709.60	3.88	0.0488
period	7	2050.43	4718.04	24.33	0.0010
civst	2	2148.73	4826.35	122.63	0.0000
income	3	2075.63	4751.25	49.53	0.0000
educ	6	2047.56	4717.17	21.46	0.0015

Table 8: Effect of covariates for men 65-89, 1990-2005, causes 19.