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Sex differences in health and mortality by income and income changes

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Abstract

Background: The adverse association between income, health and survival is well-documented, but little is known about how income trajectories influence health and survival for men and women. We aim to investigate sex differences in mortality and hospitalizations by income and income changes.

Methods: We performed a population-based, nationwide study including 1,063,787 Danes born 1935-55 and residing in Denmark during 1980-2015. Income was calculated during two age intervals: 45-49 and 55-59 years. The average income was divided into quartiles for men and women separately, which formed the basis for the income trajectories. Individuals were followed-up from age 60 until 2014/2015 for hospital admission and mortality, respectively.

Results: Men had higher mortality and were more hospitalized than women. Sex differences in mortality were most pronounced for people with stable low income (relative difference in hazard = 1.93; 95% CI 1.89-1.98) and a downward income trajectory (1.91; 95% CI 1.85-1.98) with smaller sex differences for people with an upward trajectory (1.59; 95% CI 1.56-1.62) and stable high income (1.37; 95% CI 1.33-1.41). A similar pattern was found for family income. Regarding hospitalizations, similar results were found, though less pronounced. Investigation of mortality and hospitalizations by all possible trajectories demonstrated that income at ages 55-59 was an important predictor of mortality, with increasing mortality for decreasing income quartile.

Conclusion: Income trajectories as a proxy for change in social position have a larger influence on men's than women's health and mortality. Income in the late 50s is an important predictor of mortality, particularly for men**.**

Keywords Sex differences; income; mortality; hospital admissions; Denmark

Introduction

Although women in general live longer than men [1], they tend to report poorer self-rated health and worse physical functioning [2, 3], they are more frail, have slightly more comorbidity [4], and perform worse on physical tests [5, 6]. Despite increasing research on the male-female health survival paradox [7], we know little about the causes of sex differences or whether they can be reduced or eliminated.

Socioeconomic status (SES) is an important determinant of health [8], and differences in morbidity and mortality between SES groups are one of the most consistent epidemiological findings [9, 10]. In many populations, people with higher measures of SES such as income [11, 12], education [13, 14] and occupational class [15, 16] are more likely to have longer life expectancy and reduced morbidity. Sex differences in the associations between income and health [17] have received little attention, but SES gradients in mortality are generally weaker among women than men [11, 12].

SES has shown to be important for health and survival, but few studies have investigated the effects of income changes on health [18]. A longitudinal study investigating income changes in relation to various self-assessed health measures [19] found that income reduction over time resulted in poorer health compared to income increases or stable income, and that average income over a five-year period had the strongest effects on health. Miething et al. [18] confirmed the higher risk of poor health following a substantial, downward income change, with stronger effects for men than women.

Research on the effect of changes in SES over the life course on sex differences in health and mortality has been limited. Using hospital admissions as indicator of population health [20],

we investigated sex differences in health and mortality by income and income changes. We hypothesize that for women the loss of income and, thus, social status, is most strongly associated with health status and that for men it is most strongly associated with mortality.

Methods

Setting and study population

This study is based on Danish register data that are linked through a 10–digit personal identification number [21-23]. We used the Danish Civil Registration System (CPR) for information on gender, date of birth, migrations and mortality [21], the National Patient Register for information on hospitalizations [24], the Income Statistics Register for information on income [22], the Population Education Register for information on education [25], and the Employment Classification Module for information on employment [23]. Family registration in the CPR was used for family income and to identify couples. Vital status was available until December 31, 2015, and data on hospitalizations were available until December 31, 2014.

The study population comprised persons born in 1935-55 and residing in Denmark between January 1, 1980 and December 31, 2015. People alive at age 60 with available income measures at ages 45-49 and 55-59 were included in the study. To avoid reverse causation, i.e. poor health causing low income [26], we excluded individuals retired before age 60, giving a total study population of 1,063,787 persons (Supplementary Figure 1).

Income measures

Inhabitants in Denmark aged 15 and above are registered annually in the Income Statistics Register according to income [22]. We used two income measures: individual disposable income (individual income after tax and interest expense) available from 1980-2014, and disposable household income (sum of income for all persons living in the family and liable to pay Danish taxes) available from 1990-2014. Income was calculated as an average income during five years investigated during two age periods: 45-49 and 55-59 years. The average income was divided into quartiles for men and women separately, which formed the basis for the four income trajectories: "stable high" (income above median, but in the same quartile in both periods), "upward" (an increase in income quartiles between periods), "downward" (a decrease in income quartiles between periods) and "stable low" (income below median, but in the same quartile in both periods). Because income was calculated as an average during five years, income values were corrected for inflation using the price index in Statistics Denmark, which was on average 3.1% per year for the period 1980-2014.

Socio-demographic variables

Measures of socio-demographic and SES characteristics included sex, age groups (60-64, 65-69, 70-74 and 75-81), birth cohorts (1935-39, 1940-44, 1945-49 and 1950-55), highest attained education measured according to the International Standard Classification of Education (ISCED) [27] grouped into low (ISCED 1-2), medium (ISCED 3)[1], and high (ISCED 5-8), and employment status containing employed (including self-employed, earners and assisting spouse), unemployed and others (including students and unknown). Education and employment were identified at age 45, if possible, or at the earliest age thereafter.

[1] ISCED 4 was not included because there were no observations in this category.

Statistical analyses

Survival analyses were used, with age as the time scale, to investigate all-cause mortality by individual and family income trajectories. Because family income was only available from 1990, analyses were restricted to the 1945-55 birth cohorts. Due to differences in the income-health associations for singles and couples, particularly a higher mortality among single men with stable low income (Supplementary Figure 2), analyses of family income were restricted to contain couples only. Follow-up started at age 60 and continued until death, emigration or end of follow-up in 2015, whichever came first. Using a Cox proportional hazards analysis, we calculated hazard ratios (HRs) with 95% confidence intervals (CIs) for mortality among men and women with an upward trajectory, a downward trajectory and stable low income, respectively, relative to people with stable high income. Furthermore, we estimated the relative difference in hazard between men and women by income trajectories. Hospitalization was measured at each age from age 60 to 80 as admission to a hospital for any reason as an inpatient at this specific age. Using Poisson regressions stratified by birth cohort, we estimated incidence rate ratios (IRRs) with 95% CIs, comparing all-cause hospitalizations for the different income trajectories with stable high income as the reference group. Also, we calculated IRRs for the differences between men and women. The Cox proportional hazards assumption was checked using the log-log plot of the Kaplan-Meier survival function, while the assumptions of the Poisson regressions were checked by plotting estimated log-hazard functions.

Analyses were performed for the total study population and stratified by age groups. All mortality analyses were adjusted for birth cohorts, and the analyses combining all age groups were further adjusted for education and employment, respectively. Moreover, within a subsample of

people with partners in the study population, we investigated mortality and hospitalizations by income trajectories for spouses/partners adjusted for birth cohorts and income quartiles for the index person at ages 45-49. Partners were defined as the spouse/partner at the age range 45-59 years or, if not available, the partner at the age closest to 45 years outside the interval. To examine a more detailed pattern of the income-health associations, we also investigated mortality and hospitalizations for all 16 possible income trajectories. All analyses were performed using Stata version 14.2.

Results

A total of 115,008 (10.8%) deaths were observed in 1,063,787 persons during the 21-year follow-up period: 72,629 (13.3%) men and 42,379 (8.2%) women. Hospitalization rates were 150/1000 person-years for men and 124/1000 person-years for women (Table 1). Individual disposable income was on average higher among people aged 55-59 than peopled aged 45-49, and in both periods, income was higher for men than for women; however, more men than women (47.2% vs 41.9%) had an upward income trajectory, and slightly more men than women had a downward trajectory (8.8% vs 8.5%). Fewer men than women had stable low (17.0% vs 19.8%) and stable high income (27.0% vs 29.8%) (Table 1).

[Table 1 about here]

When investigating the income-health associations, we found the highest mortality among men with a downward income trajectory (HR = 1.79; 95% CI 1.75-1.84) and stable low income (HR = 1.71; 95% CI 1.67-1.75), but also men with an upward income trajectory (HR = 1.16; 95% CI 1.13-

1.18) had higher mortality than men with stable high income (Figure 1A). A similar pattern was found for hospitalizations, though less pronounced (Figure 1D). Women with a downward income trajectory (HR = 1.29; 95% CI 1.24-1.34) and a stable low income (HR = 1.20; 95% CI 1.16-1.23) had higher mortality than women with stable high income, whereas no difference was found for women with an upward income trajectory (Figure 1A). Women with a downward income trajectory were more hospitalized than women with stable high income, whereas no overall differences were found for stable low income and an upward income trajectory (Figure 1D). For family income, the highest mortality was found for people in families with stable low income and a downward income trajectory, but also people in families with an upward income trajectory had slightly higher mortality than people in families with stable high income, though most pronounced for men (Figure 1B). A similar pattern was found for hospitalizations (Figure 1E). However, the association between income and mortality depended on age, with the strongest association at ages 60-64, but with a decreasing effect with advancing age (Figures 1A and 1B). For hospitalizations, a similar pattern was indicated, though less pronounced (Figures 1D and 1E). Regarding mortality and hospitalizations by partner's income trajectory, we found that women with partners having a downward income trajectory and a stable low income had higher mortality and were more often hospitalized than women with partners having a stable high income. Contrarily, only small differences were found for men in relation to their partners' income trajectory (Figures 1C and 1F). Generally, the patterns remained similar after further adjustments for education and employment, respectively (Supplementary Table 1).

[Figure 1 about here]

When examining sex differences, we found that men had higher mortality and were more hospitalized than women. Sex differences in mortality and hospitalizations were most pronounced for people with a stable low income (relative difference in hazard = 1.93; 95% CI 1.89-1.98; IRR = 1.32; 95% CI 1.31-1.33) and a downward income trajectory (1.91; 95% CI 1.85-1.98; IRR = 1.27; 95% CI 1.25-1.28) with smaller sex differences for people with an upward trajectory (1.59; 95% CI 1.56-1.62; IRR = 1.19; 95% CI 1.18-1.20) and a stable high income (1.37; 95% CI 1.33-1.41; IRR = 1.11; 95% CI 1.10-1.12) (Figures 2A and 2C). Identical patterns were found for family income, although slightly lower sex differences in mortality and hospitalizations were found for people in families with a stable low income and regarding hospitalizations also for people with a downward income trajectory (Figures 2B and 2D). This was also the case after further adjustments for education and employment, respectively (Supplementary Table 2). Sex differences were relatively stable over age groups except from a slight decrease in stable low income at ages 75-81 (Figures 2A and 2C).

[Figure 2 about here]

Examination of mortality by all possible income trajectories demonstrated that the association with mortality for the upward and downward income trajectories was more influenced by the income quartile at ages 55-59 compared with the income quartile at ages 45-49. For instance, for people having an upward income trajectory ending at the highest quartile in their late 50s, the mortality was more similar to those with stable incomes at the highest quartile compared with those

from the income quartile that they originally belonged to. This pattern was also observed for hospitalizations among men, whereas no clear pattern was found for women (Table 2).

[Table 2 about here]

Sex differences for all income trajectories confirmed the pattern from the main trajectories with the most pronounced sex differences for people with a downward income trajectory and a stable low income. Nevertheless, income in the late 50s was also important for sex differences, with the smallest differences in mortality between men and women with incomes in the highest quartile at ages 55-59 and the largest differences for people with incomes in the lowest quartile. A similar pattern was found for hospitalizations, though less clear (Table 3).

[Table 3 about here]

Discussion

The present study examined sex differences in mortality and hospitalization after age 60 by income changes between 45-49 and 55-59 years. Overall, we found that income differentiates men more than women regarding mortality and hospitalizations. Sex differences were most pronounced for people with a stable low income and a downward income trajectory, with smaller sex differences for people with an upward income trajectory and a stable high income. Investigation of mortality and hospitalizations by all possible income trajectories showed that a main predictor of mortality was income in the late 50s, particularly for men.

We hypothesized that, for women, loss of income would be most strongly associated with health status, whereas for men we expected the association to be strongest with mortality. For all income trajectories, we found that men had higher mortality than women. Thus, it seems that men are more vulnerable than women towards income loss, and that men do not benefit as much as women from an increase in income, which may contribute to the shorter survival among men. Furthermore, the pattern of hospitalizations by income trajectories was in the same direction as that of mortality, lending no support to the notion that changes in income over the life course can explain the poorer health of women compared with men; nevertheless, we found that the health and survival of women were slightly negatively influenced by the income of their partner when the partner had a downward income trajectory or a stable low income. Few studies have examined the effects of partner's income [28], but a study comparing the relative importance of spouses' SES indicators to mortality found that both education, occupational class and income were slightly associated with women's mortality, whereas in men, only wife's education had an impact on mortality [28]. Similarly, McDonough et al. found that elevated spousal income lowered the odds of dying for women, whereas the opposite was found for men [29].

Similar to previous studies on income-health associations, e.g. [8-10, 30], we found that SES is a powerful determinant of health and that being disadvantaged during a period in midlife has a significant impact on health and mortality particularly for men. Social mobility theories hypothesize that SES mobility across the life course impact adult health. The “health constraint” hypothesis posits that socially mobile individuals have the health characteristics of both the SES groups that they leave and of their new social group [31]. There is growing evidence that life course SES is associated with cardiovascular disease risk [32, 33]. Findings from the British Women’s Heart and Health Study suggest that women aged 60 to 79 for whom SES improved or decreased over the life

course adopt the eating and exercising habits of their new social group [34]. In this study, the effects on mortality of a downward trajectory were overall at the same level as the effects of stable low income. However, people in families with an upward income trajectory had higher risk of mortality than people with a stable high income, lending support for the "health constraint" hypothesis, placing socially mobile individuals at an intermediate risk [31].

In line with earlier studies [35-37], we found smaller relative associations between individual income and mortality with advancing age, indicating that income best predicts differences in health and mortality among the youngest elderly. The reason may be that the elderly population represents a selected group [38] or that income in middle age does not accurately reflect the true socioeconomic conditions to which individuals are exposed in large portions of their adulthood. However, importantly, this study demonstrates that income at ages 55-59 is an important predictor of mortality after age 60, suggesting that income in the late 50s may compensate, at least partly, for a lower income in middle age.

Previous studies have highlighted the importance of using both household and individual income measures [17, 39], showing that household income is more strongly and consistently associated with health than individual income [17]. This study demonstrated that the way in which income was measured appeared to make little difference for sex differences in mortality and hospitalizations except from a slightly lower sex difference for stable low income when using family income. Also, we found overall similar results when adjusting for education and employment, suggesting that, in Denmark, income has an independent effect on health and mortality.

The main strength of this study is the use of Danish registers with complete unselected information on mortality and hospital admissions. The study population provides nationwide

coverage with 21 years of follow-up. Thus, there is little selection bias due to non-response or loss to follow-up. A central concern in income-health analyses is the possibility of confounding by reverse causation [26]. Although reverse causation cannot be completely ruled out because of, e.g., no control for baseline health measures, the longitudinal design with measures of income that precede the health outcomes and the exclusion of early retirees can help in the assessment of the direction of causality. A limitation was that mortality and hospital admissions before age 60 were not considered, and that only people with available income measures in the two investigated age periods were included. Furthermore, the study design did not allow us to examine whether the observed sex differences changed over time or across cohorts. In Denmark, hospital care is financed through taxes, and access to health care services is free and universally independent of sex and socioeconomic status [40]. Thus, the external validity in less egalitarian countries may be limited. Our study examined sex differences in mortality and hospitalizations by income changes, but the underlying reasons for these differences should be addressed in future studies.

In conclusion, this study demonstrated that, after age 60, income differentiation is more marked among men than women regarding mortality and hospitalization. Sex differences were most pronounced for people with a stable low income and a downward income trajectory, with smaller differences between men and women with an upward income trajectory and a stable high income. Income in the late 50s was a main predictor of mortality, particularly among men. The study lends support for the notion that men are more vulnerable to income loss than women, possibly contributing to the shorter survival among men, whereas income change cannot explain why women's health is generally poorer than men's health.

Contributors

Contributors LJA and RLJ conceptualised and designed the study. LJA conducted the analyses, drafted all versions of the manuscript, and revised the manuscript. JKP contributed substantially to the analyses and helped interpreting the data. MT contributed to the analyses, to the interpretation of data, and provided input on the manuscript. KC and RLJ provided valuable input on the drafts of the manuscript. All authors approved the final version.

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Competing interest

None declared.

Ethics Approval

The study involves secondary data analyses of existing register data approved by the Danish Data Protection Agency.

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What is already known on this subject

- Although socioeconomic status is an important determinant of health, there has been a lack of attention to sex differences in income-health associations, and very little is known about the degree to which changes in socioeconomic position over the life course can explain sex differences in health and mortality.

What this study adds

- Through a large sample of more than one million Danes, we demonstrate that income in middle age has a greater differentiating effect on men than women regarding mortality and hospitalizations after age 60.
- Men had higher mortality and were more hospitalized than women, but sex differences were most pronounced for people with stable low income and a downward income trajectory, and sex differences were smaller among people with an upward income trajectory and a stable high income.
- Income level in the age-period 55-59 years was a main predictor of mortality for both sexes and of hospitalizations among men.

Figure labels

Figure 1 – Associations between all-cause mortality (Figures 1A-C) and hospitalizations (Figures 1D-F) by individual income, family income and partner's income trajectories for men and women, respectively.

Figure 2 – Sex differences in all-cause mortality (Figures 2A-B) and hospitalizations (Figures 2C-D) by individual and family income trajectories.

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Table 1 - Baseline characteristics of men and women born 1935-55 and resident in Denmark after age 60 during 1980-2015

	Men	Women	Total study population
Study population N (%)	544,696 (51.2)	519,091 (48.8)	1,063,787
Birth cohorts			
1935-39	100,088 (18.4)	88,152 (17.0)	188,240 (17.7)
1940-44	126,613 (23.3)	115,516 (22.3)	242,129 (22.8)
1945-49	154,079 (28.3)	149,724 (28.8)	303,803 (28.6)
1950-55	163,916 (30.1)	165,699 (31.9)	329,615 (31.0)
Emigrated after age 60	2,799 (0.5)	1,718 (0.3)	4,517 (0.4)
Death after age 60[a]	72,629 (13.3)	42,379 (8.2)	115,008 (10.8)
Hospitalization rates per 1000 person-years after age 60[b]	150	124	137
Education[c]			
Low	141,228 (25.9)	180,747 (34.8)	321,975 (30.3)
Medium	257,757 (47.3)	194,500 (37.5)	452,257 (42.5)
High	136,777 (25.1)	136,380 (26.3)	273,157 (25.7)
Unknown/missing	8,934 (1.6)	7,464 (1.4)	16,398 (1.5)
Employment			
Employed	507,235 (93.1)	456,467 (87.9)	963,702 (90.6)
Unemployed	23,888 (4.4)	28,331 (5.5)	52,219 (4.9)
Others[d]	13,573 (2.5)	34,293 (6.6)	47,866 (4.5)
Individual disposable income			
Median (IQR) ages 45-49	207,070 (172,243-253,000)	170,718 (137,006-207,436)	189,203 (152,889-230,788)
Median (IQR) ages 55-59	245,265 (196,161-312,090)	196,289 (154,592-247,245)	220,700 (172,343-280,730)
Change in individual disposable income[e]			
Stable low	92,785 (17.0)	102,636 (19.8)	195,421 (18.4)
Downward	47,778 (8.8)	44,021 (8.5)	91,799 (8.6)
Upward	257,069 (47.2)	217,582 (41.9)	474,651 (44.6)
Stable high	147,064 (27.0)	154,852 (29.8)	301,916 (28.4)
Family disposable income			
Median (IQR) ages 45-49	415,660 (324,453-500,631)	413,046 (316,072-505,312)	414,438 (320,105-502,949)
Median (IQR) ages 55-59	460,817 (347,056-577,331)	432,038 (312,494-552,613)	446,937 (328,864-565,584)
Change in family disposable income[e]			
Stable low	70,321 (22.3)	67,328 (21.5)	137,642 (21.9)
Downward	42,686 (13.5)	60,366 (19.3)	103,052 (16.4)
Upward	115,129 (36.5)	92,262 (29.4)	207,391 (33.0)
Stable high	87,526 (27.7)	93,877 (29.9)	181,403 (28.8)

Values are numbers (percentages) unless stated otherwise.

[a]Before age 81 or December 31, 2015

[b]Before age 80 or December 31, 2014

[c]Highest completed education during 1980-2016. Low education refers to primary or lower secondary education, medium refers to upper secondary education, and high refers to short-cycle tertiary education, bachelor level, master level, doctorial or equivalent level.

[d]Contains students and missing

[e]Stable low: income below median, but in the same quartile in both periods. Downward: a decrease in income quartiles between periods. Upward: an increase in income quartiles between periods. Stable high: income above median, but in the same quartile in both periods.

Table 2 – All-cause mortality and hospitalizations for Danish men and women aged 60 and above for the 16 possible income trajectories by individual income

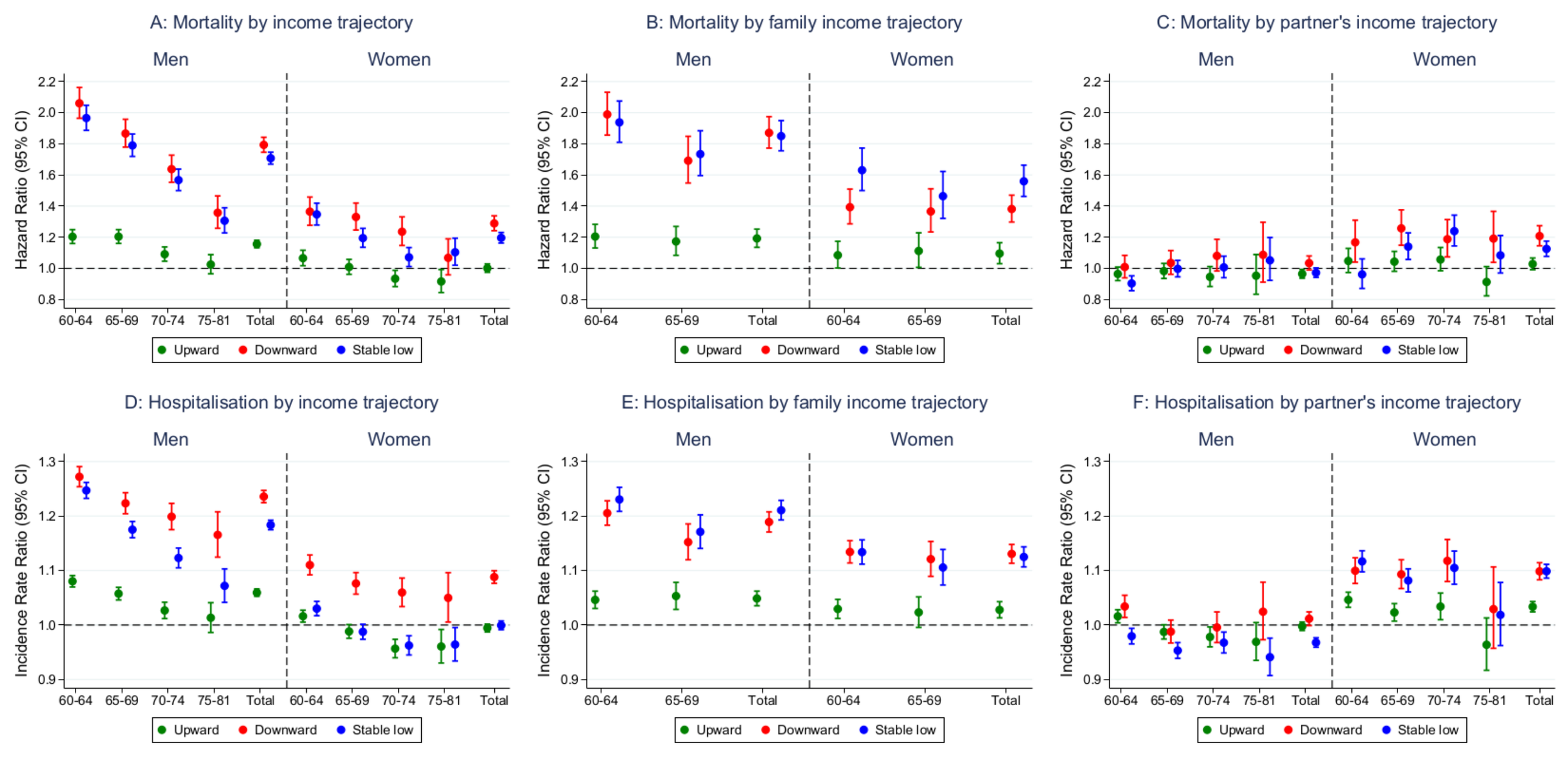
		Mortality		Hospitalization	
		HR (95% CI)		IRR (95% CI)	
		Men	Women	Men	Women
Income quartiles age 45-49	Income quartiles age 55-59				
4	4 (ref)	1.00	1.00	1.00	1.00
3	4	1.10 (1.06-1.13)	1.04 (1.00-1.09)	1.03 (1.02-1.04)	1.02 (1.01-1.04)
2	4	1.14 (1.08-1.19)	1.02 (0.96-1.09)	1.09 (1.07-1.10)	1.03 (1.01-1.05)
1	4	1.22 (1.14-1.30)	1.05 (0.96-1.15)	1.09 (1.07-1.11)	1.03 (1.01-1.05)
4	3	1.52 (1.42-1.62)	1.23 (1.12-1.34)	1.15 (1.13-1.18)	1.12 (1.09-1.14)
3	3	1.45 (1.40-1.50)	1.26 (1.21-1.32)	1.13 (1.12-1.14)	1.09 (1.07-1.10)
2	3	1.42 (1.38-1.47)	1.21 (1.16-1.27)	1.12 (1.11-1.13)	1.06 (1.05-1.08)
1	3	1.55 (1.48-1.62)	1.15 (1.08-1.22)	1.19 (1.18-1.21)	1.03 (1.02-1.05)
4	2	1.85 (1.68-2.04)	1.52 (1.34-1.73)	1.26 (1.21-1.30)	1.11 (1.07-1.15)
3	2	1.88 (1.79-1.97)	1.51 (1.42-1.59)	1.28 (1.26-1.30)	1.16 (1.15-1.18)
2	2	1.91 (1.85-1.97)	1.40 (1.34-1.46)	1.23 (1.22-1.25)	1.11 (1.09-1.12)
1	2	1.83 (1.76-1.89)	1.22 (1.16-1.28)	1.24 (1.23-1.25)	1.03 (1.01-1.04)
4	1	2.04 (1.84-2.27)	1.26 (1.03-1.55)	1.29 (1.24-1.34)	1.07 (1.01-1.13)
3	1	2.46 (2.30-2.62)	1.55 (1.40-1.72)	1.32 (1.29-1.35)	1.14 (1.11-1.18)
2	1	2.65 (2.54-2.75)	1.54 (1.44-1.64)	1.41 (1.39-1.43)	1.11 (1.09-1.13)
1	1	2.30 (2.22-2.37)	1.35 (1.29-1.40)	1.28 (1.27-1.29)	0.99 (0.98-1.00)

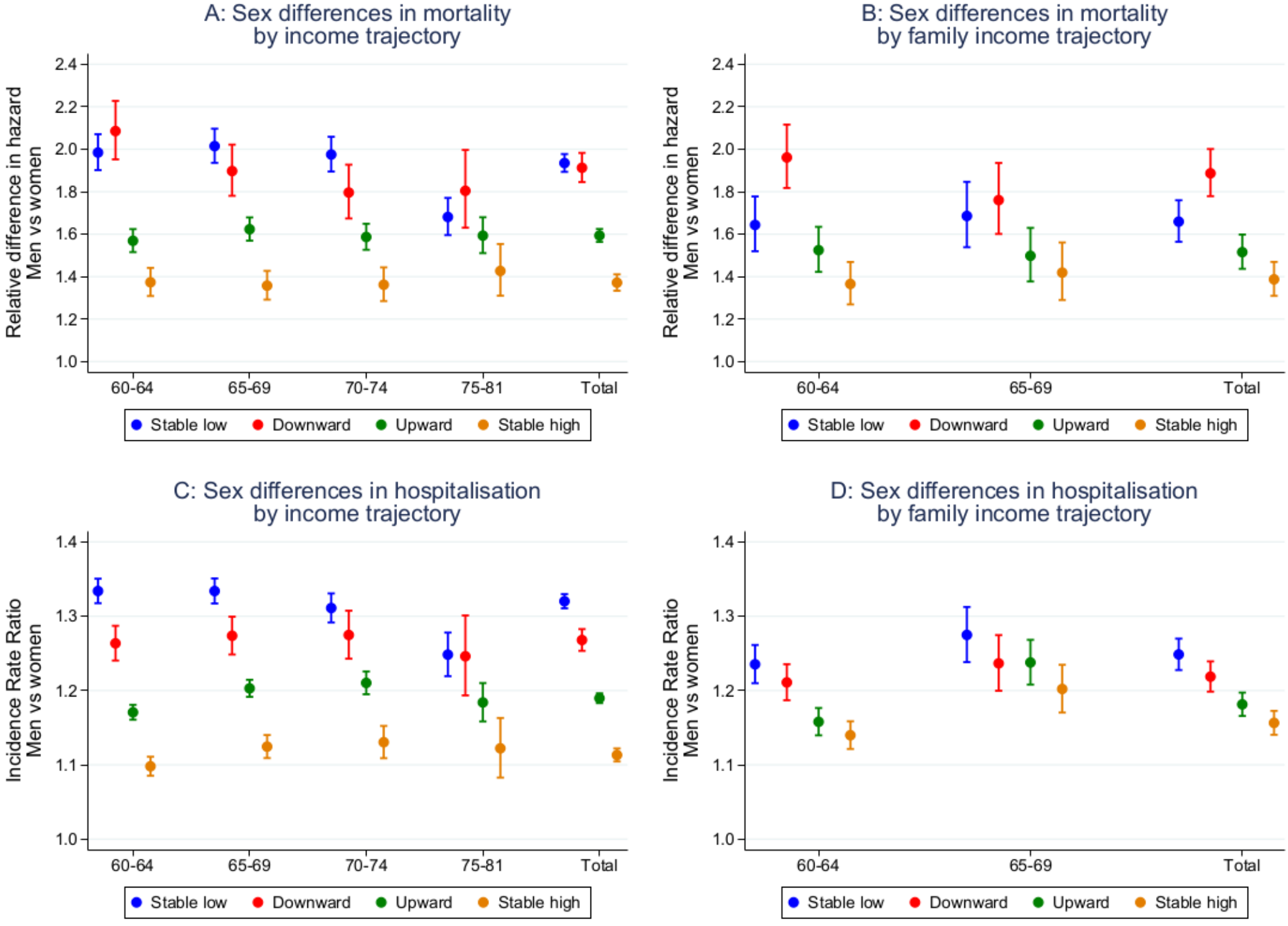
HR = hazard ratio, IRR = incidence rate ratio, CI = confidence interval

Table 3 – Sex differences in all-cause mortality and hospitalization for the 16 possible income trajectories by individual income among Danish men and women age 60 and above

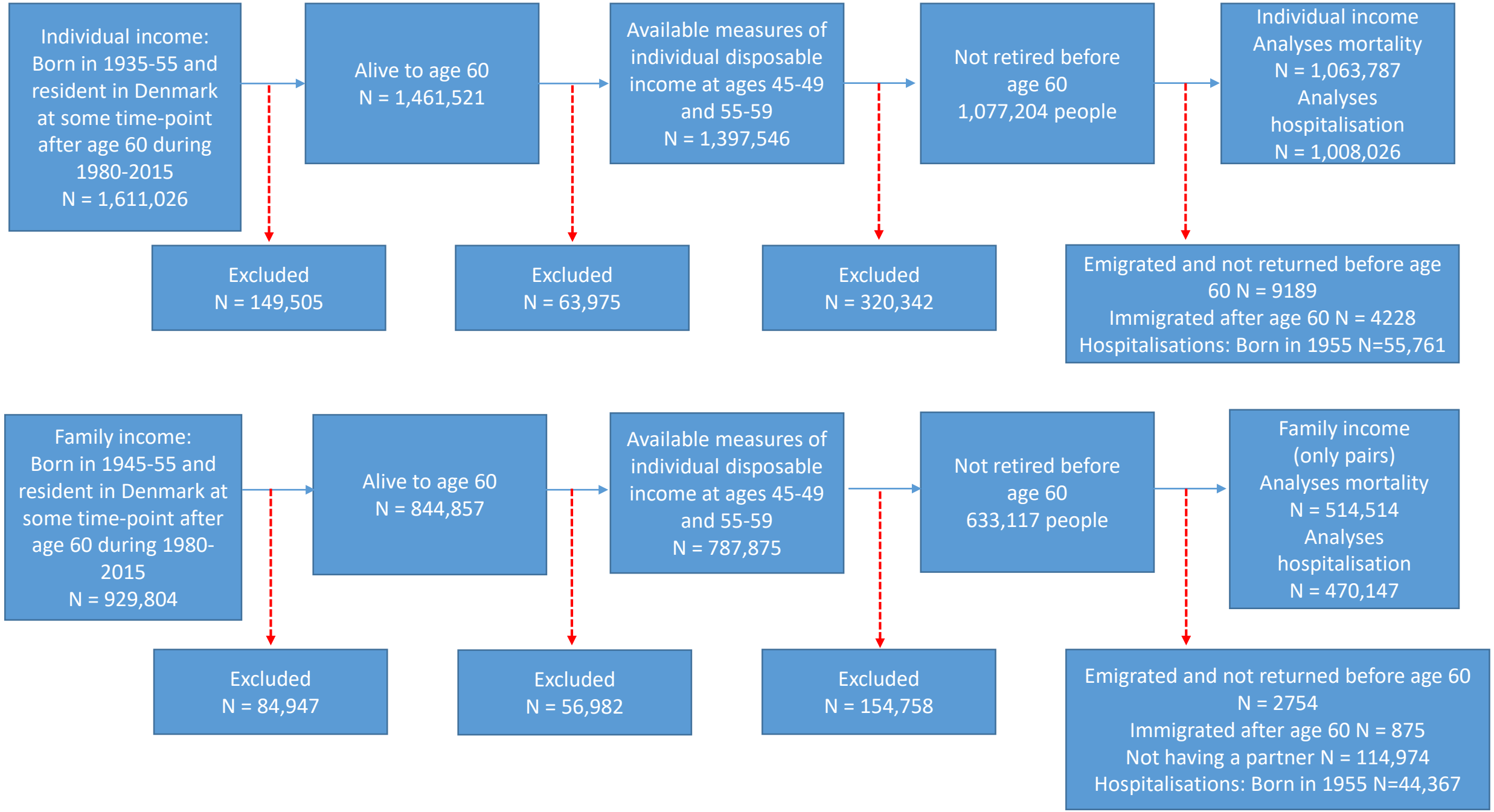
Income quartiles ages 45-49	Income quartiles ages 55-59	Mortality HR (95% CI)	Hospitalization IRR (95% CI)
4	4	1.29 (1.24-1.35)	1.10 (1.09-1.11)
3	4	1.39 (1.33-1.44)	1.11 (1.10-1.12)
2	4	1.46 (1.36-1.57)	1.17 (1.15-1.19)
1	4	1.51 (1.36-1.58)	1.17 (1.13-1.20)
4	3	1.61 (1.45-1.78)	1.13 (1.10-1.17)
3	3	1.50 (1.44-1.56)	1.14 (1.13-1.16)
2	3	1.54 (1.49-1.60)	1.16 (1.15-1.17)
1	3	1.74 (1.64-1.85)	1.27 (1.25-1.29)
4	2	1.60 (1.37-1.87)	1.27 (1.25-1.29)
3	2	1.62 (1.52-1.72)	1.25 (1.19-1.32)
2	2	1.77 (1.71-1.82)	1.21 (1.19-1.23)
1	2	1.92 (1.85-1.99)	1.23 (1.22-1.24)
4	1	2.10 (1.67-2.63)	1.32 (1.31-1.34)
3	1	2.08 (1.85-2.33)	1.27 (1.22-1.32)
2	1	2.23 (2.09-2.37)	1.39 (1.36-1.42)
1	1	2.15 (2.09-2.22)	1.41 (1.40-1.43)

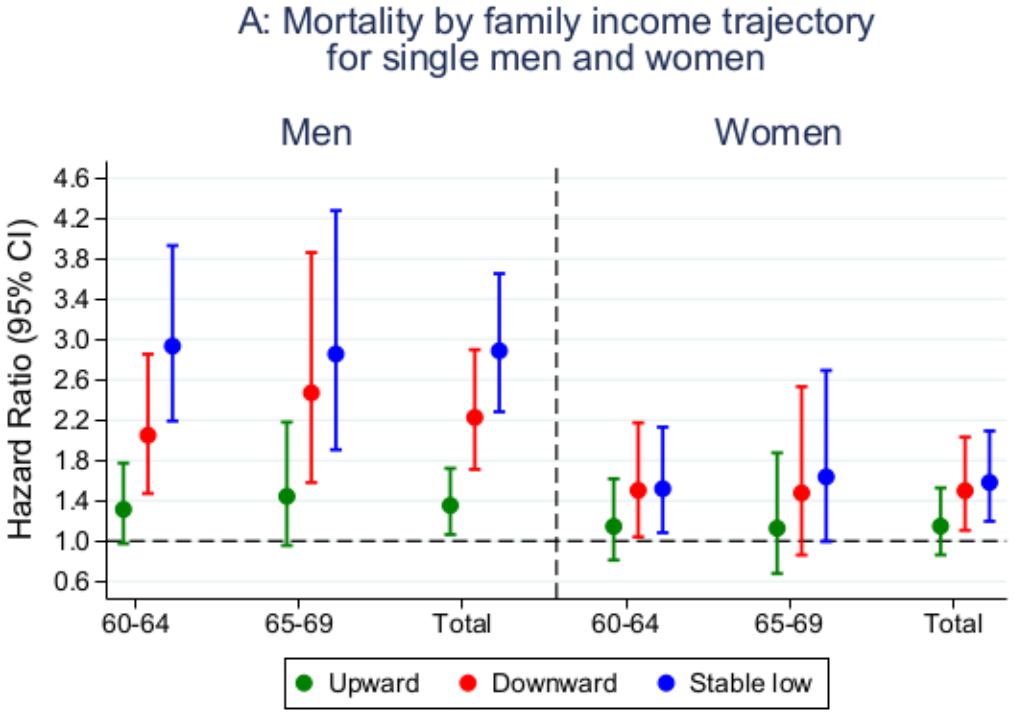
HR = hazard ratio, IRR = incidence rate ratio, CI = confidence interval

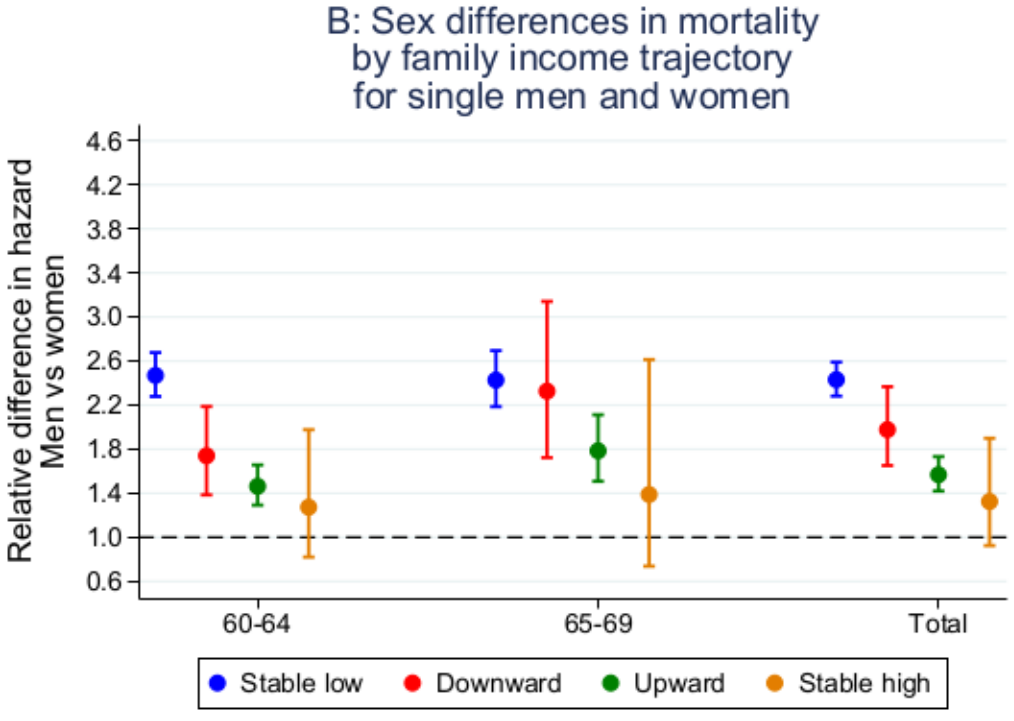

A: Mortality by income trajectory
Men
Women
Hazard Ratio (95% CI)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
60-64
65-69
70-74
75-81
Total
Upward
Downward
Stable low
B: Mortality by family income trajectory
C: Mortality by partner's income trajectory
D: Hospitalisation by income trajectory
Incidence Rate Ratio (95% CI)
1.3
1.2
1.1
1.0
0.9
E: Hospitalisation by family income trajectory
F: Hospitalisation by partner's income trajectory

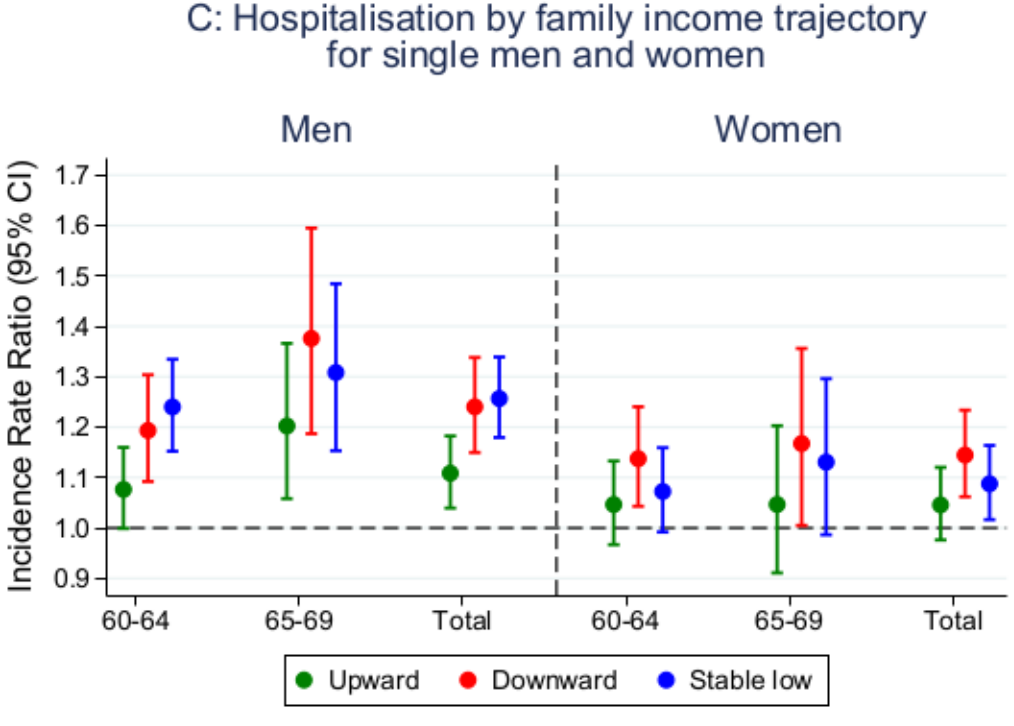

A: Sex differences in mortality by income trajectory
Relative difference in hazard Men vs women
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
60-64
65-69
70-74
75-81
Total
Stable low
Downward
Upward
Stable high
B: Sex differences in mortality by family income trajectory
Relative difference in hazard Men vs women
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
60-64
65-69
Total
Stable low
Downward
Upward
Stable high
C: Sex differences in hospitalisation by income trajectory
Incidence Rate Ratio Men vs women
1.4
1.3
1.2
1.1
1.0
60-64
65-69
70-74
75-81
Total
Stable low
Downward
Upward
Stable high
D: Sex differences in hospitalisation by family income trajectory
Incidence Rate Ratio Men vs women
1.4
1.3
1.2
1.1
1.0
60-64
65-69
Total
Stable low
Downward
Upward
Stable high

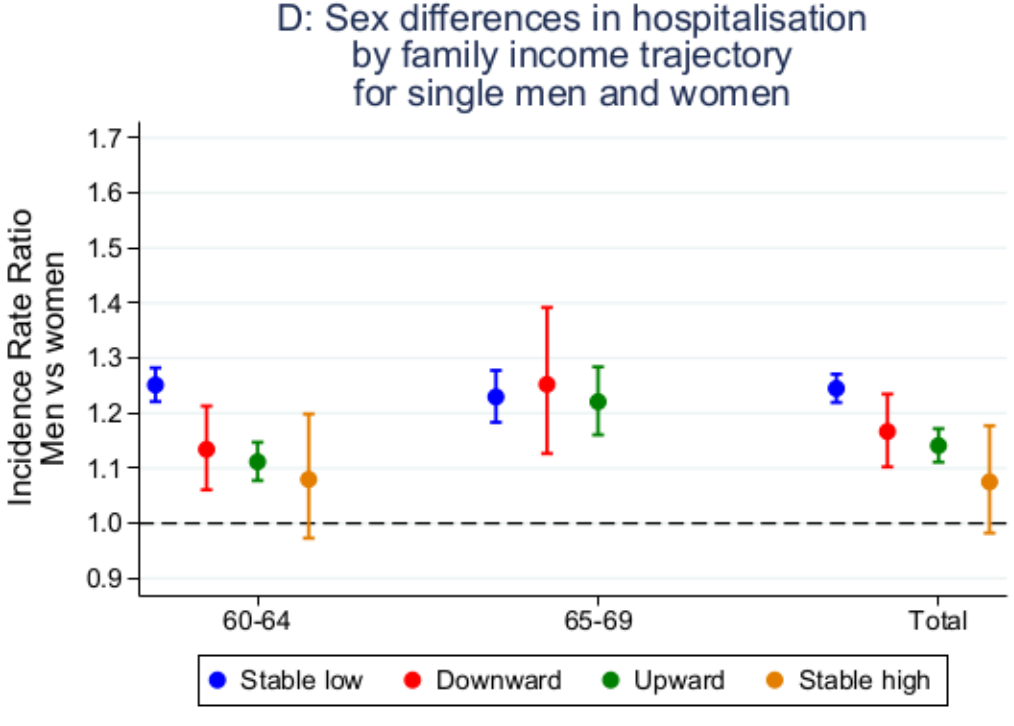
Supplementary Figure 1 - Flow chart of the study population




A: Mortality by family income trajectory
for single men and women
Men
Women
Hazard Ratio (95% CI)
4.6
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
0.6
60-64
65-69
Total
60-64
65-69
Total
Upward
Downward
Stable low


B: Sex differences in mortality
by family income trajectory
for single men and women
Relative difference in hazard
Men vs women
4.6
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
0.6
60-64
65-69
Total
Stable low
Downward
Upward
Stable high


C: Hospitalisation by family income trajectory
for single men and women
Men
Women
Incidence Rate Ratio (95% CI)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
60-64
65-69
Total
60-64
65-69
Total
Upward
Downward
Stable low


D: Sex differences in hospitalisation
by family income trajectory
for single men and women
Incidence Rate Ratio
Men vs women
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
60-64
65-69
Total
Stable low
Downward
Upward
Stable high

Supplementary Table 1 - Associations between all-cause mortality and hospitalisations by individual income, family income and partner's income trajectories for men and women, respectively

	Adjusted for birth cohorts		Adjusted for birth cohorts and education		Adjusted for birth cohorts and employment	
	Men	Women	Men	Women	Men	Women
Mortality	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)
Individual income						
Stable high (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Upward	1.16 (1.13-1.18)	1.00 (0.97-1.03)	1.10 (1.08-1.13)	0.95 (0.92-0.97)	1.15 (1.12-1.17)	0.99 (0.96-1.02)
Downward	1.79 (1.75-1.84)	1.29 (1.24-1.34)	1.69 (1.65-1.74)	1.20 (1.16-1.25)	1.70 (1.66-1.75)	1.26 (1.21-1.30)
Stable low	1.71 (1.67-1.75)	1.20 (1.16-1.23)	1.56 (1.53-1.60)	1.07 (1.04-1.11)	1.63 (1.59-1.67)	1.15 (1.11-1.18)
Family income						
Stable high (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Upward	1.19 (1.14-1.25)	1.10 (1.03-1.16)	1.16 (1.11-1.22)	1.05 (0.99-1.12)	1.17 (1.11-1.23)	1.08 (1.01-1.15)
Downward	1.87 (1.77-1.97)	1.38 (1.30-1.47)	1.77 (1.67-1.87)	1.29 (1.21-1.37)	1.83 (1.74-1.94)	1.35 (1.27-1.44)
Stable low	1.85 (1.76-1.95)	1.56 (1.46-1.66)	1.71 (1.62-1.80)	1.39 (1.30-1.49)	1.77 (1.68-1.86)	1.49 (1.40-1.59)
Partner's income						
Stable high (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Upward	0.96 (0.94-0.99)	1.03 (0.99-1.07)	0.95 (0.92-0.97)	1.01 (0.97-1.04)	0.96 (0.94-0.99)	1.04 (1.00-1.08)
Downward	1.03 (0.99-1.08)	1.21 (1.15-1.27)	1.01 (0.97-1.06)	1.17 (1.11-1.24)	1.03 (0.99-1.08)	1.21 (1.15-1.27)
Stable low	0.97 (0.94-1.00)	1.13 (1.08-1.18)	0.94 (0.91-0.97)	1.07 (1.02-1.11)	0.97 (0.94-1.00)	1.13 (1.08-1.18)
Hospitalisation	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)
Individual income						
Stable high (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Upward	1.06 (1.05-1.07)	1.00 (0.99-1.01)	1.04 (1.03-1.05)	0.98 (0.97-0.99)	1.06 (1.05-1.06)	0.99 (0.98-1.00)
Downward	1.24 (1.22-1.25)	1.09 (1.07-1.10)	1.21 (1.20-1.22)	1.06 (1.05-1.08)	1.22 (1.21-1.23)	1.08 (1.06-1.09)
Stable low	1.18 (1.17-1.19)	1.01 (1.00-1.02)	1.14 (1.14-1.15)	0.97 (0.97-0.98)	1.17 (1.16-1.18)	0.98 (1.00-0.99)
Family income						
Stable high	1.00	1.00	1.00	1.00	1.00	1.00
Upward	1.05 (1.04-1.06)	1.03 (1.01-1.04)	1.04 (1.02-1.05)	1.02 (1.00-1.03)	1.04 (1.03-1.06)	1.02 (1.01-1.04)
Downward	1.19 (1.17-1.21)	1.13 (1.11-1.15)	1.16 (1.14-1.18)	1.11 (1.10-1.13)	1.18 (1.16-1.20)	1.12 (1.11-1.14)
Stable low	1.21 (1.19-1.23)	1.12 (1.11-1.14)	1.17 (1.15-1.29)	1.10 (1.08-1.12)	1.19 (1.18-1.21)	1.11 (1.09-1.13)
Partner's income						
Stable high	1.00	1.00	1.00	1.00	1.00	1.00
Upward	1.00 (0.99-1.01)	1.03 (1.02-1.04)	1.00 (0.99-1.01)	0.96 (0.95-0.97)	1.00 (0.99-1.01)	1.03 (1.02-1.04)
Downward	1.01 (1.00-1.02)	1.10 (1.08-1.11)	0.91 (0.90-0.92)	0.90 (0.89-0.91)	1.01 (1.00-1.02)	1.10 (1.08-1.11)
Stable low	0.97 (0.96-0.98)	1.10 (1.09-1.11)	0.99 (0.97-1.02)	1.01 (0.98-1.05)	0.97 (0.96-0.98)	1.10 (1.08-1.11)

HR = hazard ratio, IRR = incidence rate ratio, CI = confidence interval

Supplementary Table 2 – Sex differences in all-cause mortality and hospitalisations by individual and family income trajectories

	Adjusted for birth cohorts	Adjusted for birth cohorts and education	Adjusted for birth cohorts and employment
Mortality	Relative difference in hazard (95% CI)	Relative difference in hazard (95% CI)	Relative difference in hazard (95% CI)
Individual income			
Stable high	1.37 (1.33-1.41)	1.39 (1.35-1.43)	1.37 (1.33-1.41)
Upward	1.59 (1.56-1.62)	1.62 (1.58-1.65)	1.62 (1.59-1.65)
Downward	1.91 (1.85-1.98)	1.94 (1.88-2.02)	1.91 (1.85-1.98)
Stable low	1.93 (1.89-1.98)	1.96 (1.91-2.00)	1.99 (1.94-2.03)
Family income			
Stable high	1.39 (1.31-1.47)	1.41 (1.33-1.49)	1.40 (1.32-1.49)
Upward	1.52 (1.44-1.60)	1.55 (1.48-1.62)	1.55 (1.47-1.63)
Downward	1.89 (1.78-2.00)	1.92 (1.81-2.03)	1.93 (1.82-2.05)
Stable low	1.66 (1.56-1.76)	1.71 (1.61-1.81)	1.71 (1.61-1.82)
Hospitalisation	IRR (95% CIs)	IRR (95% CIs)	IRR (95% CIs)
Individual income			
Stable high	1.11 (1.10-1.12)	1.11 (1.11-1.12)	1.11 (1.10-1.12)
Upward	1.19 (1.18-1.20)	1.19 (1.19-1.20)	1.20 (1.19-1.20)
Downward	1.27 (1.25-1.28)	1.27 (1.26-1.29)	1.27 (1.25-1.28)
Stable low	1.32 (1.31-1.33)	1.32 (1.31-1.33)	1.31 (1.30-1.32)
Family income			
Stable high	1.16 (1.14-1.17)	1.16 (1.14-1.18)	1.16 (1.14-1.17)
Upward	1.18 (1.17-1.20)	1.19 (1.18-1.21)	1.19 (1.17-1.20)
Downward	1.22 (1.20-1.24)	1.22 (1.20-1.24)	1.23 (1.21-1.25)
Stable low	1.25 (1.23-1.27)	1.25 (1.23-1.28)	1.26 (1.24-1.28)

IRR = incidence rate ratio, CI = confidence interval