Who Dies during Economic Downturns? Disaggregating the Impact of Economic Fluctuations on Mortality in Finland for the Period 1988-2007

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Abstract

Studies suggest that economic recessions are associated with mortality reductions, but aggregate associations might mask heterogeneous effects. We assessed whether economic downturns have different effects according to individual employment and educational level using a rich dataset linking individuals in administrative registries in Finland, a country with a strong social safety net. We implemented region fixed effect models to assess the impact of unemployment rates on mortality in men and women of working age (25-64 years), exploiting regional variations in unemployment rates from 1989 to 2007. Fluctuations in regional unemployment rates from 1989 to 2007 were overall unrelated to mortality. However, from 1989 to 1996, a period covering a deep depression, increased regional unemployment reduced male mortality from traffic accidents but not from other causes, while it increased overall and cancer female mortality. Overall associations for men masked heterogeneous effects. Among employed men, increased unemployment reduced mortality from cardiovascular disease (CVD) and traffic accidents and increased suicide mortality, while it increased CVD mortality in men who became unemployed. In addition, higher educated men were significantly more vulnerable to increased mortality during downturns than lower educated men. Among women, there were generally weak effects of economic fluctuations on mortality from most causes regardless of employment status and educational level. Results suggest that social protection policies in Finland may have been effective in preventing fluctuations in mortality associated with relatively small fluctuations in the economy. However, they may have been less effective in preventing increases in regional mortality from some causes and for specific population sub-groups during the severe economic depression of the early 1990s.

Introduction

Several studies based on aggregate data suggest that mortality from several causes, and in some countries all-cause mortality, declines during economic contractions(1-6). These findings are in sharp contrast with studies suggesting that individual unemployment and job loss are associated with poor physical health and increased mortality (7-11). Earlier studies on the impact of economic downturns on mortality, however, have primarily relied on aggregate data, ignoring potentially heterogeneous effects of economic downturns across individuals with different vulnerability to negative labor and social outcomes shocks during economic downturns. In particular, aggregate associations might mask differential effects of economic downturns across workers who remain on the labor market, workers losing their job or individuals out of the labor market. In addition, socioeconomic status may be key to understanding how economic downturns influence mortality, as exposure to negative labor market outcomes and the ability to deal with their consequences may be strongly determined by educational level or occupational class. Due to a lack of disaggregated data, no studies have been able to appropriately assess whether the impact of economic downturns differs according to these individual characteristics.

Recent evidence from the US suggests that the impact of economic recessions on labor market outcomes is born disproportionally by men, black and Hispanic workers, youth, and lower educated workers, partly due to the demographic composition of workers across industries and occupations which are differentially affected by economic downturns(12). Few studies have examined whether this results in heterogeneous effects of economic downturns on health and mortality across these groups. A study based on US data found that working age adults in the lowest educational attainment group and the employed experience increased mortality during economic contractions, while the higher educated, unemployed, disabled and retired experience reduced mortality during economic downturns(1). However, this study was based on a one-time cross-sectional assessment of demographic characteristics and did not have information on how employment status evolved as the economy changed. Changes in employment occurring alongside economic downturns may lead to fundamentally different effects on mortality. Displaced workers may experience a drop in income and lack of access to health services, which may in turn lead to increased mortality during an economic downturn (13, 14). Employed workers may experience increased stress due to downsizing or other stressors(15, 16) leading to poor mental health, but they may also smoke and drink less due to financial constrains during economic downturns(17, 18).

Finland represents an interesting country to assess the impact of economic downturns on mortality. Unemployment benefits and the social security system in Finland are, by international standards, relatively comprehensive. In 2010, the net replacement rate –the proportion of former income a worker could expect to receive after job loss- was on average 44% in Finland, as compared to 34% in the US. Unemployment benefits are also provided for an extensive period and are complemented by other benefits such as housing and income assistance. A potential hypothesis is that their strong social safety net makes the Finnish population resilient to the health consequences of economic shocks. If this were the case, we would expect economic fluctuations to have a weaker effect on mortality in Finland than in countries such as the US, where social safety nets are less comprehensive. A second motivation to study the impact of economic downturns in Finland refers to the severe recession that hit the country in the early 1990's. The Gross National Product contracted for three years in a row, contracting by as much as 7% in 1991. As a result, unemployment rates increased from 4% in 1990 to 22% in 1994. The depression was followed by a period of strong and sustained economic growth during the second half of the 1990's, with the unemployment rate reaching 12.5% in 2001. A potential hypothesis is that while small fluctuations in the economic might have weak or even positive effects on mortality, large fluctuations such as those experienced by Finland during the 1990s might be particularly detrimental to the health of vulnerable groups hit by the recession.

In this paper, we examine whether fluctuations in regional economic conditions from 1988 to 2007 were associated with regional changes in mortality in Finland, and disaggregate effects for individuals who experienced job loss, remained employed or were out of the labor force, as well as individuals from different socioeconomic status. Previous studies have not been able to address this question

appropriately as they relied on data aggregated at the population level, or were based on a cross-sectional assessment of individual characteristics. Our study is based on a unique dataset of linked registries for the Finnish population containing detailed demographics linked to yearly information on employment and mortality status for Finnish residents. We examine the impact of regional unemployment rates on regional mortality for the full period, and separately analyze the impact of the large fluctuations observed from 1988 to 1996 in Finland.

Methods

Data and variables

The cohort was formed by linkage between population, employment and mortality registers covering the whole Finnish population using unique personal identification numbers assigned to each Finnish resident. Data included an 11% representative sample of the Finnish population between 1987 and 2007, with an 80% oversample of the population that died during this period. Data on employment status was obtained from Statistics Finland's labor force data files, which cover all employment and unemployment episodes of individuals and are updated continuously. Our analysis focused on individuals aged 25 years and older, which included 1,183,174 persons and 14,242,982 person-years.

Employment status change

Employment status was ascertained for each individual based on registered employment status in the last day of the immediately preceding year. Data were available since the last day of 1987, so the first employment transition was from end of year 1987 to end of year 1988. We first categorized yearly employment status into employed, unemployed or out of the labor force. We then constructed a variable to indicate change in employment status between year t and t+1, comprising six groups: (a) stable employees, who were employed in both year t and t+1; (b) displaced workers, who were employed in year t but unemployed in year t+1; (c) newly employed workers, who were unemployed in year t and employed in year t+1; (d) long-term unemployed, who were unemployed in both year t and year t+1; and (e) individuals out of the labor force, who were out of the labor force in either of the years t and t+1. Those with unknown employment status in year t were classified in a separate category.

Mortality

Data on mortality came from national registries and included vital status, date and cause of death. Causes of death were classified into broad categories based on the 9th (1988–1995) and 10th (1996–2007) versions of the international classification of Diseases (ICD) as follows: Alcohol-related mortality (ICD9 codes 291, 303, 3050, 3575, 4255, 5353, 5710–5713, 5770D–5770F,5771C–5771D, 7607A,7795A, E851; ICD10 codes F10, G312, G4051, G621, G721, I426, K292, K70, K860, K8600, 0354, P043, X45), Cardiovascular Disease (ICD9 codes 2891–2892, 390–4254, 4258–434, 436–4376, 4378X–444, 447–459; ICD10 codes I00–I425, I427–I99), Cancer (ICD9 codes 140–208, 2386, 2733; ICD10 codes C00–C97), suicide (ICD9 codes E9500–E959; ICD10 codes X60–X84, Y870), traffic accidents (ICD9 codes E800–E848; ICD10 codes V01–V99). We focused on these broad categories because they have been previously shown to be associated with economic cycles. We also conducted sensitivity analysis based on more specific causes of death, but patterns were similar to those for broad categories and are therefore not presented.

Other covariates

In addition to age and sex, information from population registries was available for a set of demographic variables. *Highest educational attainment* was classified into basic or unknown (approximately nine years or less), secondary, lowest level of tertiary education (13-14 years), and higher tertiary education (15+ years). Occupational status was obtained from the most recent census

and assigned retroactively for participants that were retired or unemployed. Occupations were first classified according to the Nordic Classification of Occupations, and subsequently categorized into upper non-manual, lower non-manual, manual skilled, manual unskilled, farmer, entrepreneur, and other/unknown. Yearly region of residence for each individual was based on 72 small-area units ranging from a few thousand to two million inhabitants. To reduce the impact of size heterogeneity and immigration across regions, we reclassified areas into 21 broader regions. In sensitivity analysis, we found similar results when using the more refined area classification, thus we present only results using the broader regional classification.

Regional unemployment rates
As indicator of economic conditions we used the unemployment rate by region and year for the period 1988-2007. Unemployment rates were directly calculated from our data based on aggregation of individual-level data on employment status by the end of each year for all men and women in the labor force at ages 15-74. For each individual, we linked the regional unemployment rate in year t to employment transitions from year t to t+1 based on region of residence.

Methods of analysis

Following the approach applied in previous studies, we applied a region-fixed effect model to examine how fluctuations in the regional economy were associated with short-term changes in mortality over the period 1988-2007. The impact of the economy was identified out variation in unemployment rates over time within a given region, relative to variations in other regions. This model effectively controls for all time-invariant differences among regions. Extending previous specifications to incorporate employment status(3), our basic model was as follows:

$$D_{ijt} = \alpha_t + (W_{ijt-2} - W_{ijt-1})\gamma + X_{ji}\omega + U_{jt-1}\beta + R_j + \varepsilon_{ijt} \tag{1}$$

Where D is vital status of individual i in region j at time t, $W_{ijt-2} - W_{ijt-1}$ is the change in employment status for individual i in region j between the end of year t-2 and end of year t-1, X is a vector of personal characteristics X assumed to be time-invariant (year of birth, sex and educational level), U is the regional unemployment rate for region j at end of year t-1, α is the year-specific intercept, and ε is the error term. Employment transitions from end of year t-2 to t-1 were linked to mortality outcomes in year t because information on employment status was for the last day of the year, so that employment status in year t-1 can be roughly taken to indicate employment status in the beginning of year t. In addition, an individual dying in year t was not in the employment registry by the end of year t, and therefore lacked employment status information for that year. In sensitivity analyses, we explored effects for further lags in employment status transitions, and obtained similar results. Year fixed effects control for factors that vary uniformly across regions over time, while region fixed-effects control for time-invariant factors that differ across regions.

To assess differences in the impact of the economy on mortality, we then introduced interaction terms of the regional unemployment rate with employment status change and educational level. Interaction terms indicated whether the effect of economic shocks differed for individuals from different employment status and educational level. To separately assess whether the large economic fluctuations during the early 1990's had a unique effect on mortality as compared to periods of less economic turmoil, we first carried out analysis for all years, and subsequently reproduced all analyses for the years 1988 to 1996. All analyses were conducted in STATA version 11 using appropriate weights to account for oversampling of deaths.

Results

Table 1 shows the distribution of sample variables. Over the follow-up period, 115,844 deaths were observed in men and 48,170 in women. 64% of all person-years corresponded to stable employment, while 22% were out of the labor force person-years. 3% of person-years corresponded to job loss transitions, and only 2.6% to a return to work. 29% of the sample had a tertiary education while 32% had only basic or unknown education.

Figure 1 shows national mortality rates plotted against national unemployment rates. For the entire country, results would suggest that mortality tends to decline during years of rising unemployment. There was a negative correlation for total (r=-.54), cancer (r=-.65), CVD (r=-.40) and traffic accidents mortality (r=-.44). Figure 2 show the correlation between regional unemployment rates and regional mortality from 1988 to 2007. In contrast to Figure 1, except for cancer, results would suggest that mortality is higher in regions and years in which unemployment is high. There was a positive correlation for mortality from all-causes (r=0.24), alcohol-related causes (r=0.18), CVD (r=0.15) and suicide (r=0.30).

Associations in Figures 1 are confounded by trends in other factors at the national level that may drive associations, while those in Figure 2 are confounded by unmeasured differences between regions. To address these bias, Figure 3 shows rate ratios of the impact of one-point increase in regional unemployment, from a region and year fixed effect model. Separate estimates are presented for the years 1988-1996 and 1988-2007. Among men, there was no evidence of an effect of unemployment rates of mortality for the period 1988-2007. In the years 1988-1996, however, a one-point increase in the regional unemployment rate was associated with an 8% decrease in traffic accident mortality (Rate ratio[RR]=0.92, 95%Confidence Interval [CI] 0.86, 0.99). There was no effect of fluctuations in unemployment on total mortality or mortality from other causes. Among women, a one-point increase in the unemployment rate was associated with a 1% increase in mortality from all-causes (RR= 1.01, 95%CI 1.00, 1.02) and cancer (RR=1.01, 95%CI 1.00, 1.02). Although the effect for total mortality was only significant for the years 1988-2007, this pattern was similar for both periods.

Table 1 shows estimates from an extended model that incorporates interactions between a change in employment status and the regional unemployment rate for the years 1988-1996. Among men, there were significant interactions for mortality from alcohol-related causes, cancer and suicide mortality. Figure 4 shows rate ratios from models stratified by employment change. Among men, although the joint interaction did not reach statistical significance (p=.14), there was a distinct pattern by employment status change for CVD. A one-point increase in unemployment was associated with a 3% significant decline in CVD mortality for employed workers (RR=0.97, 95%CI 0.95, 1.00), in contrast to a 17% (RR=1.17, 95% 1.03, 1.33) increase for displaced workers. An increase in unemployment was also associated with increased suicide mortality in employed men, while there was no clear effect for other men. An increase in unemployment led to increased alcohol-related mortality among long-unemployed men (RR=1.21, 95%CI 1.00, 1.10), while there was no significant effect in other men. Among females, there was a significant interaction between the regional unemployment rate and employment status change for alcohol-related mortality, suicide and traffic accidents (Table 1). As shown in Figure 4, a one-point increase in unemployment decreased mortality from suicide among women out of the labor force (RR=0.86, 95%CI 0.79, 0.93), compared to a non-significant increase in employed women (RR=1.06, 95%CI 0.99, 1.14). An increase in unemployment led to increased mortality from traffic accidents among women losing their job (RR=3.39, 95%CI 1.35, 8.49) and transiting into employment (RR=1.96, 95%CI 1.09, 3.51), but it had no effect among employed or other women.

Results for the years 1988-2007 are summarized in Appendix Table 2 and Appendix Figure 1. Effects were generally weaker when considering this period. Among men, there was a significant interaction between regional unemployment and employment status changes for total and alcohol-related mortality. While there was no clear effect on total mortality in any group, an increase in

unemployment led to reduced alcohol-related mortality in newly employed men (RR=0.84, 95%CI 0.73, 0.96), but not in other men. There were no significant interactions for women.

Table 2 summarizes results from a model that incorporates an interaction between regional unemployment rates and educational attainment for the years 1988-1996. Among men there was a significant interaction for mortality from all-causes and CVD, and the interaction was of borderline significance for suicide. Figure 5 shows estimates stratified by employment status change. Among men, increased unemployment was associated with increased mortality from all-causes, CVD and suicide in men of higher education, while there was no evidence of an effect for men with middle or lower educational level. Among women, there was no evidence of an interaction between unemployment and educational level.

Corresponding estimates for the full years 1988-2007 are presented in Appendix Table 3 and Appendix Figure 2. Among men, there was no evidence of an interaction between regional unemployment rates and employment status change. In stratified models, however, increase unemployment was associated with increased mortality from all-causes, CVD and traffic accidents among higher educated men, while there was no effect on other men. Among women, increased unemployment was associated with higher suicide mortality among higher educated women, while there was no effect for middle or lower educated women. There were no effects for other causes among women.

Sensitivity analysis

We carried out analyses to examine whether unemployment rates up to 5 years earlier had a lagged effect on mortality. In general, we found that the longer the lag, the weaker the effects observed. We found no evidence that lagged unemployment increased mortality neither in the years 1988-1996 or in the full period.

A possible bias may arise if regional unemployment rates are correlated with regional trends in other factors that affect mortality. We therefore replicated all models using regional unemployment rates detrended using a Hodrick-Prescott Filter (HP)(19), which separates the cyclical component of a time-series from its general trend by estimating the annual deviation from a smoothed trend curve, thus controlling for regional linear trends. We used a smoothing parameter of 100, but results did not change with alternative parameters. Results from all models using this detrended version of unemployment rates are presented in Appendix Figures 2-6. Estimates from these models had wide confidence intervals due to the large set of interactions between time and region, yielding some estimates not significant. Results, however, were very similar to those observed using crude unemployment rates (Appendix Figures 2-6), with only two exceptions. For the years 1988-1996, increased unemployment was associated with decreased all-cause mortality among men when using detrended unemployment rates (RR=0.98, 95%CI 0.97, 0.99), while this increase was not significant in the original analysis without detrending (Figure 3). This effect among men was due to mortality from traffic accidents, which decreased significantly when detrended regional unemployment rates increased (RR=0.90, 95%CI 0.83, 0.99), an effect also observed without detrending. A second discrepancy refers to CVD mortality. Although the effect of unemployment on CVD mortality for employed men was similar regardless of whether detrended or crude unemployment rates were used, the increase in CVD mortality observed for displaced workers in the main models (Figure 3) was not statistically significant in models that used detrended unemployment rates (Appendix Figure 4, RR=1.15, 95%CI 0.96, 1.38). However, estimates were very similar in both models, suggesting that the lack of significance in the latter may be due to the lack of power in models with detrended unemployment rates. Results for other models were similar for models with and without detrending unemployment rates.

Finally, we conducted analyses separately for ages 25-49 and 50-64. Overall, there was no evidence of differential effects of regional unemployment rates on mortality. For the years 1988-2007, the effect of unemployment rates on mortality among women was significant for the age group 50-64

(RR=1.01, 95%CI 1.00, 1.02), while the effect for women 25-49 was not significant (RR=1.05, 95%CI 0.98, 1.03). However, there was no significant interaction with age, and estimates for both age groups indicated an increased risk. A similar pattern was observed for the years 1988-1996.

Conclusion

Our study was motivated by earlier reports suggesting that mortality decreases during economic downturns, while it increases during economic upturns. Our study used individual-level data to shed light on this puzzle by examining whether these effects were different for working age individuals who remained employed as compared to those who became unemployed, as well as for individuals from different educational level. In addition, we assessed whether patterns observed for other countries such as the US (1-5), Germany(20) and OECD countries(6), suggesting that mortality decreases during economic downturns, were observed for Finland, a country with a strong social safety net.

Overall, our findings suggest that from 1986 to 2007 fluctuations in the regional economy had weak effects on mortality from most causes of death in Finland, with significant effects being confined to the years of the economic depression of the early 1990's. From 1989 to 1996, covering the years of the depression, increased regional unemployment reduced male mortality from traffic accidents but not from other causes, while among females, it increased mortality from cancer but not from other causes. Aggregate associations among men, however, masked heterogeneous effects by individual employment status and educational level. Among employed men, increased unemployment reduced mortality from CVD and traffic accidents and increased suicide mortality, while it increased CVD mortality in men who became unemployed. In addition, there was a consistent pattern suggesting that higher educated men were significantly more vulnerable to increased mortality during downturns than lower educated men, particularly for mortality from CVD and suicide. Although increases un unemployment were associated with reduced suicide mortality in women out of the labor force and increased mortality from traffic accidents in women changing employment status, there were generally weak effects of economic fluctuations on mortality from most causes among women regardless of employment status and educational level. Results suggest that social protection policies in Finland may have been effective in preventing fluctuations in mortality associated with relatively small fluctuations in the economy. However, they may have been less effective in preventing increases in regional mortality from some causes and for specific sub-populations during the severe economic depression of the early 1990's.

TABLES AND FIGURES

Table 1. The impact of one-point increase in the regional unemployment rate in interaction with individual employment status change on all-cause and cause-specific mortality in Finland, 1988-1996

1989-1996	Total mortality			Alcohol-related causes			Cancer			Cardiovascular			Suicide			Traffic accidents		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Males																		
Age	1.05	1.05	1.05	1.03	1.02	1.03	1.10	1.10	1.11	1.10	1.10	1.10	0.99	0.98	0.99	1.01	1.01	1.01
Employment status																		
Stable employment	1.00			1.00			1.00			1.00			1.00			1.00		
Job loss	2.92	2.39	3.57	9.80	6.48	14.81	1.04	0.53	2.07	1.38	0.87	2.19	2.33	1.10	4.92	2.39	1.00	5.73
Newly employed	2.57	2.17	3.04	3.33	1.46	7.57	1.15	0.57	2.33	2.12	1.38	3.25	3.35	2.21	5.08	4.74	2.55	8.82
long-term unemployed	4.54	3.83	5.38	10.23	8.05	13.01	1.64	1.01	2.67	2.44	1.66	3.58	5.45	3.84	7.72	2.77	1.88	4.09
Out of workforce	4.59	4.35	4.86	7.72	5.76	10.34	2.58	2.13	3.11	3.66	3.34	4.01	4.54	3.34	6.16	1.70	1.27	2.27
Employment unknown	1.73	1.38	2.19	6.65	0.90	49.17	1.83	0.45	7.53	0.57	0.16	2.02	1.38	0.85	2.24	2.00	1.05	3.81
Unemployment rate (UR)	0.98	0.96	1.00	1.05	0.95	1.16	0.96	0.92	1.00	0.97	0.95	1.00	1.08	1.02	1.15	0.92	0.85	0.98
UR X Job loss	0.97	0.91	1.04	0.85	0.68	1.05	0.81	0.66	0.99	1.21	1.05	1.39	0.89	0.74	1.08	0.97	0.68	1.39
UR X Newly employed	0.98	0.91	1.06	0.75	0.53	1.05	1.04	0.80	1.35	1.00	0.80	1.24	0.98	0.82	1.16	1.13	0.83	1.54
UR X long-term unemployed	1.02	0.97	1.08	1.05	0.90	1.21	0.98	0.78	1.25	1.03	0.90	1.17	0.84	0.72	0.99	1.11	0.94	1.32
UR X Out of workforce	1.03	1.00	1.05	0.96	0.88	1.06	1.04	0.99	1.09	1.04	1.00	1.08	0.90	0.80	1.02	1.00	0.87	1.15
UR X Employment unknown	0.96	0.86	1.08	0.41	0.14	1.27	1.03	0.50	2.12	1.25	0.73	2.15	0.80	0.68	0.95	1.00	0.77	1.30
P for overall interaction	0.25			0.01			0.02			0.14			0.02			0.66		
Females																		
Age	1.06	1.06	1.06	1.03	1.02	1.04	1.08	1.07	1.08	1.10	1.10	1.10	1.00	1.00	1.00	1.02	1.02	1.03
Employment status																		
Stable employment	1.00			1.00			1.00			1.00			1.00			1.00		
Job loss	1.95	1.25	3.04	10.22	2.03	51.44	0.34	0.12	1.01	2.01	1.10	3.65	2.56	0.57	11.56	0.80	0.29	2.23
Newly employed	1.66	1.01	2.74	2.73	0.60	12.47	1.30	0.47	3.59	2.90	1.39	6.05	0.94	0.10	8.75	0.83	0.09	7.97
long-term unemployed	2.97	2.11	4.18	13.57	5.24	35.15	0.39	0.16	0.94	2.24	1.00	5.03	4.28	1.49	12.34	1.44	0.33	6.19
Out of workforce	3.43	3.18	3.69	4.35	2.93	6.46	2.49	2.25	2.76	2.67	2.24	3.17	6.07	4.48	8.22	1.06	0.53	2.10
Employment unknown	1.12	0.66	1.91	2.03	0.26	16.11	0.43	0.14	1.38	0.14	0.01	2.10	1.06	0.23	4.88	2.66	0.59	12.00
Unemployment rate (UR)	1.00	0.98	1.02	0.91	0.77	1.07	1.01	0.99	1.04	0.98	0.93	1.03	1.07	1.00	1.14	0.99	0.88	1.11
UR X Job loss	1.07	0.94	1.23	0.98	0.57	1.69	1.09	0.91	1.31	1.00	0.84	1.20	1.02	0.72	1.44	3.41	1.44	8.10
UR X Newly employed	1.07	0.90	1.28	1.48	0.74	2.95	0.88	0.68	1.15	0.90	0.70	1.15	0.83	0.42	1.65	1.98	1.13	3.46
UR X long-term unemployed	1.03	0.94	1.12	0.98	0.76	1.26	0.93	0.72	1.20	1.00	0.78	1.29	1.12	0.79	1.59	1.34	0.84	2.14
UR X Out of workforce	1.02	0.99	1.04	1.20	1.07	1.36	1.00	0.96	1.05	1.05	0.99	1.11	0.81	0.73	0.89	0.98	0.78	1.24
UR X Employment unknown	1.01	0.75	1.36	0.18	0.03	1.04	1.17	0.76	1.81	1.43	0.40	5.15	1.04	0.55	1.98	1.20	0.41	3.48
P for overall interaction	0.30			0.00			0.84			0.65			0.00			0.00		

Table 2. The impact of one-point increase in the regional unemployment rate in interaction with educational level on all-cause and cause-specific mortality in Finland, 1988-1996

| 1987-1996	Total mortality			Alcohol-related causes			Cancer			Cardiovascular			Suicide			Traffic accidents		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Males																		
Age	1.08	1.07	1.08	1.05	1.04	1.05	1.13	1.13	1.14	1.13	1.13	1.13	0.99	0.99	1.00	1.01	1.01	1.01
Lower tertiary	1.58	1.34	1.85	1.59	1.04	2.43	1.30	1.05	1.60	1.65	1.30	2.10	1.15	0.73	1.83	1.32	0.48	3.67
Secondary	2.25	2.00	2.53	2.25	1.54	3.27	1.32	1.02	1.72	2.15	1.82	2.53	2.59	1.79	3.74	1.93	1.07	3.50
Basic or unknown	2.88	2.61	3.17	3.31	2.32	4.71	1.51	1.20	1.90	3.01	2.62	3.46	3.03	2.04	4.49	2.31	1.48	3.61
unemprate	1.08	1.05	1.11	1.08	0.93	1.24	0.98	0.90	1.07	1.16	1.08	1.24	1.20	1.04	1.38	1.02	0.89	1.18
unempXedu1	0.90	0.87	0.95	0.92	0.78	1.09	0.96	0.85	1.07	0.87	0.80	0.95	0.83	0.71	0.96	0.89	0.63	1.27
unempXedu2	0.91	0.88	0.95	0.94	0.79	1.12	0.97	0.89	1.07	0.87	0.80	0.94	0.84	0.73	0.96	0.88	0.75	1.04
unempXedu3	0.92	0.89	0.95	0.93	0.81	1.06	1.01	0.91	1.12	0.86	0.79	0.93	0.82	0.70	0.98	0.90	0.80	1.01
p_inter	0.00			0.36			0.42			0.00			0.08			0.33		
Females																		
age	1.08	1.08	1.08	1.04	1.03	1.04	1.10	1.09	1.10	1.12	1.12	1.13	1.01	1.00	1.01	1.02	1.01	1.03
edu1	0.90	0.72	1.13	0.64	0.25	1.63	0.94	0.70	1.26	1.34	0.86	2.10	1.79	0.87	3.68	1.23	0.32	4.65
edu2	1.27	1.03	1.57	1.49	0.79	2.81	0.98	0.72	1.33	1.16	0.76	1.76	2.78	1.53	5.06	3.10	1.05	9.19
edu3	1.61	1.34	1.92	1.59	0.79	3.19	1.07	0.84	1.37	2.21	1.46	3.35	3.14	1.69	5.81	2.20	1.01	4.81
unemprate	0.99	0.91	1.07	0.86	0.59	1.26	1.06	0.95	1.17	0.99	0.79	1.23	1.15	0.84	1.58	0.80	0.52	1.23
unempXedu1	1.02	0.92	1.13	1.22	0.88	1.69	0.96	0.84	1.10	0.94	0.74	1.21	0.78	0.52	1.18	1.46	0.75	2.84
unempXedu2	1.03	0.94	1.12	1.10	0.77	1.57	0.97	0.86	1.10	1.08	0.88	1.34	0.80	0.57	1.13	1.22	0.72	2.07
unempXedu3	1.02	0.94	1.11	1.21	0.83	1.77	0.95	0.85	1.06	1.03	0.82	1.28	0.85	0.60	1.19	1.39	0.94	2.04
p_inter	0.95			0.58			0.46			0.42			0.63			0.11		
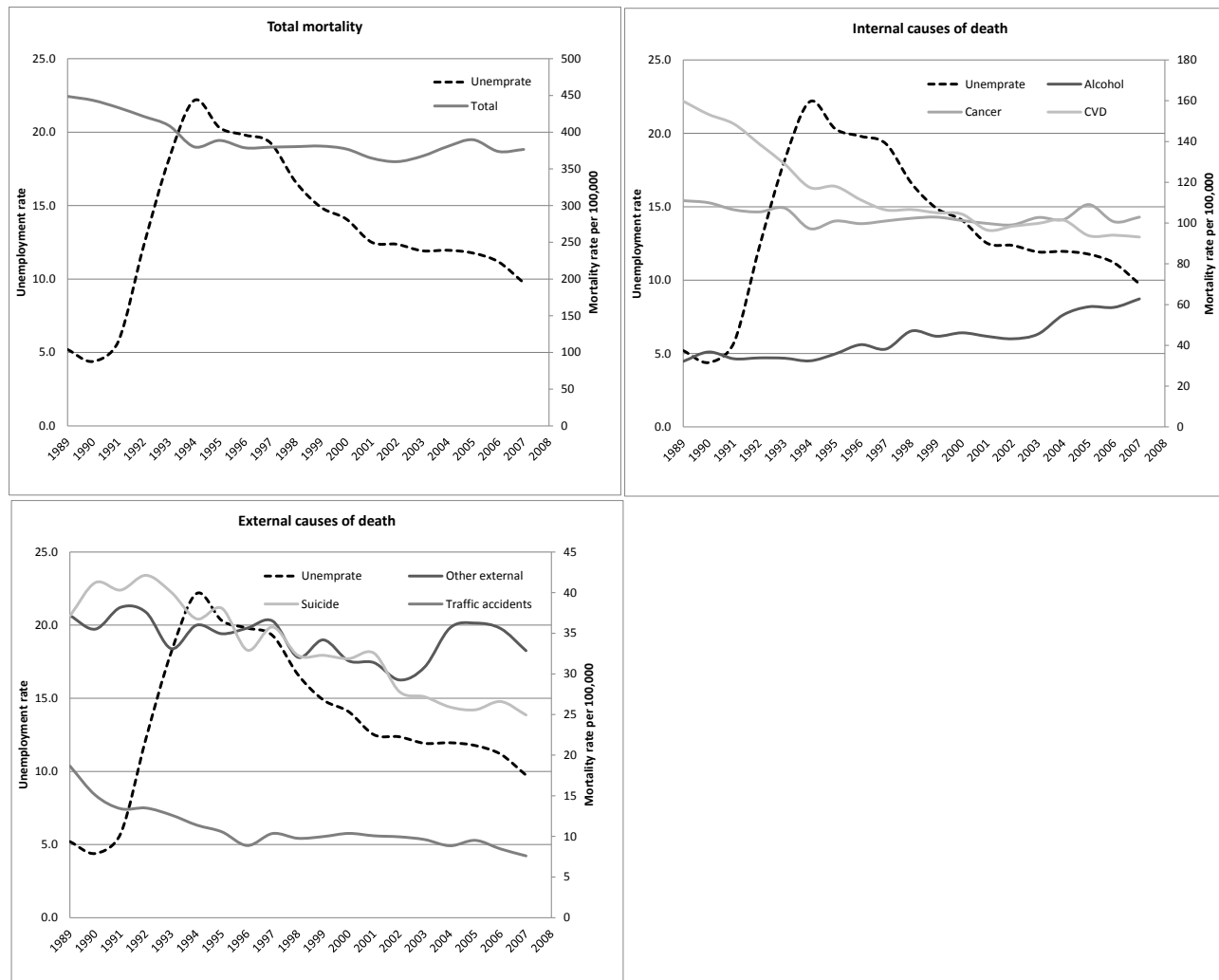
Figure 1. National unemployment rates and mortality in Finland, 1988-2007
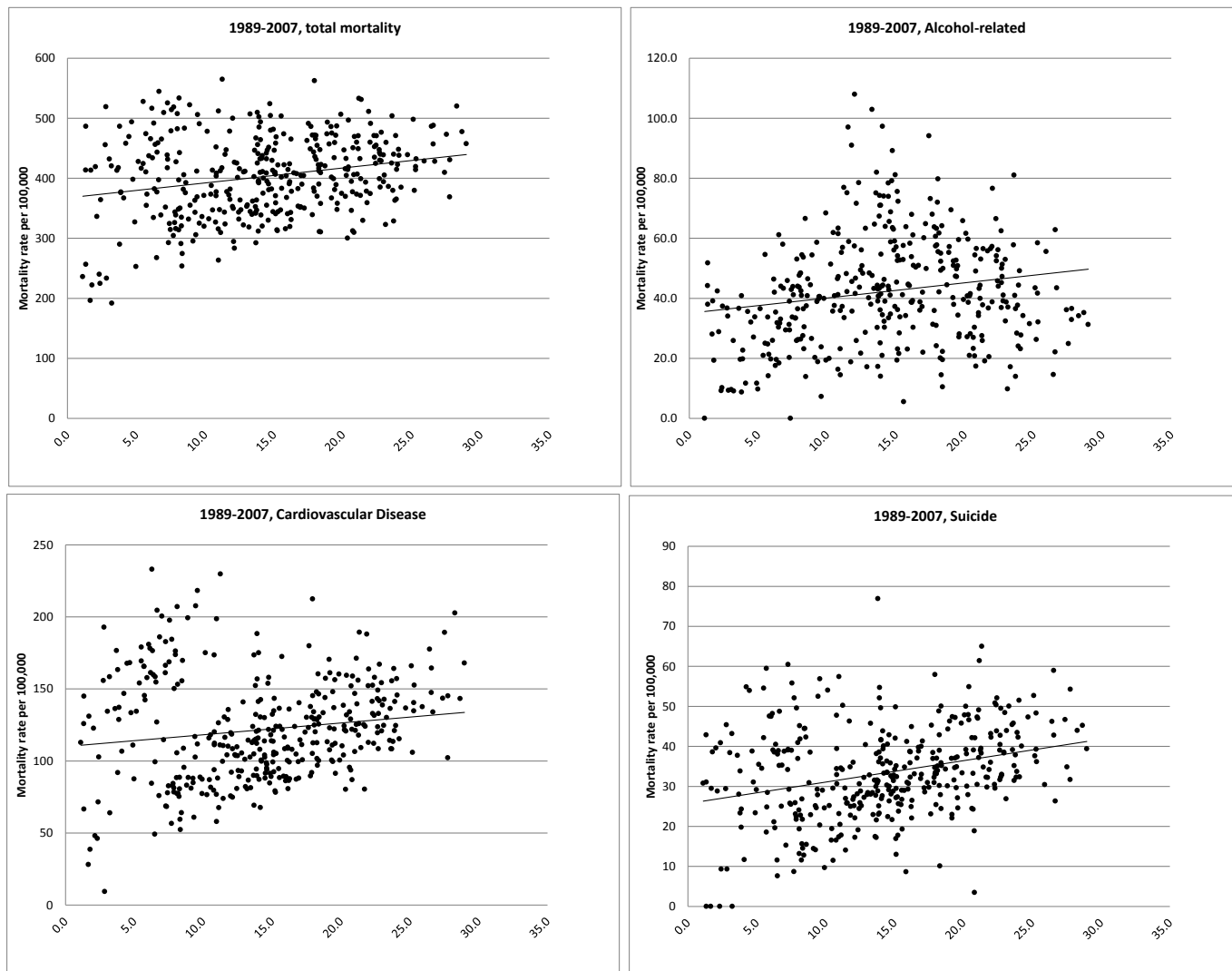
Figure 2. Regional mortality rate and total and cause-specific mortality from 1988 to 2007

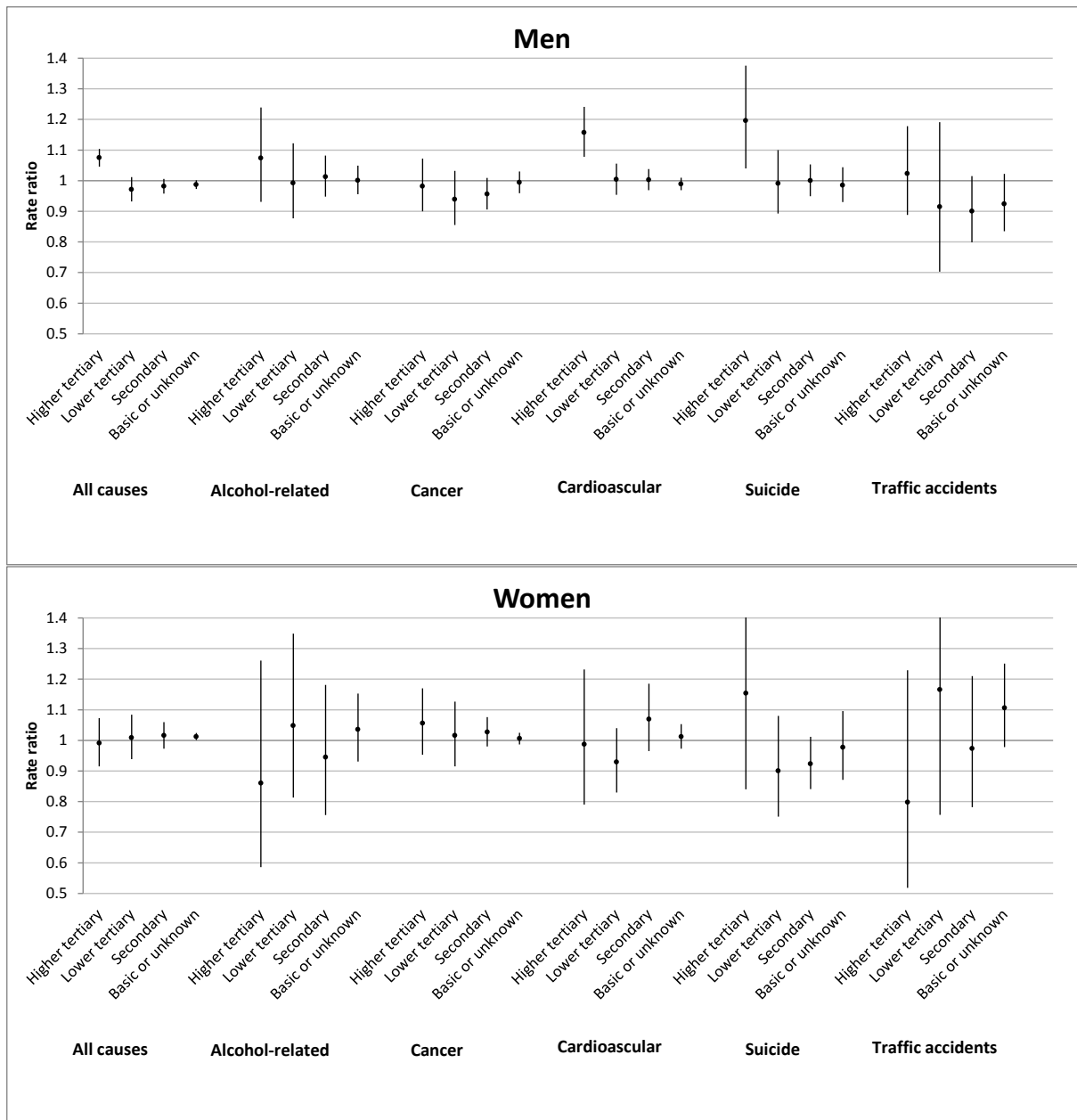**Figure 3. The impact of a one-point increase in the regional unemployment rate on mortality for the periods 1988-2007 and 1988-1996**
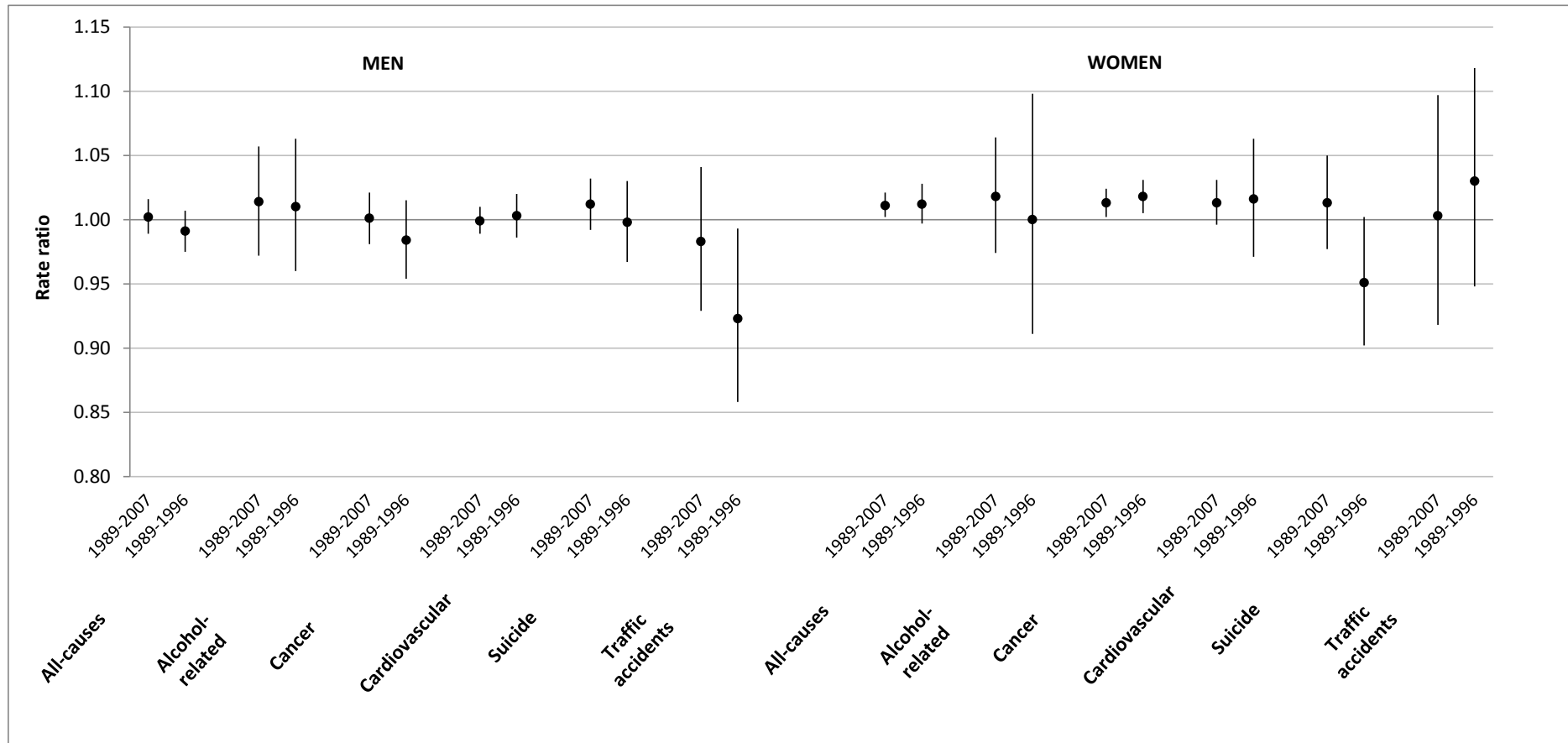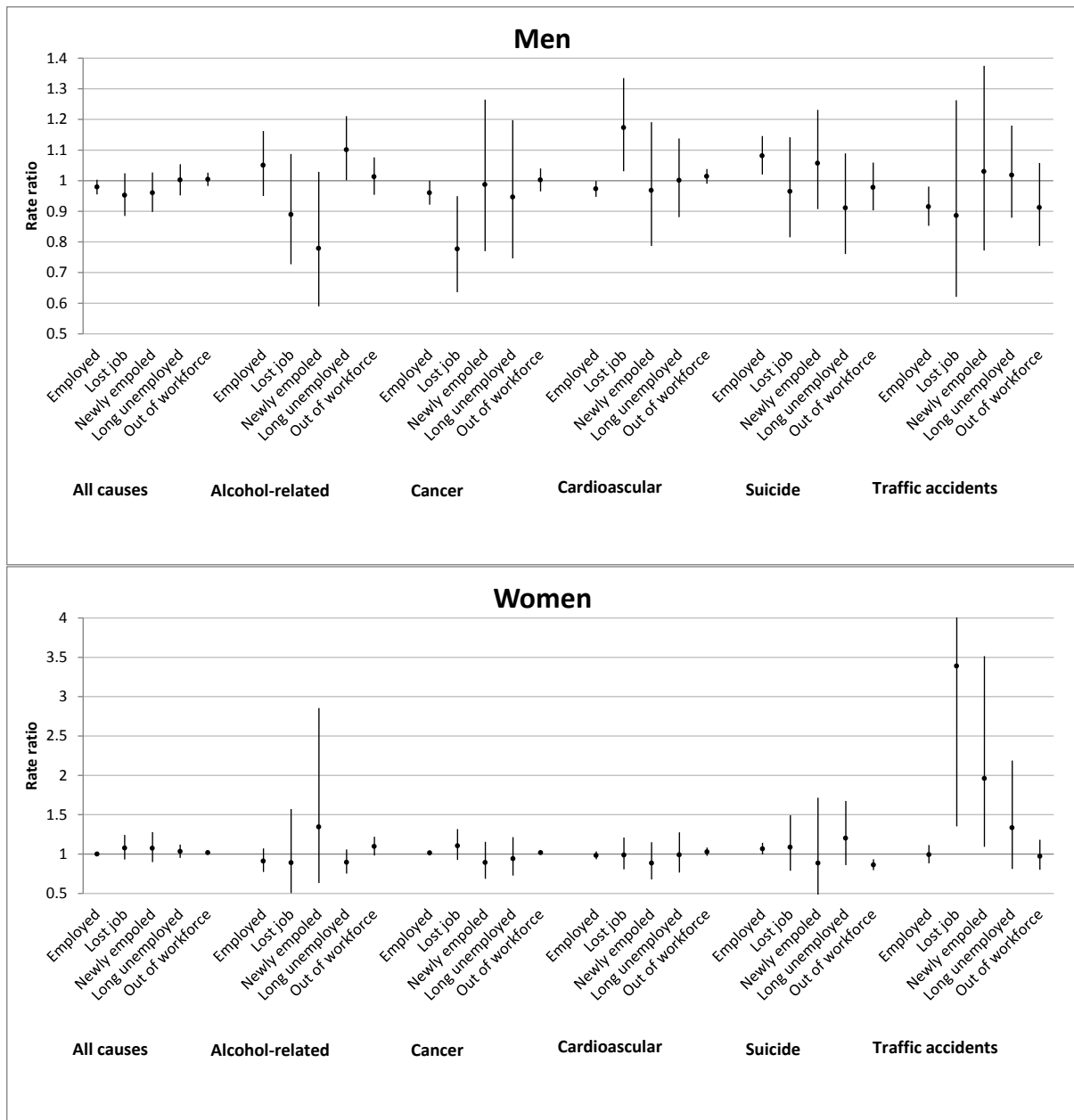
Figure 4. The impact of a one-point increase in the regional unemployment rate on mortality by occupational status change, 1988-1996

Figure 5. The impact of a one-point increase in the regional unemployment rate on mortality by educational level, 1988-1996

APPENDIX TABLE AND FIGURES

**Appendix Table 1. Basic sample descriptives, Finland 1988-2007**

	Person-years			N of deaths (no weights)						
	N (no weights)	% (weights)		Total	Alcohol	Cancer	CVD	SUI	Traffic accidents	Other external
Sex										
Men	4220003	50.2		115844	14769	23621	37768	10796	3618	11574
Women	3515315	49.8		48170	3453	19689	10163	3119	974	2868
Age										
25-49	4579258	67.0		54467	8190	9393	9758	9537	2773	7722
50-64	3156059	33.0		109547	10032	33917	38173	4378	1819	6720
Change in employment status during previous year										
Stable employment	4413144	63.8		42195	3199	13360	12087	5106	2194	3431
Job loss	234928	3.0		4186	820	512	1000	688	208	629
Newly employed	186489	2.6		2447	357	468	572	384	160	330
Long term unemploye	480791	5.6		14577	3710	1472	3210	1694	493	2549
Out of workforce	2256694	22.4		99561	10090	27385	30963	5707	1420	7333
Unknown origin	163271	2.6		1048	46	113	99	336	117	170
Education		28.8								
Upper tetriary	909349	13.7		10284	955	3612	2472	961	424	771
Lower tetriary	1016426	15.1		12630	1325	4133	3137	1172	404	1029
Secondary	2770943	38.9		48962	6456	11905	12153	5829	1715	5158
Basic or unknown	3038600	32.3		92138	9486	23660	30169	5953	2049	7484
Occupational social class										
Upper white-collar	1028886	14.9		14154	1343	4886	3686	1085	476	1034
Lower white-collar	2144407	30.2		32336	3157	11227	8146	2593	792	2330
Manual - skilled	1597345	18.6		42890	5185	9591	13450	3892	1199	4142
Manual - unskilled	1530543	18.0		43335	5735	9908	12962	3602	1153	4360
Farmer	481153	5.3		12271	694	3312	4527	795	328	676
Entrepreneur	523791	6.7		11404	1340	3089	3608	885	380	954
Other / unknown	429193	6.3		7624	768	1297	1552	1063	264	946

Appendix Table 2. The impact of one-point increase in the regional unemployment rate in interaction with individual employment status change on all-cause and cause-specific mortality in Finland, 1988-2007

1987-2007	Total mortality			Alcohol-related causes			Cancer			Cardiovascular			Suicide			Traffic accidents		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Males																		
Age	1.05	1.05	1.05	1.03	1.02	1.03	1.10	1.10	1.11	1.09	1.09	1.10	0.99	0.98	0.99	1.01	1.00	1.01
Job loss	2.98	2.53	3.49	9.54	6.87	13.24	0.89	0.47	1.71	1.76	1.16	2.66	2.16	1.17	3.99	2.56	1.19	5.49
Newly employed	2.47	2.13	2.87	3.31	1.52	7.22	1.30	0.67	2.53	2.07	1.55	2.76	2.86	1.99	4.10	3.80	2.34	6.17
long-term unemployed	4.80	4.22	5.45	11.00	8.51	14.22	1.75	1.19	2.57	3.14	2.25	4.37	4.18	2.96	5.90	3.07	2.13	4.43
Out of workforce	4.74	4.46	5.03	6.48	5.07	8.27	2.81	2.32	3.40	4.00	3.71	4.32	3.97	3.17	4.97	1.45	1.14	1.84
Employment unknown	1.39	1.10	1.75	1.29	0.63	2.65	1.62	0.91	2.89	0.41	0.13	1.24	0.92	0.53	1.61	1.40	0.90	2.17
Unemployment rate	0.99	0.97	1.02	1.03	0.98	1.08	0.99	0.97	1.02	0.99	0.98	1.01	1.01	0.98	1.05	0.96	0.90	1.03
X Job loss	0.98	0.95	1.02	0.91	0.81	1.03	1.01	0.86	1.17	1.04	0.96	1.13	1.01	0.94	1.10	0.96	0.84	1.11
X Newly employed	0.97	0.93	1.01	0.81	0.71	0.93	0.92	0.80	1.06	1.00	0.89	1.12	1.01	0.91	1.12	1.13	0.92	1.39
X long-term unemployed	1.00	0.98	1.02	1.00	0.95	1.05	0.99	0.89	1.11	0.95	0.91	0.99	1.05	0.96	1.14	1.07	0.96	1.19
X Out of workforce	1.02	1.00	1.03	0.99	0.95	1.04	1.01	0.99	1.04	1.01	0.99	1.03	0.99	0.95	1.05	1.04	0.98	1.10
X Employment unknown	1.02	0.93	1.11	1.06	0.76	1.47	1.00	0.80	1.26	1.31	1.00	1.71	0.94	0.82	1.08	1.21	0.98	1.48
P for overall interaction	0.01			0.01			0.17			0.08			0.62			0.10		
Females																		
Age	1.06	1.05	1.06	1.03	1.03	1.04	1.08	1.07	1.08	1.09	1.09	1.09	1.00	1.00	1.00	1.01	1.01	1.02
Job loss	1.87	1.27	2.77	8.17	2.20	30.27	0.32	0.11	0.92	2.42	1.49	3.93	2.35	0.55	9.96	2.76	0.67	11.34
Newly employed	1.71	1.09	2.68	5.20	1.35	19.99	0.97	0.46	2.05	2.75	1.43	5.29	1.29	0.16	10.76	1.36	0.16	11.42
long-term unemployed	3.25	2.34	4.51	15.04	6.34	35.67	0.55	0.25	1.22	2.35	1.09	5.08	4.72	1.68	13.28	1.56	0.40	6.10
Out of workforce	3.44	3.20	3.70	4.88	3.15	7.56	2.40	2.18	2.63	3.13	2.59	3.78	4.34	3.30	5.70	0.85	0.44	1.65
Employment unknown	0.87	0.58	1.31	0.52	0.04	6.37	0.34	0.10	1.17	0.23	0.03	1.55	1.09	0.37	3.18	1.78	0.74	4.32
Unemployment rate	1.01	0.99	1.02	1.01	0.93	1.10	1.01	0.99	1.03	1.00	0.98	1.03	1.06	1.01	1.12	0.98	0.90	1.07
X Job loss	1.02	0.93	1.12	1.01	0.82	1.23	1.02	0.88	1.17	0.99	0.86	1.14	0.97	0.76	1.24	1.11	0.79	1.55
X Newly employed	1.01	0.93	1.10	1.04	0.79	1.37	0.96	0.83	1.11	0.94	0.80	1.11	0.82	0.58	1.18	1.09	0.78	1.53
X long-term unemployed	1.00	0.96	1.04	1.01	0.90	1.14	0.95	0.85	1.06	0.96	0.86	1.08	0.92	0.79	1.07	1.22	0.86	1.74
X Out of workforce	1.01	0.99	1.03	1.01	0.94	1.08	1.00	0.97	1.03	1.02	0.98	1.05	0.93	0.86	1.01	1.01	0.86	1.18
X Employment unknown	1.14	1.03	1.26	1.00	0.52	1.92	1.21	0.90	1.64	1.21	0.87	1.69	1.18	0.80	1.73	1.29	0.83	1.99
P for overall interaction	0.09			1.00			0.11			0.62			0.37			0.70		

Appendix Table 3. The impact of one-point increase in the regional unemployment rate in interaction with educational level on all-cause and cause-specific mortality in Finland, 1988-2007

1987-2007	Total mortality			Alcohol-related causes			Cancer			Cardiovascular			Ischaemic heart disease			Suicide			Traffic accidents		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
Males																					
Age	1.08	1.07	1.08	1.05	1.05	1.06	1.13	1.13	1.14	1.12	1.12	1.13	1.14	1.14	1.15	1.00	0.99	1.00	1.01	1.01	1.01
Lower tertiary	1.35	1.18	1.56	1.63	1.07	2.46	1.16	0.98	1.37	1.49	1.18	1.90	1.66	1.24	2.22	0.88	0.56	1.38	1.00	0.47	2.12
Secondary	1.93	1.73	2.15	2.12	1.53	2.94	1.18	0.94	1.47	1.92	1.60	2.29	2.11	1.68	2.65	2.03	1.48	2.79	1.72	1.10	2.70
Basic or unknown	2.58	2.38	2.78	2.76	1.98	3.85	1.47	1.29	1.68	2.60	2.21	3.07	2.71	2.21	3.33	2.23	1.63	3.05	2.18	1.46	3.25
unemprate	1.03	1.01	1.05	1.00	0.90	1.11	0.98	0.95	1.02	1.05	1.00	1.10	1.04	0.97	1.11	1.05	0.98	1.13	1.14	1.03	1.25
unempXedu1	0.97	0.94	1.01	1.05	0.94	1.17	0.99	0.95	1.04	0.94	0.88	0.99	0.94	0.85	1.03	1.00	0.91	1.10	0.83	0.71	0.96
unempXedu2	0.98	0.95	1.00	1.02	0.90	1.15	1.01	0.97	1.05	0.96	0.91	1.00	0.96	0.90	1.02	0.96	0.89	1.04	0.87	0.80	0.95
unempXedu3	0.98	0.95	1.00	1.02	0.90	1.15	1.03	0.99	1.07	0.95	0.91	1.00	0.96	0.89	1.03	0.97	0.88	1.05	0.86	0.78	0.95
p_inter	0.28			0.41			0.41			0.12			0.54			0.51			0.00		
Females																					
age	1.08	1.07	1.08	1.04	1.04	1.05	1.10	1.10	1.10	1.11	1.11	1.12	1.16	1.15	1.16	1.01	1.00	1.01	1.01	1.00	1.02
edu1	0.93	0.76	1.14	0.96	0.35	2.66	0.92	0.69	1.24	1.20	0.88	1.65	0.74	0.32	1.74	1.38	0.80	2.37	1.09	0.34	3.45
edu2	1.26	1.05	1.52	1.38	0.77	2.46	0.93	0.71	1.21	1.31	0.95	1.81	1.46	0.84	2.54	2.15	1.31	3.54	2.41	1.03	5.63
edu3	1.74	1.53	1.98	1.80	1.01	3.21	1.09	0.89	1.33	2.53	1.88	3.41	2.50	1.50	4.17	2.90	1.77	4.77	2.03	0.95	4.34
unemprate	1.01	0.98	1.04	0.94	0.79	1.12	1.04	1.00	1.10	0.98	0.87	1.09	0.86	0.71	1.03	1.13	1.04	1.23	0.86	0.70	1.06
unempXedu1	1.01	0.96	1.07	1.08	0.92	1.26	0.97	0.92	1.03	1.08	0.94	1.23	1.23	1.00	1.53	0.89	0.78	1.00	1.17	0.90	1.52
unempXedu2	1.01	0.98	1.05	1.14	0.96	1.35	0.98	0.93	1.03	1.05	0.94	1.17	1.17	0.99	1.38	0.90	0.78	1.02	1.18	0.95	1.47
unempXedu3	0.99	0.96	1.02	1.08	0.89	1.32	0.95	0.90	1.00	1.03	0.93	1.15	1.16	0.95	1.40	0.89	0.82	0.96	1.20	0.95	1.51
p_inter	0.15			0.33			0.03			0.69			0.10			0.01			0.40		
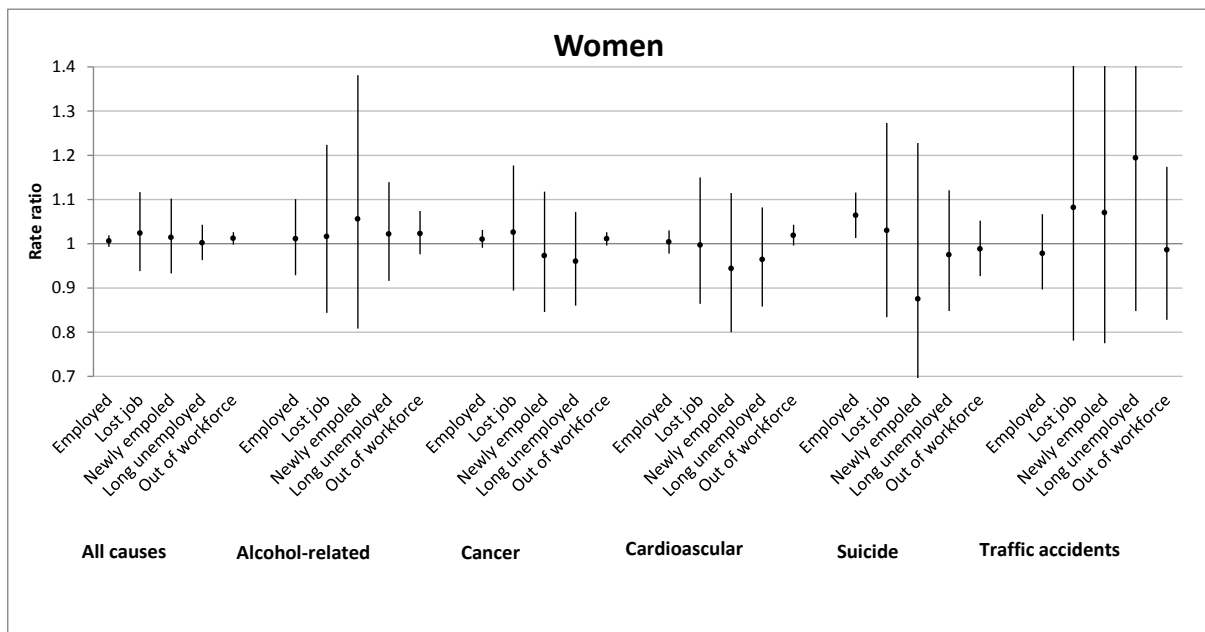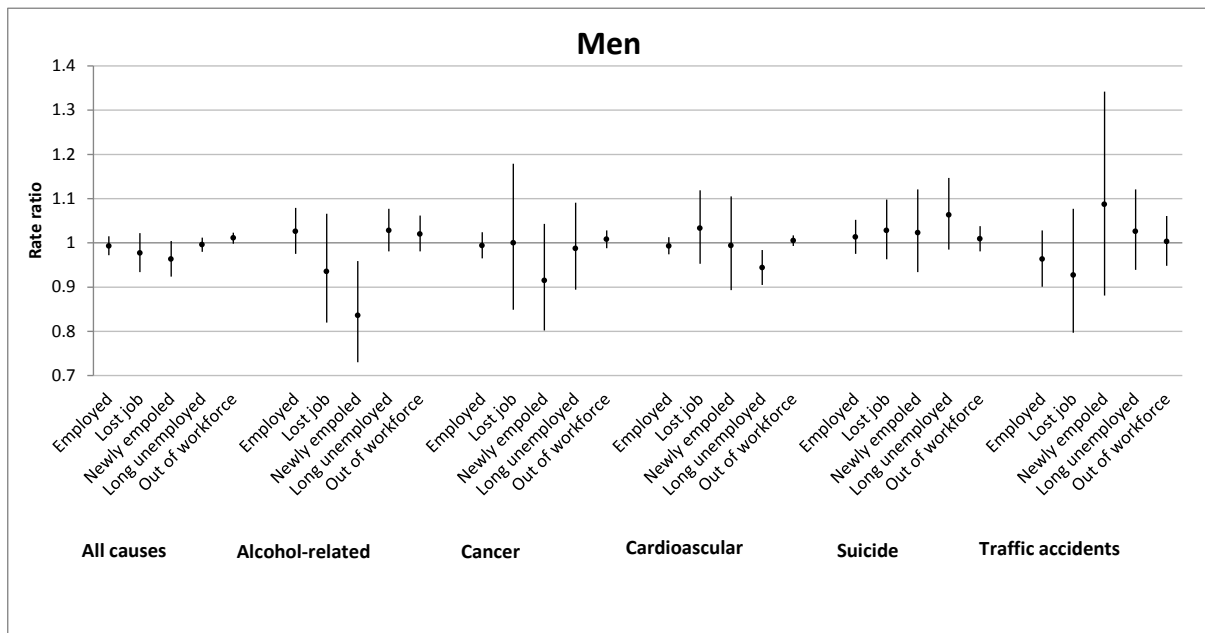
Appendix Figure 1. The impact of a one-point increase in the regional unemployment rate on mortality by occupational status change, 1988-2007
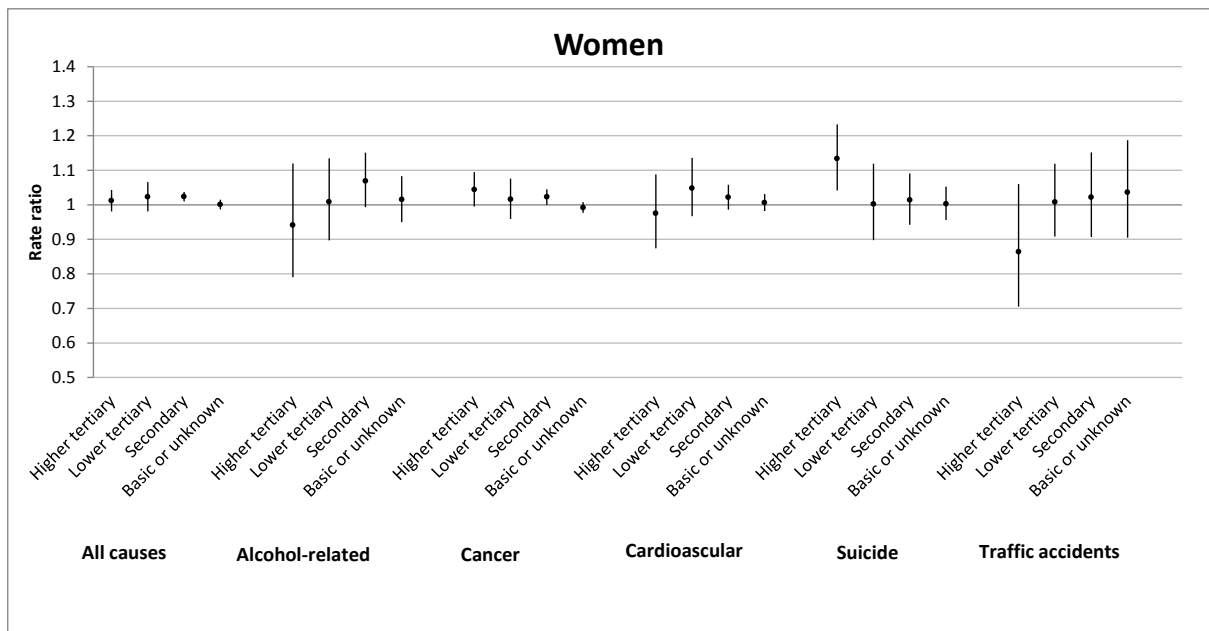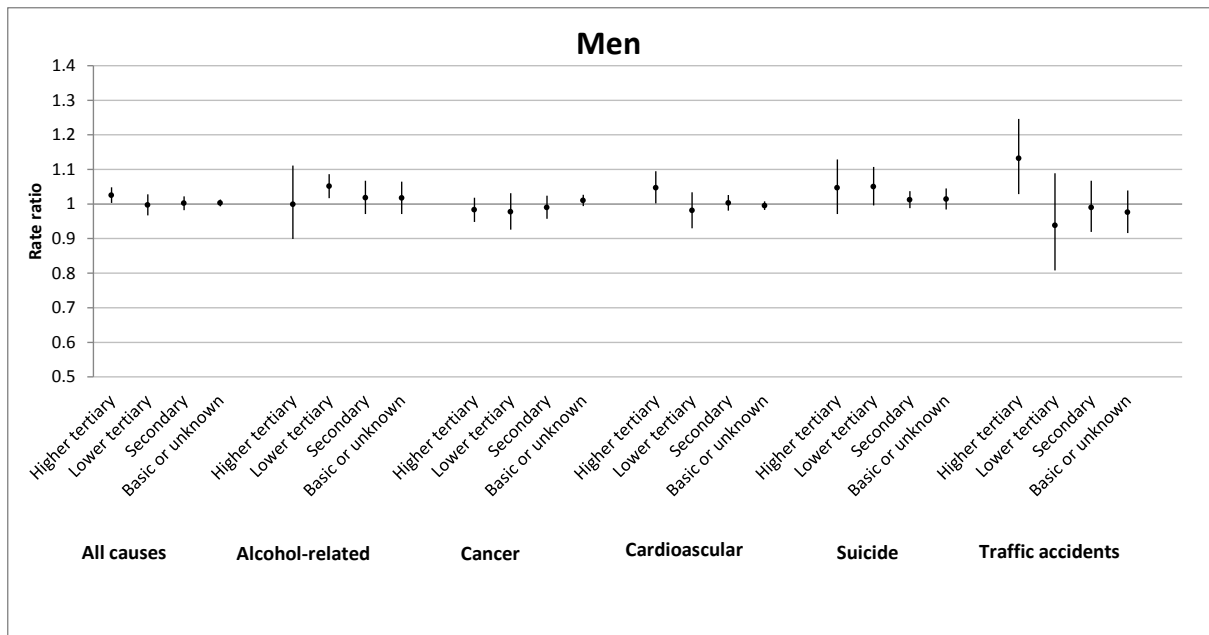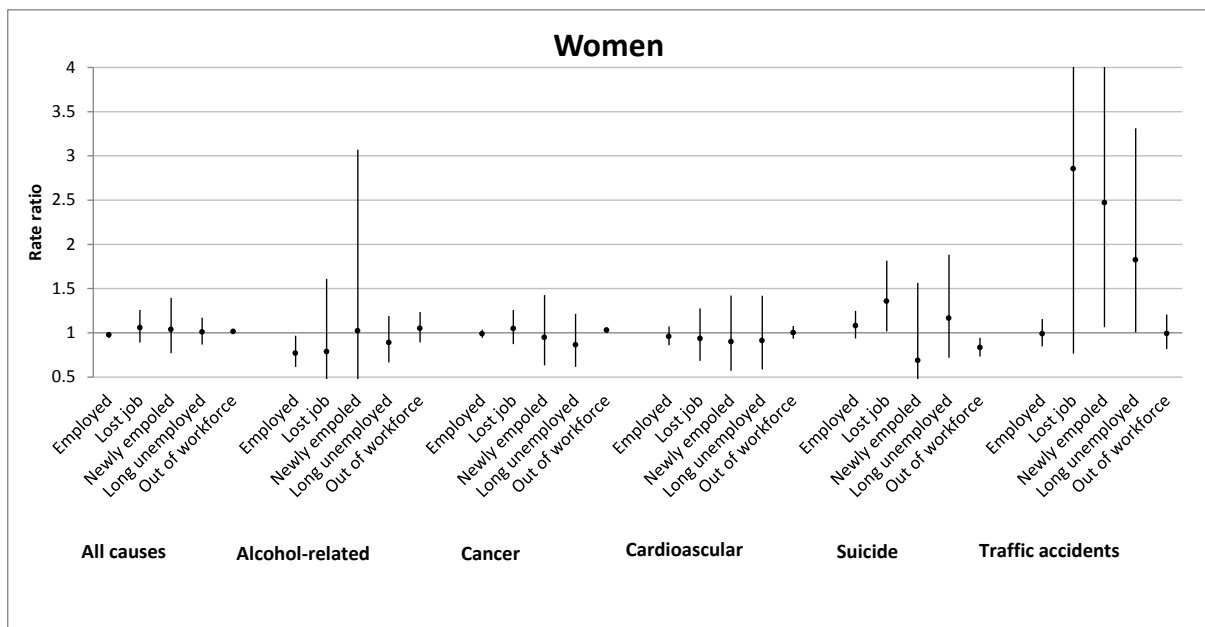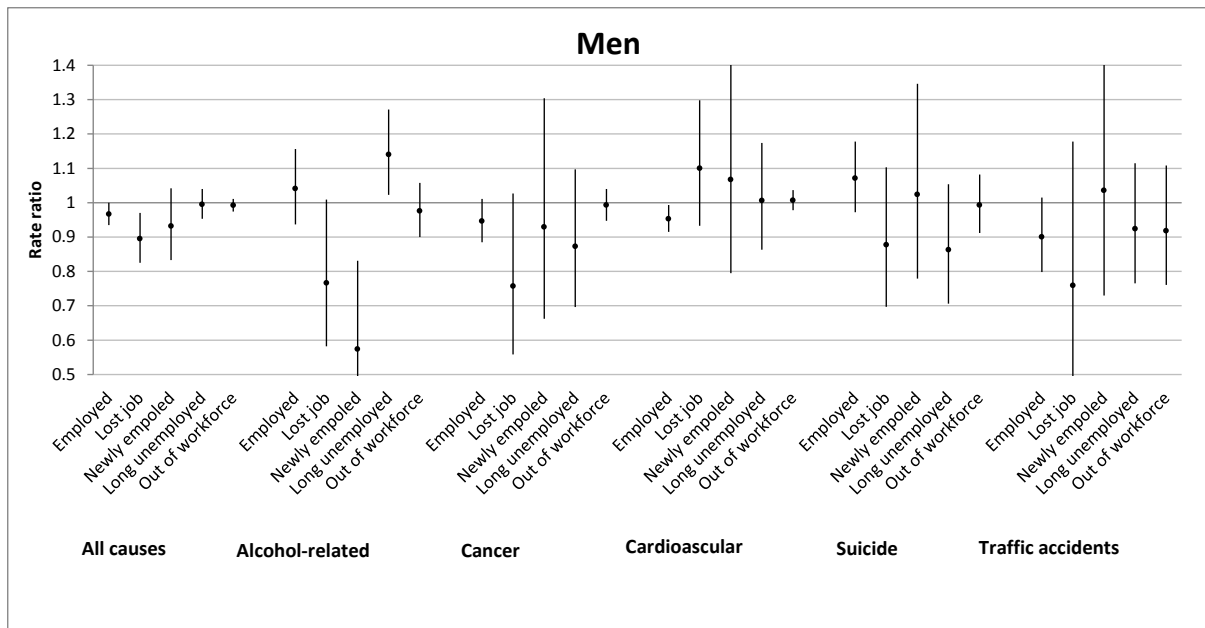
Appendix Figure 2. The impact of a one-point increase in the regional unemployment rate on mortality by educational level, 1988-2007
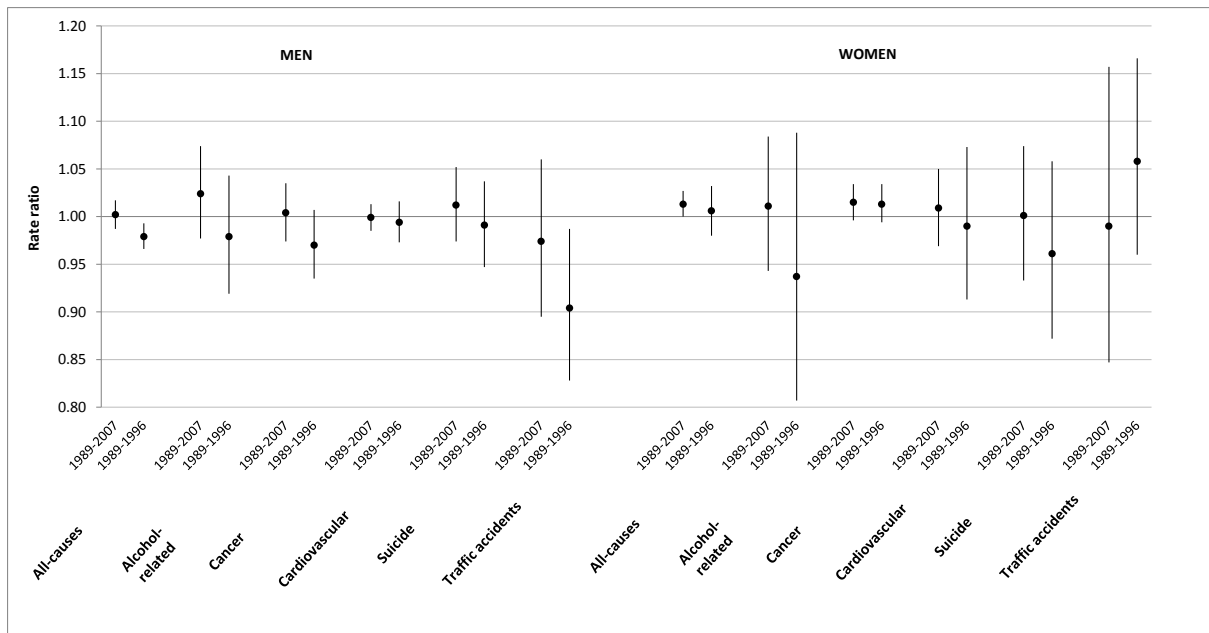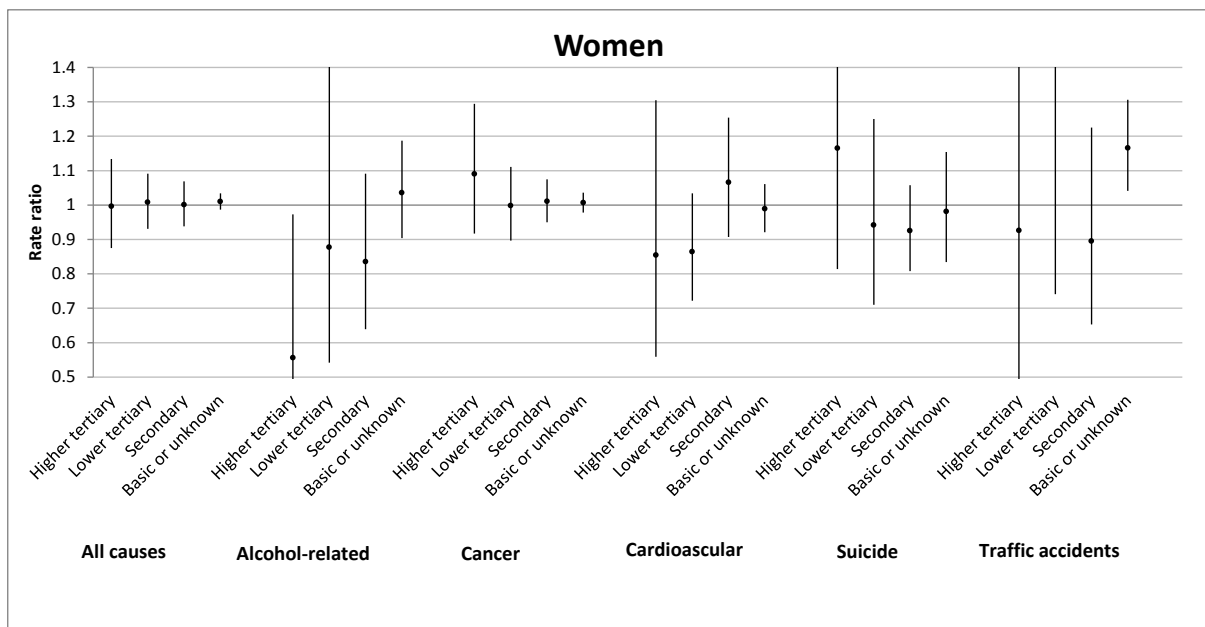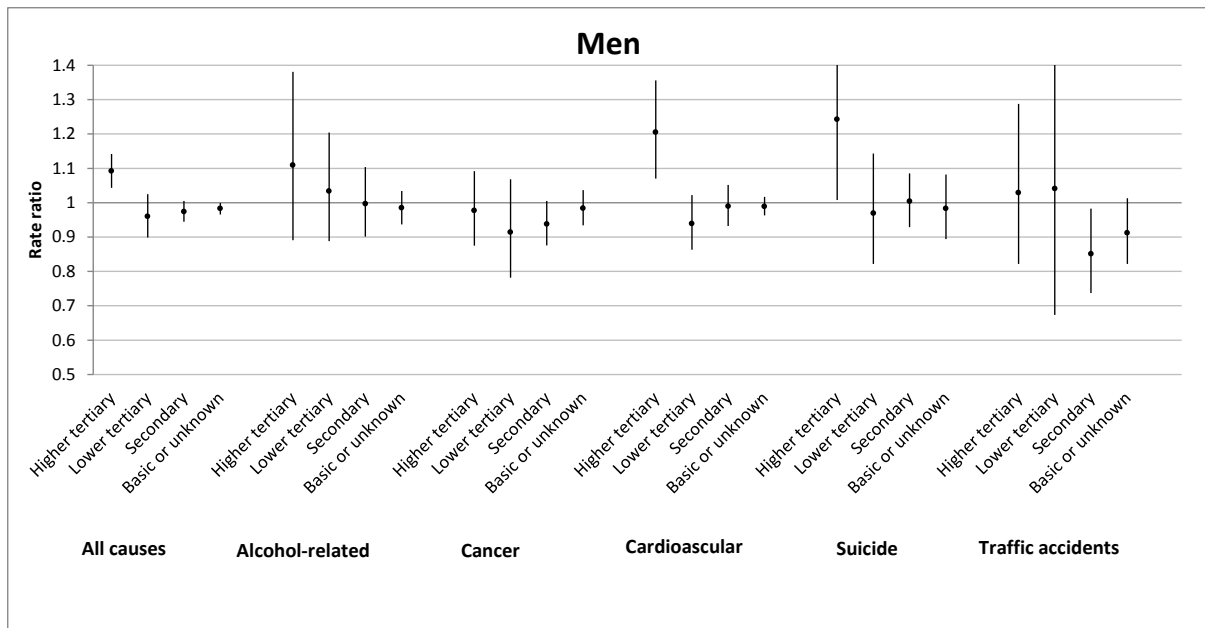
Appendix Figure 3. The impact of a one-point increase in the regional unemployment rate (detrended) on mortality for the periods 1988-2007 and 1988-1996

Men

Women

Appendix Figure 4. The impact of a one-point increase in the regional unemployment rate (detrended) on mortality by occupational status change, 1988-1996

Appendix Figure 5. The impact of a one-point increase in the regional unemployment rate (detrended) on mortality by educational level, 1988-1996

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