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GEOGRAPHIC ANCESTRY AND CAUSE-SPECIFIC MORTALITY IN A NATIONAL POPULATION

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Abstract. This paper is concerned with how geographic ancestry, as proxied by persons' population group and birth region, interrelates with cause-specific mortality in Finland, focusing on people aged between their mid-thirties and late-forties. Many previous studies have argued that mortality variation across population groups and regions in Finland reflect some aspects of culture and thus differentials in lifestyles. However, no exhaustive empirical explanation has yet been provided. Here we treat the two mortality features in the similar setting in order to illuminate the potential role of genetic predisposal. The longitudinal population register data used offer opportunities to account for variables that represent both the individuals' social background and own social status at young adult age. Results of Cox proportional hazard models reveal that these measures for ecological and behavioural circumstances generally have substantial effects on mortality of different causes. Their impact on the variation in death rates across population groups and birth regions is fairly modest, however. The geographic mortality pattern is further found to be more pronounced for causes of death that can be assumed fairly unrelated to persons' lifestyles. In our opinion, these results strongly support the view that variation in genetic predisposal within the population of Finland may underlie mortality differentials.

Keywords: Birth regions, Cause-specific mortality, Finland, Population groups

1. Introduction

In numerous countries around the world mortality risks vary across population groups. Finland is no exception in this context. It is well documented that people of the two main population groups, Finnish speakers and Swedish speakers, differ in life expectancy (Sauli, 1979; Valkonen et al., 1992; Koskinen, 1994; Martelin, 1994; Koskinen and Martelin, 2003). Finnish-speaking men are expected to live three years shorter and Finnish-speaking women one year shorter than their Swedish-speaking counterparts (Saarela and Finnäs, 2006).

What is so specific in the Finnish case is that both groups are indigenous, and that those constituting the minority in numbers – the Swedish speakers who amount to barely six per cent of the total population – have lower death risks. Finnish speakers and Swedish speakers live highly intermingled in specific regions of the country, and they have equal constitutional rights. The national population register identifies a person according to her unique mother tongue. From an objective perspective Finnish speakers and Swedish speakers cannot therefore be distinguished otherwise than by native language.

In spite of the great interest devoted to understand why the two population groups differ in mortality, no satisfactory explanation has yet been provided. In principle, there may be three main contributors to the differential. Firstly, it could be due to socio-economic conditions and other environmental circumstances, and thus be given a broad ecological interpretation. Secondly, it could be hypothesised that differences in cultural ways of living impact on health behaviours and exposure to risky lifestyles. Thirdly, it could be argued that variation in the heritability of genetic propensities is important.

To some extent the two population groups differ on socio-economic characteristics. However, particularly in men such variation has in a number of studies been found accounting for only a minor part of the mortality differential (Saarela and Finnäs, 2005a; 2005b).

Little is known about variation in health behaviours and exposure to risk across Finnish speakers and Swedish speakers, and the latent determinants of such potential variation. With regard to alcohol consumption, it has been argued that Finnish speakers have less healthy drinking habits than Swedish speakers (Simpura, 1990), which is supported by findings which say that Finnish-speaking men in working ages have twice higher risk of alcohol-related mortality than Swedish-speaking men (Blomgren et al., 2004). There is no exhaustive study that explicitly compares the two groups with regard to risk factors for health and health behaviours, however. Any conclusions on this point must therefore be considered fairly vague.

Studies from the field of population genetics say that the variation in genetic markers within the population of Finland resembles how the country was inhabited according to archaeological and historical data (Workman et al., 1976; Norio, 2003). The ancestors of the Swedish speakers came from Western Europe, as Finland was a part of Sweden until 1809. The Finnish speakers inhabited the country from the East. Results of blood group analyses also indicate that Swedish speakers differ from Finnish speakers with regard to geographic ancestry, albeit the degree of genetic admixture appears to be fairly high (Kajanoja, 1972; Eriksson, 1973; Sahi, 1974; Eriksson et al., 1986; Virtaranta-Knowles et al., 1991). No study has managed to establish a direct relationship between the population-group mortality differential and variation in specific genetic markers, however.

Thus it seems evident that there is no simple and all-embracing answer to why Swedish speakers and Finnish speakers differ in mortality risks, specifically when considering that factors underlying each explanation may manifest in different ways, for various causes of death, over the age span. We are convinced, however, that detailed analyses of longitudinal register data will help to adjudicate between the potential contributors.

The difference in mortality risks between the two groups is particularly marked between ages 35 and 50 years, during which Finnish-speaking men have almost twice higher death risk than Swedish-speaking men (Figure 1). In women in the same ages, the excess mortality of Finnish speakers is around 40 per cent. As can be seen in Table 1, these ages represent a period where non-natural causes of death contribute to a large proportion of all deaths. Alcohol-related mortality (alcohol-related diseases and alcohol poising) amounts to almost a fifth of all male deaths, and suicides and all other external causes, respectively, to about equally many. Alcohol is still involved also in many of the deaths caused by external causes. As compared with younger ages, cardiovascular diseases become more common and account for about a quarter of all male deaths in the age group 45-49 years. In women, the number of deaths is very low in these ages, but for mortality due to diseases other than cardiovascular (primarily neoplasms), the number of deaths is about as many as for men, which explains their large share of all female deaths in the age group.

(Figure 1 here)

(Table 1 here)

To understand the factors that underlie mortality variation, it is consequently of utmost importance to focus on fairly short age intervals and to undertake analyses of cause-specific deaths. In our opinion, these issues have been overlooked by most previous studies in the area.

The aim of the present paper is therefore to get better insight into the potential causes of the population-group mortality differential by performing analyses of cause-specific death rates for a reasonably short age interval. The ages we are concerned with are those in which the overall differential in death risks between the two population groups is the widest, i.e. people aged between their mid-thirties and late-forties.

The data we use come from longitudinal population registers, linked to mortality records. All information is based on concurrent censuses, so there are no missing observations and no individual recall bias. The data offer great opportunities to perform analyses that account for a number of presumably relevant confounders. For the ages under study we can include cohorts for which there is information about the persons' social background as well as their own social status at young adult ages. Both sets of variables can be assumed important predictors of adulthood health and mortality, reflecting the direct effects of social and economic circumstances during childhood and as an adult, and the indirect effects that work via health behaviours and hazardous lifestyles. Social background is measured by the family's social class when the person was a child, whether the person lived with both parents, the number of siblings, and an additional indicator of socio-economic status within social class that indicates if the family owned the accommodation. Own social status is measured by the person's educational level, marital status and unemployment experience.

Like in some other countries, e.g. Germany and the United Kingdom (Langford and Bentham, 1996; Luy, 2004), there is a geographical mortality pattern also in Finland. In the Finnish case, death rates have a tendency to increase in the South-West to North-East direction (Koskinen and Martelin, 1994; Pitkänen et al., 2000). This is illustrated by Figure 2 for total mortality and for main causes of death in the age group 35-49 years. All calculations referred to here are based on official statistics for the total population during the time period 1985 to 2005 (Statistics Finland, 2006a; 2006b). In contrast with the subsequent register data to be used, these official statistics cannot be separated by population group. These death rates have been standardised for age and observation year, and are expressed in relation to the national average. The bars represent the 20 provinces in Finland, with a separate category for the Helsinki metropolitan area (the municipalities Helsinki, Vantaa, Espoo and Kauniainen). On the map in the figure, the provinces are numbered in an order that roughly go in the South-

West to North-East direction. Labels on the x-axes are in this spatial order and thus correspond with those on the map. The bars are coloured in order to increase readability with regard to how we categorise these provinces into larger regions in the analyses to come (see the next chapter). During this time period there has been a substantial decrease in overall mortality, but differences across regions, and between population groups (Saarela and Finnäs, 2006), have remained almost the same.

(Figure 2 here)

In line with findings of previous research, we can see that there is a clear East-West-divide, and particularly a South-West to North-East increase, in overall mortality. In the coastal regions, where most of the Swedish speakers live, the levels are clearly the lowest. The geographical mortality pattern is fairly similar across sexes and main causes of death. Some variation is still worthy of highlighting. Alcohol-related mortality is most common in Eastern Finland, whereas the risk of death due to cardiovascular diseases is highest in Northern Finland. For deaths due to diseases other than cardiovascular causes, which account to half of all the female deaths, there appears to be a very weak geographical pattern. We can also see that women in the Helsinki area have remarkably high relative risks of death due to external causes. Within the category that excludes suicides, domestic violence contributes to the largest share of all female deaths in Finland (Kauppila, 2003; Statistics Finland, 2006d).

Like the case with the population-group mortality differential, the geographical variation in death rates has not been sufficiently understood and can principally be related to the same latent factors. Many previous studies have argued that it reflects some aspects of culture. The potential role of hereditary factors has therefore been quite unfairly treated. In our opinion, these two striking features of mortality variation in Finland should be understood in the similar setting. The potential role of genetic predisposal may thus be illuminated by performing detailed individual-level analyses of cause-specific mortality by population group

and birth region, where account is taken for any effects of social background as well as the persons' own social status. In the next, we present the data to be used and motivate the methodology chosen in further detail.

2. Data and methodology

The data come from the longitudinal census data file compiled by Statistics Finland (2006e). It consists of linked individual information for all Finnish residents from the censuses of 1970, 1975, 1980, 1985, 1990, 1995 and 2000. The version used here is a stratified random sample, comprising 50 per cent of all Swedish speakers and 5 per cent of all Finnish speakers. Due to confidentiality reasons, it is not possible to obtain a larger sample. Our data include information about each person's population group, sex, year of birth, birth region, and variables related to socio-economic position and family conditions. They are discussed below.

For each individual, the data have been complemented with information about the event of death. If the person had died before 2005, we know in which year and the cause according to ten main categories. The taxonomy means that age-specific death risks can be estimated at the single-year level. Cox proportional hazard models are used, where age provides the baseline function (starting at age 35), and each variable of interest enters as a covariate. Persons who migrate abroad are treated as right-censored observations.

Our study covers the ages 35-48 years, in which the differential in all-cause mortality between the population groups is the widest. Given that both social background and own status is of interest, we can include the cohorts born 1956 to 1969 into the analysis. Men are of primary interest, but parallel analyses are undertaken for women as well. Year of birth is included to capture variation in mortality over calendar time.

In total we use information on 72,851 individuals and 889 deaths. With these data, we for men perform analyses of mortality due to (1) Alcohol-related causes of death, (2)

Cardiovascular diseases, (3) Other diseases, (4) Suicides, and (5) Other external causes of death, respectively (see the footnote of Table 1). Since the number of deaths is very few in women, we separate only between two categories: all diseases other than cardiovascular (Other diseases) and all other causes of death (Other causes).

The variables utilised to reflect living conditions in the parental home, socio-economic status, homeownership, family type and number of siblings, are all commonly used in register-based studies on social background and mortality (Pensola, 2003). They are measured at the latest census before age 15, i.e. when the person was 10-14 years of age. The situation at these ages thus serves as a proxy for conditions throughout whole childhood.

Socio-economic background measures parental social class, according to the position of the head of the household (usually the father), by distinguishing children of (1) Upper-level white-collar workers, (2) Lower-level white collar workers, (3) Blue-collar workers, (4) Self-employed, and (5) Others. The two latter are fairly heterogeneous in character. With regard to *Homeownership background* we distinguish persons who come from families renting their accommodation and those raised in families owning their dwelling. As only a quarter of all households in Finland belong to the former category, the variable should primarily be seen as an additional indicator of socio-economic conditions, within social class. *Family background* separates people who were living with both parents from all others. *Number of siblings* distinguishes between persons who lived without any sibling, with one, with two, or with more than two siblings (in the same household). Each of the variables can be assumed associated with mortality of different causes of death through material, behavioural as well as psychological mechanisms.

Own social status, as measured by educational level, marital status and unemployment experience, are known to be highly correlated with various causes of mortality at working ages (Pensola, 2003). *Educational level* reflects the situation at age 30-34 years, whereas

marital status and unemployment experience are summary measures for the ages 20-24, 25-29 and 30-34 years of age, respectively. The first one distinguishes people with (1) Primary, (2) Secondary, (3) Lowest tertiary, (4) Lower-degree tertiary and (5) Higher-degree tertiary education. *Marital status* separates people (1) with a partner, i.e. those who are married or live in consensual unions, (2) who previously had a partner, and (3) who never had a partner. *Unemployment experience* distinguishes people according to whether they have (1) not been unemployed whatsoever, (2) been unemployed (registered as a jobseeker) at some time during one of three census years, and (3) been unemployed at some time during more than one of three census years.

All three variables may be highly selective with respect to health and mortality, which means that people with poor health have worse opportunities for obtaining higher education, for marriage, and for becoming and remaining employed, than others (Bartley, 1994; Hu and Goldman, 1990; Martikainen and Valkonen 1996). We will not devote any interest to the causality problem involved, but rather treat these variables as broadly reflecting variation in social circumstances at young adulthood. It is essential to note, however, that own social status generally correlates with social background (Pensola, 2003). Accounting for one subset of variables will therefore likely reduce the estimated effects of those in the other markedly.

Certain features of internal migration in Finland make it possible to use persons' birth region to proxy their geographic ancestry and thus potential variation in genetic predisposal. During past centuries, particularly the latest, migration flows in Finland have mainly gone from the East and the North towards the Southern parts of the country, including the Helsinki metropolitan area. These population shifts have predominantly been undertaken by Finnish speakers. Swedish speakers, on the other hand, have always lived along the coast, and they have had very low internal migration rates. Most of their internal migration has been in the

direction of the Helsinki metropolitan region (Korkiasaari and Söderling, 2004; Saarela, 2006).

These circumstances have resulted in the situation, that Finnish speakers born in the interior regions of the country, and Swedish speakers in the coastal region outside the Helsinki area, represent geographic rather stable and thus presumably also genetic quite homogeneous subgroups of the population.

Hence, people born in regions from which the large part of all internal migration has taken place can on fairly reasonable grounds be assumed representing the descendants of persons who have lived there since the regions were inhabited. This is the case for Swedish speakers born in the Coastal area, as well as Finnish speakers born in Northern Finland, in Eastern Finland, and in Western Finland excluding the Coastal area. People in the other three subgroups – Finnish speakers born in the Coastal area, Finnish speakers born in the Helsinki area, and Swedish speakers born in the Helsinki area – represent a mixture of geographic ancestry, as many of them are the offspring of people who originate from various parts of the country.

The geographical categorisation adopted here, which consequently accounts for both population group and birth region, accounts for the above discussed circumstances. It is illustrated by the map in Figure 3. The variable used has the categories (1) Swedish speakers in the Coastal area, (2) Finnish speakers in the Coastal area, (3) Finnish speakers in Western Finland, (4) Finnish speakers in Northern Finland, (5) Finnish speakers in Eastern Finland, (6) Swedish speakers in the Helsinki area, and (7) Finnish speakers in the Helsinki area. The whole settlement area of the Swedish speakers, except for the Helsinki area, is considered to be one region (cf. Figure 1). Less than three per cent of the Swedish speakers live elsewhere in Finland, and they are excluded from this analysis.

Table 2 gives distributions of the variables that represent persons' social background and own social status according to this geographical categorisation. As can be seen, there is in many instances large variation across the geographic subgroups, and the Helsinki area in particular is evidently very different from the others. When considering that these variables can be assumed highly correlated with health and mortality, it is essential to include them into the analysis.

(Figure 3 here)

(Table 2 here)

3. Results

Table 3 provides results of Cox regressions that account for each person's population group, birth region and birth cohort. Each parameter can be straightforwardly interpreted in the sense that it gives the relative difference in mortality as compared with mortality in the reference group. Parameters with relatively small standard errors, i.e. those that are statistically significant at the five per cent level, are underlined. This way of presenting the results is undertaken in order to increase readability.

For all-cause mortality represented by the first column, we can see that, as compared with Swedish speakers born in the Coastal area, Finnish speakers born in Western Finland have twice higher, those born in Northern Finland 2.5 times higher, and those born in Eastern Finland 2.8 times higher death risks in ages 35-48 years. Also Finnish speakers born in the Coastal area, and Swedish speakers and Finnish speakers born in the Helsinki area, have substantially, or roughly twice, higher death rates than those in the reference group.

(Table 3 here)

The regional variation in all-cause mortality manifests primarily in alcohol-related mortality and in suicides. Considering that a substantial part of the liability for developing

alcoholism and mental health disorders is due to genetic factors (Eley and Plomin, 1997; McGue, 1999; Sullivan et al., 2000; Hesselbrock et al., 2001), this is a quite striking finding. Finnish speakers born in Western Finland have almost three times higher, those born in Northern Finland 3.8 times higher and those born in Eastern Finland 5.9 times higher risks of alcohol-related mortality than Swedish speakers born in the Coastal area. Also within the Swedish-speaking group there is substantial variation, however. Those born in the Helsinki area have almost five times higher alcohol-related mortality than those born in the Coastal area. Separating these two groups implies that the overall variation in alcohol-related mortality is larger than the Swedish-Finnish differential found by previous research (Blomgren et al., 2004). Thus it appears quite clear that mortality within the Helsinki area in particular is interrelated with environmental factors outside the scope of this paper (cf. Valkonen and Kauppinen, 2001; Galea et al., 2005).

The overall pattern for suicide is fairly similar in the sense that there is a clear South-West to North-East pattern in mortality rates. As compared with Swedish speakers born in the Coastal area, Finnish speakers born in Western Finland have 1.6 times higher suicide rates, those born in Northern Finland three times higher, and those born in Eastern Finland 3.1 times higher. Again, Swedish speakers born in the Helsinki area have markedly high death rates, and even somewhat higher than Finnish speakers born in the same area.

In cardiovascular diseases there is a clear level difference between Swedish speakers and Finnish speakers, which puts the latter at rates that are between two and four times higher than those of the former. For other diseases the pattern is the same, albeit less marked. As compared with Swedish speakers born in the Coastal area, Finnish speakers have about twice higher death risks.

Also with regard to external causes excluding suicides there is a mortality differential between the two population groups, which say that Finnish speakers have almost two times

higher death rates than Swedish speakers. Specifically noteworthy still is that there is no differential between Swedish speakers born in the Coastal area and Finnish speakers born in the Coastal area. A difference in this respect would have indicated that the mortality gradient is interrelated with cultural factors, as external causes of death excluding suicides can be assumed highly correlated with exposure to hazardous lifestyles (cf. Cubbin et al., 2000).

In women, the low number of deaths makes the results more sensitive to random variation. We are therefore somewhat reluctant to draw any far-reaching conclusions. The results still confirm those of previous research for wider age intervals (Koskinen and Martelin, 2003). In overall mortality there is no differential between Swedish speakers and Finnish speakers born in the Coastal area, whereas those born in the other regions have approximately 50 per cent higher death risks. There is substantial variation across the two main causes of death, however. Diseases other than cardiovascular (predominantly neoplasms) are most common among Swedish-speaking women born in the Coastal area, but for all the other causes (predominantly accidents and violence) women in this group have clearly the lowest death rates.

To see if these results are confounded by ecological and behavioural factors we proceed by including factors that represent the individuals' social background in terms of socio-economic position, homeownership, family and siblings (results in Table 4), and in the subsequent step add variables that reflect the persons' own social status in terms of educational level, marital status and unemployment experience (results in Table 5).

(Table 4 here)

(Table 5 here)

Based on the results of Table 4 we can see that persons who come from families of higher social class generally have lower death rates than those who come from families of lower social class. Specifically alcohol-related mortality is strongly linked to the socio-economic

position of the family. A person who come from a family where the head of the household is an upper-level white-collar, say, has a risk of dying of alcohol-related causes that is more than 60 per cent lower than that of a person who comes from a blue-collar family. The parameters for “self-employed” and “other” are difficult to interpret as these categories are quite heterogeneous in character. Persons raised in families that do not own their accommodation have higher mortality risks of almost all main causes of death than those who come from house-owning families. Alcohol-related mortality, for instance, increases with approximately 40 per cent in case of the absence of homeownership. Family background is also relevant. Men who lived with one parent have about 40 per cent higher death risks than those who lived with both parents. The impact varies somewhat across causes of death. The most prevalent effect is for external causes of death excluding suicides, which suggest that persons raised in single-parent families are under markedly higher exposure to the risk of accidents and violence than others. The least prevalent effect on this concern is found for suicidal deaths. Persons with no sibling, and those with more than one sibling, generally have higher death risks than those with one sibling. The reasons behind this pattern are not clear. It might reflect some additional variation in living conditions that impact on behaviours, as the most prevalent effects are for external causes of death and alcohol-related mortality.

The most striking finding still is that, in spite that living conditions at childhood clearly impact on adult death risks, the mortality variation across birth regions and population groups remains almost unaltered when we account for these circumstances. Thus the overall pattern and sizes of these parameters is almost the same as in Table 3.

Even when we also include persons’ own social status (Table 5), this variation across subgroups changes marginally. Only for alcohol-related causes, suicides, and other external causes of death, which must be considered at least partly related to health behaviours and hazardous lifestyles, there is some reduction across subgroups. The impact of social

background, and particularly of socio-economic background, on mortality tampers off markedly, however. This is evidently because the variable correlates highly with education, which has a stronger predictive power on mortality. Number of siblings is the only variable for which the estimated parameters change modestly when own social status is included. It consequently seems to reflect some alternative dimension of childhood living conditions, unrelated to the variables that proxy persons' own social status.

In general, these variables have substantial effects on all main causes of mortality. Death rates fall almost consistently over educational level, and the pattern is fairly equal across different causes of death. Thus schooling is an important measure of socio-economic status, but causality obviously also work in both directions in these ages. On the one hand, higher education works as to prevent mortality, e.g. of alcohol-related causes and accidents. On the other hand, people with poor health and thus at increased risk of diseases and suicides, obtain less schooling.

Persons who live with a partner have substantially lower mortality rates than others, which reflect both the protective effect of partnership, but also that partnership selects the more healthy people in the population. This appears specifically prominent in women. Women who never had a partner have more than twice higher death risk due to diseases (other than cardiovascular) than those with a partner. For all other causes of death, both divorced women and those previously living in consensual unions, as well as those who never had a partner, have three times higher mortality risks than women with a partner.

A similar argumentation may naturally be applied to labour market history. People with no unemployment experience generally have good health and are thus found to have low mortality rates, but having experienced no unemployment may also protect from poor health behaviours and hazardous ways of living that increase the death risk. Obviously both these variables have a strong social link. The differential in death risks between people with a

partner and those without a partner, and between people with no unemployment experience and those with unemployment experience, is the widest for alcohol-related mortality and other external causes of death.

4. Discussion and conclusions

This paper shows that ecological and behavioural circumstances at childhood and adulthood have strong effects on cause-specific mortality in Finland. Variation in death rates across population groups and birth regions, which are interpreted as reflecting persons' geographic ancestry, is only marginally reduced when account is taken for these factors, however. Thus the results support the view that variation in genetic predisposal within the population of Finland may underlie mortality differentials. In specific, it is difficult to see what factors other than those used here could falsify this argument. Present results are also very much in line with analyses and conclusions from recent studies that have focused on both higher and lower age groups than that studied here (Saarela and Finnäs, 2006; 2007).

We find that regional variation in alcohol-related mortality and external causes of death is partly confounded by region-specific environmental and behavioural circumstances. The reduction is still fairly modest, and there remains a consistent pattern across birth regions and population groups. For deaths due to external causes excluding suicides, which predominantly are interrelated with hazardous lifestyles and thus exposure to the risk of death due to cultural behaviours, we find the least emphasised geographic mortality pattern. Deaths due to diseases, on the other hand, which hardly can be attributed to lifestyles in the ages studied, are not reduced at all when account is taken for the confounders. This seems to be a support for the fact that a number of non-cardiovascular diseases are known to be concentrated to smaller spatial areas in Finland, and thus presumably related to a family-history of the disease (Norio, 2003). We believe that variation in cardiovascular diseases may be given a similar

interpretation, as behaviours and diet are not likely to lead to mortality at these low ages. The geographic mortality pattern for women is still found to be less consistent and partly different from men, but this is not necessarily in contrast with the genetic hypothesis, considering that in these ages, diseases that dominate in the death records differ markedly between the sexes.

Geographic ancestry tends to be a useful device for making inferences about an individual's ancestry and predicting whether she carries specific genetic risk factors that influence health (Bamshad, 2005). In this context one must not, however, interpret genes at the individual level in terms of the allelic frequency of one individual locus, but on the basis of different alleles for several loci that tend to correlate. Thus a single characteristic cannot be used to determine the geographic origin of a person's recent ancestors. Human genetic variation can instead be used to deduce the geographic origins of an individual's recent ancestors by noting that alleles that vary geographically correlate with alleles for other loci that also vary geographically and form clusters. Individuals from geographically proximate regions thus share more recent common ancestry with each other than they do with individuals from more disparate regions. The closer this geographic proximity, the stronger is the genetic similarity. This interrelation helps to grouping individuals into subpopulations, and the accuracy of the classification increases with the number of loci studied (Risch et al., 2002; Edwards, 2003; Rosenberg et al., 2005). The findings of this paper should be seen in light of that argumentation.

Throughout much of human history geographic barriers have precluded random mating and thus generated small differences in polymorphism frequencies among the separated groups (Bamshad, 2006). Within modern societies, subgroups of many national populations have also been found to differ with regard to genomic ancestry (Parra et al., 2003; Jackson et al., 2004; Helgason et al., 2005). This appears to be the case also for Finland, where language is believed to have worked as an additional such barrier (Virtaranta-Knowles et al., 1991). We

believe that researchers and health policy practitioners should be more concerned with the potential role of genetic predisposal, and particularly the possibility that certain subgroups of the population may have an unfavourable predisposition with regard to both genetic factors and environmental circumstances.

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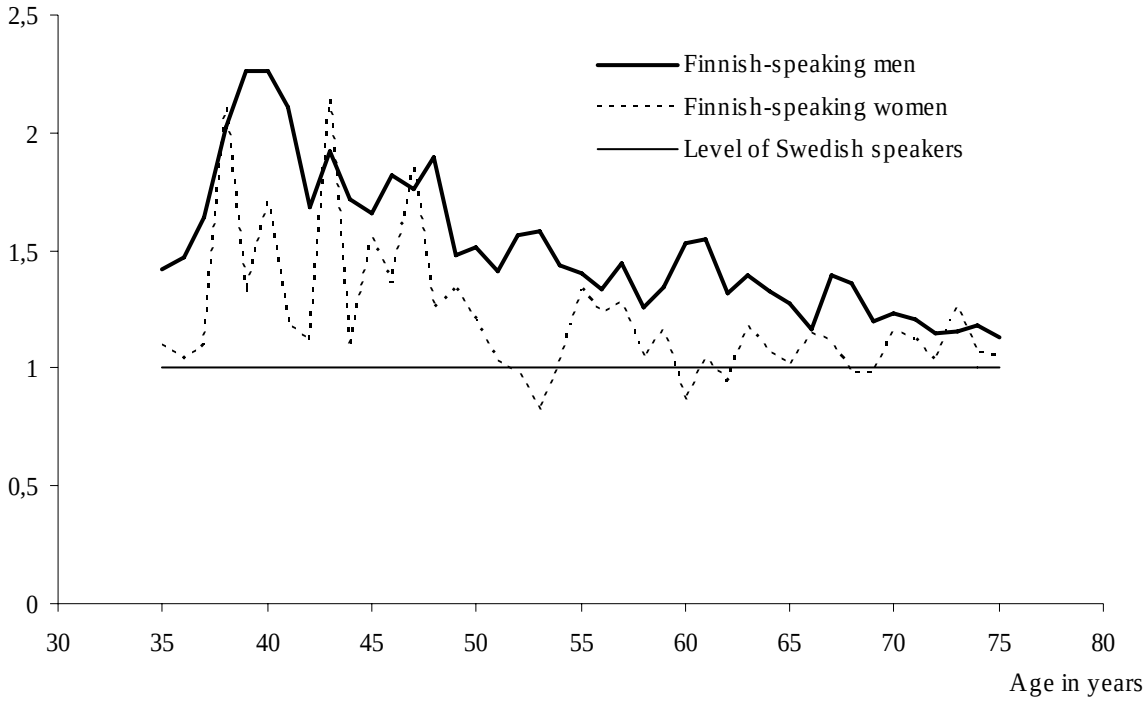
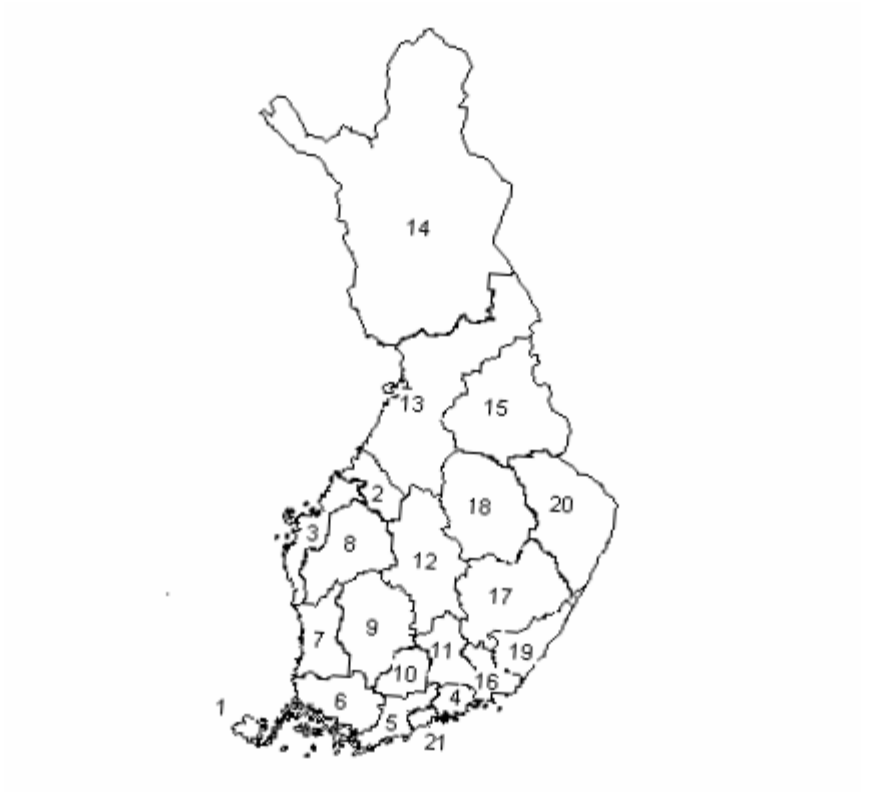


Figure 1. Age-specific death rates of Finnish speakers in relation to those of Swedish speakers, 1995-2005

Source: Authors' calculations based on Statistics Finland (2006a; 2006b; 2006c).



Map of Finland indicating the provincial borders, with a separate category for the Helsinki area (21).

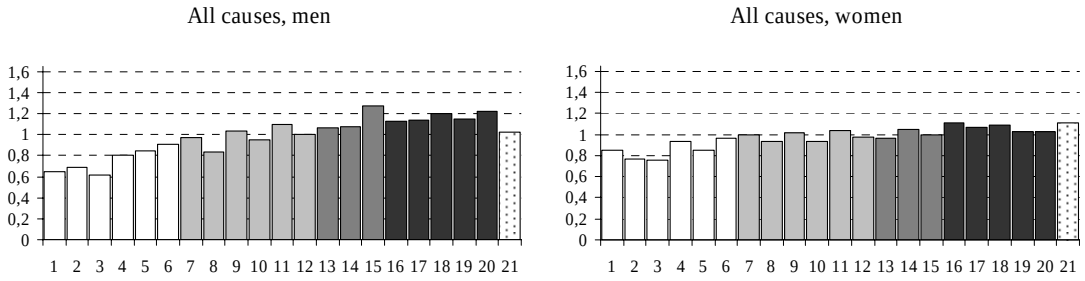


Figure 2 (page 1 of 2). Relative differentials across provinces in mortality of all causes and main causes of death in ages 35-49 years

Notes: Calculations are based on official statistics for the total population in Finland aged 35-49 years in 1985-2005 (Statistics Finland, 2006a; 2006b). Each bar gives mortality in a province in relation to the national average (which is equal to 1). All numbers are standardised for age and observation year. Provinces as referred to by the labels on the x-axes correspond with those on the map.

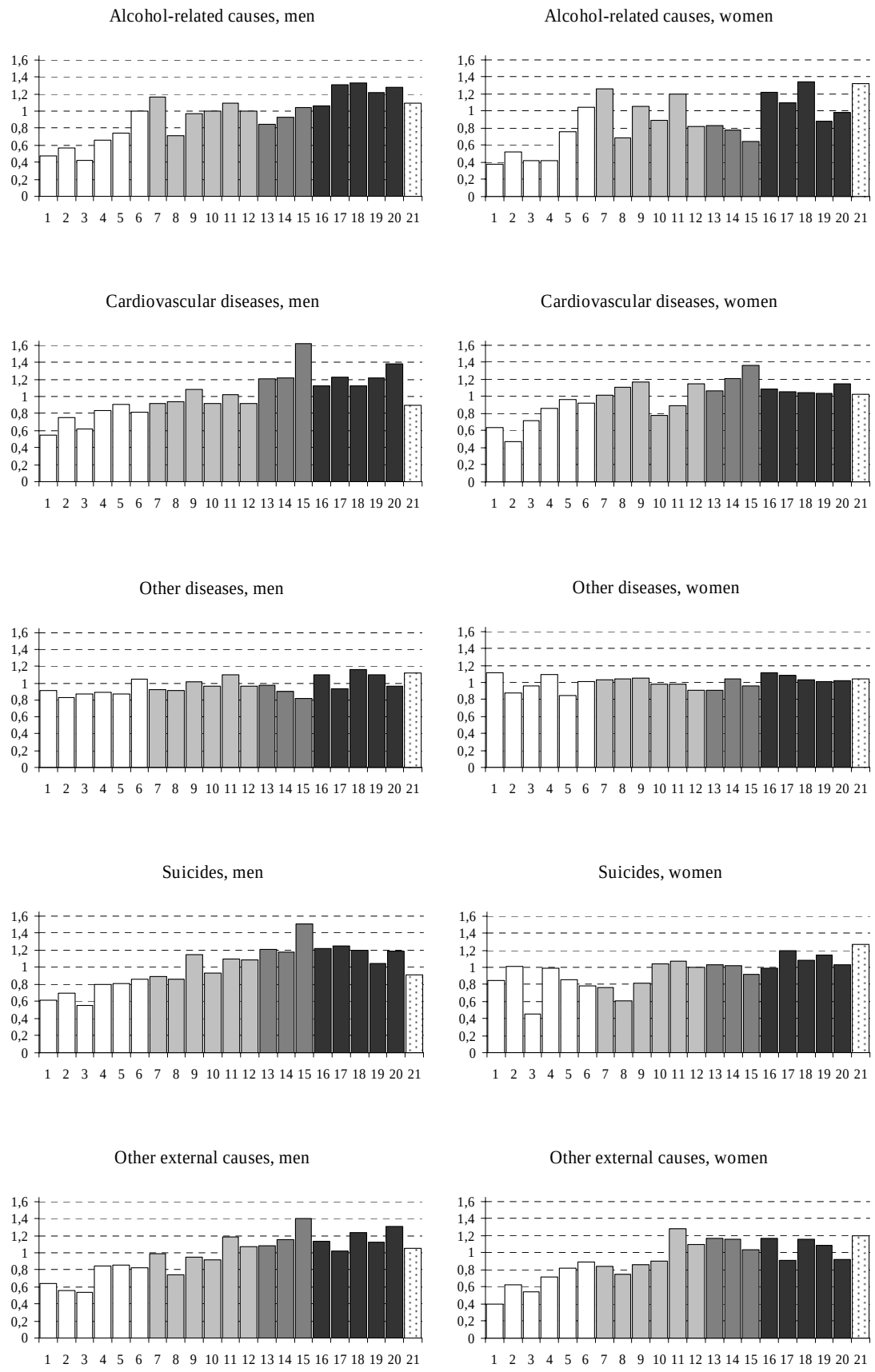


Figure 2 (page 2 of 2).

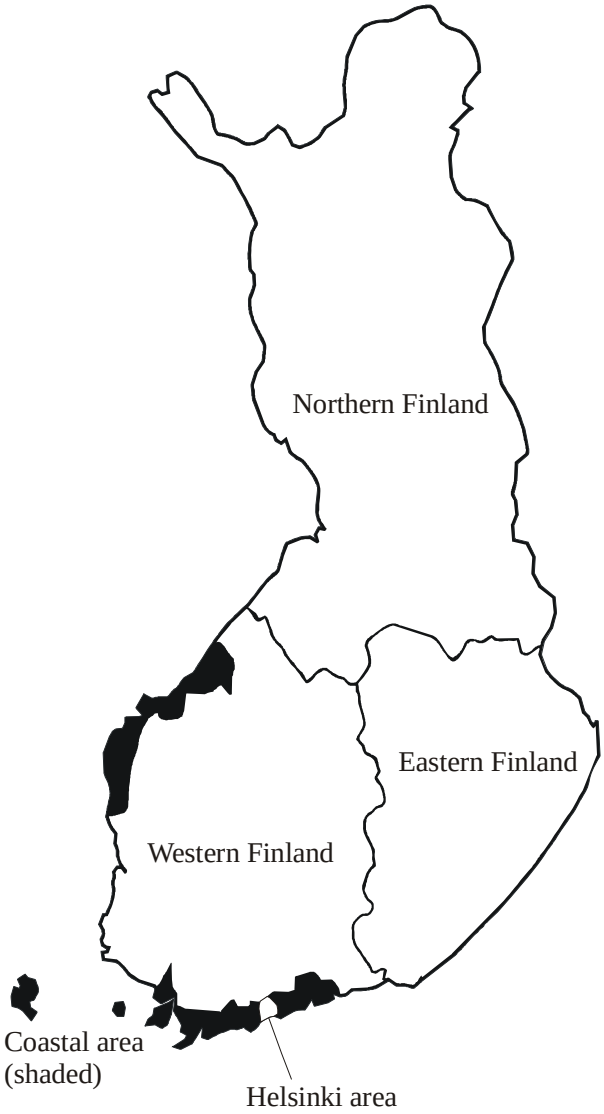


Figure 3. Map of Finland showing the geographical categorisation applied in the statistical analysis

Note: The Coastal area represents a smaller spatial region than that given by the six first provinces referred to in Figure 2. This category has been constructed with the purpose of facilitating a more refined analysis, as it includes only municipalities that have substantial Swedish-speaking settlement.

Table 1. Annual number of deaths and distribution of main causes of death by sex and age group in Finland, 1985-2005

	Men						Women					
Age group	# Deaths	% Alcohol-related	% Cardio-vascular	% Other diseases	% Suicides	% Other external	# Deaths	% Alcohol-related	% Cardio-vascular	% Other diseases	% Suicides	% Other external
0 years	157	0.0	0.8	96.2	0.0	3.0	121	0.0	1.0	96.4	0.0	2.6
1-4	33	0.0	2.8	61.6	0.0	35.6	26	0.2	3.9	66.2	0.0	29.8
5-9	31	0.0	3.4	45.1	0.2	51.3	21	0.0	4.2	60.9	0.0	34.9
10-14	33	0.0	4.7	39.7	7.7	47.9	21	0.0	4.8	51.8	5.9	37.4
15-19	128	0.5	2.6	17.1	30.7	49.1	47	0.4	5.1	31.1	18.7	44.7
20-24	203	1.9	3.0	15.1	40.0	40.0	60	1.3	6.8	34.0	26.6	31.2
25-29	230	4.4	4.7	16.6	39.4	34.9	68	2.9	8.6	37.9	25.4	25.3
30-34	310	10.9	9.0	18.5	30.9	30.7	99	5.8	10.7	42.3	21.6	19.5
35-39	471	16.0	15.0	20.1	23.7	25.3	168	8.5	13.0	45.7	16.1	16.6
40-44	694	18.3	21.8	21.8	17.2	20.9	258	10.1	15.2	49.7	11.9	13.0
45-49	940	18.1	28.6	25.3	11.5	16.5	380	9.5	16.2	55.2	9.2	9.9
50-54	1,245	14.4	35.4	30.4	7.1	12.7	510	8.2	19.1	58.6	5.9	8.2
55-59	1,623	9.7	41.6	35.3	4.5	8.9	660	5.6	24.3	60.4	3.8	5.9
60-64	2,133	5.7	46.2	39.6	2.6	6.0	965	2.9	32.9	58.0	2.2	4.0
65-69	2,709	2.9	48.7	42.5	1.6	4.2	1,525	1.4	41.6	52.9	1.1	3.0
70-74	3,335	1.3	49.4	45.0	1.0	3.3	2,508	0.5	48.1	48.3	0.6	2.6
75-79	3,660	0.5	50.1	45.6	0.8	2.9	3,939	0.1	52.7	44.3	0.3	2.6
80-84	3,214	0.2	50.2	46.0	0.5	3.1	5,092	0.0	55.2	42.0	0.1	2.7
85-89	2,095	0.1	48.4	47.8	0.4	3.3	4,738	0.0	55.0	42.0	0.0	3.0
90-94	862	0.0	47.7	48.1	0.2	4.1	2,653	0.0	53.1	43.8	0.0	3.1
95+	196	0.0	47.2	48.6	0.0	4.1	794	0.0	51.7	45.3	0.0	3.1

Annual number of deaths refers to the mean number per year for the period 1985 to 2005.

Main causes of death are according to Statistics Finland's 54-category short list of causes of death. It is comparable in respect of time and follows the 10th revision of the International Classification of Diseases (ICD-10).

Alcohol-related refer to code 41, Cardiovascular to codes 27-30, Other diseases to codes 1-26 and 31-40, Suicides to code 50, and Other external to codes 42-49 and 51-54.

Source: Authors' calculations based on Statistics Finland (2006a).

Table 2. Variable distributions by population group and birth region (%)

	Swedish speaker Coastal area	Finnish speaker Coastal area	Finnish speaker Western Finland	Finnish speaker Northern Finland	Finnish speaker Eastern Finland	Swedish speaker Helsinki area	Finnish speaker Helsinki area
Socio-economic background							
Blue-collar worker	33.0	46.9	45.2	41.0	43.4	21.8	39.8
Lower-level white-collar worker	16.9	14.6	14.1	12.5	12.6	27.9	23.5
Upper-level white-collar worker	10.7	8.8	8.1	6.7	6.0	37.3	23.6
Self-employed	34.0	22.8	25.2	28.5	28.4	6.5	6.5
Other	5.4	6.9	7.4	11.3	9.7	6.6	6.6
Homeownership background							
Yes	75.4	68.9	70.4	76.6	70.2	58.1	54.3
No	24.6	31.1	29.6	23.4	29.8	41.9	45.7
Family background							
Both parents	91.3	86.4	87.9	88.7	88.6	83.9	81.3
One parent and others	8.7	13.6	12.1	11.3	11.4	16.1	18.7
Number of siblings							
0	36.4	34.0	30.7	20.8	26.6	41.1	41.2
1	13.1	13.8	13.6	8.7	10.4	18.4	19.6
2	28.4	26.7	25.1	23.8	26.5	27.9	24.2
3+	22.1	25.5	30.5	46.7	36.5	12.6	15.1
Educational level							
Primary	26.0	25.1	21.5	17.4	20.9	21.3	28.2
Secondary	43.4	47.5	50.5	54.7	53.4	33.2	41.4
Lowest tertiary	14.2	13.6	13.7	14.7	13.6	14.0	12.7
Lower-degree tertiary	6.5	6.5	5.5	5.7	5.3	9.4	5.1
Higher-degree tertiary	9.9	7.4	8.8	7.5	6.7	22.2	12.5
Marital status							
With partner	69.2	66.2	65.6	66.0	64.1	67.9	61.6
Previously with partner	6.3	11.1	10.9	10.2	10.4	11.4	14.3
Never with partner	24.6	22.6	23.5	23.9	25.5	20.6	24.1
Unemployment experience							
None	82.8	73.1	69.9	57.5	63.7	81.0	73.7
At one census	14.0	19.2	21.3	26.6	24.7	16.8	20.6
At more than one census	3.3	7.7	8.8	15.9	11.7	2.2	5.7
# men in unweighted sample	9,918	3,562	7,600	4,174	5,684	3,114	3,223
# women in unweighted sample	9,195	3,441	7,451	4,002	5,528	2,990	2,969

Distributions refer to percentages of total risk time for men. Distributions for women are highly similar.
Socio-economic background, Homeownership background, Family background, and Number of siblings are measured at age 10-14 years. Educational level is measured at age 30-34 years. Civil status and Unemployment experience are summary measures representing ages 20-24, 25-29 and 30-34 years.

Table 3. Relative mortality risks for main causes of death in ages 35-48 years; Population group and Birth region

	MEN						WOMEN		
	All causes	Alcohol-related	Cardio-vascular	Other diseases	Suicides	Other external	All causes	Other diseases	Other causes
Population group + Birth region									
Swedish speaker in Coastal area	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Finnish speaker in Coastal area	1.91	3.59	3.14	1.86	1.69	0.98	0.92	0.52	3.70
Finnish speaker in Western Finland	2.03	2.95	2.15	2.10	1.65	1.86	1.47	0.69	6.90
Finnish speaker in Northern Finland	2.55	3.77	3.90	1.76	2.97	1.76	1.40	0.80	5.58
Finnish speaker in Eastern Finland	2.85	5.88	3.20	1.65	3.12	2.14	1.56	0.59	8.34
Swedish speaker in Helsinki area	1.79	4.75	0.74	1.97	2.56	0.55	0.97	0.46	4.52
Finnish speaker in Helsinki area	2.29	2.94	3.16	2.22	2.33	1.72	1.43	0.37	8.79
Birth cohort									
1956-1960	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1961-1965	0.95	0.82	0.86	0.99	0.84	1.26	0.85	0.81	0.87
1966-1970	0.75	0.66	1.57	0.19	0.55	1.12	0.98	1.13	0.88
# deaths in unweighted sample	639	120	105	112	141	161	250	116	134

An underlined parameter means that a 95% confidence interval does not include 1.00.
Other causes for women refer to all other causes of death except codes 1-26 and 31-40.

Table 4. Relative mortality risks for main causes of death in ages 35-48 years; Population group, Birth region and Social background

	MEN						WOMEN		
	All causes	Alcohol-related	Cardio-vascular	Other diseases	Suicides	Other external	All causes	Other diseases	Other causes
Population group + Birth region									
Swedish speaker in Coastal area	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Finnish speaker in Coastal area	1.81	3.30	3.05	1.82	1.58	0.93	0.86	0.50	3.39
Finnish speaker in Western Finland	1.93	2.75	2.12	2.08	1.50	1.75	1.40	0.67	6.51
Finnish speaker in Northern Finland	2.40	3.69	3.97	1.82	2.48	1.59	1.37	0.76	5.58
Finnish speaker in Eastern Finland	2.67	5.49	3.16	1.62	2.73	2.00	1.46	0.55	7.80
Swedish speaker in Helsinki area	1.85	5.46	0.83	1.96	2.55	0.54	0.92	0.48	4.03
Finnish speaker in Helsinki area	2.21	2.83	3.25	2.07	2.22	1.63	1.24	0.37	6.99
Socio-economic background									
Blue-collar worker	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lower-level white-collar worker	0.86	0.48	0.83	1.14	1.09	0.90	0.98	0.66	1.18
Upper-level white-collar worker	0.67	0.36	0.48	0.57	0.82	1.07	0.60	0.68	0.56
Self-employed	0.97	0.94	1.00	1.27	0.81	0.97	1.12	1.26	0.99
Other	0.97	0.72	0.90	1.35	1.25	0.83	1.44	1.83	1.22
Homeownership background									
Yes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
No	1.18	1.42	1.02	1.61	1.18	0.92	1.48	1.24	1.66
Family background									
Both parents	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
One parent and others	1.42	1.59	1.37	1.27	1.05	1.82	1.86	1.45	2.16
Number of siblings									
0	1.56	1.84	1.31	1.36	2.21	1.33	1.38	1.33	1.45
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.28	1.43	1.23	1.09	1.93	1.01	1.03	0.86	1.17
3+	1.34	1.12	0.89	0.91	2.63	1.53	0.96	0.95	0.97
Birth cohort									
1956-1960	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1961-1965	0.94	0.81	0.84	0.94	0.85	1.28	0.79	0.77	0.80
1966-1970	0.77	0.67	1.53	0.19	0.62	1.15	0.94	1.13	0.81
# deaths in unweighted sample	639	120	105	112	141	161	250	116	134

An underlined parameter means that a 95% confidence interval does not include 1.00.
Other causes for women refer to all other causes of death except codes 1-26 and 31-40.

Table 5. Relative mortality risks for main causes of death in ages 35-48 years; Population group, Birth region, Social background and Own social status

	MEN						WOMEN		
	All causes	Alcohol-related	Cardio-vascular	Other diseases	Suicides	Other external	All causes	Other diseases	Other causes
Population group + Birth region									
Swedish speaker in Coastal area	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Finnish speaker in Coastal area	1.63	2.65	2.94	1.74	1.43	0.82	0.79	0.48	3.01
Finnish speaker in Western Finland	1.74	2.22	2.08	2.06	1.34	1.52	1.31	0.65	5.95
Finnish speaker in Northern Finland	2.05	2.70	3.95	1.82	2.08	1.25	1.25	0.73	4.91
Finnish speaker in Eastern Finland	2.24	3.91	3.00	1.55	2.28	1.58	1.35	0.54	7.02
Swedish speaker in Helsinki area	1.90	5.44	0.88	2.02	2.62	0.56	0.83	0.44	3.65
Finnish speaker in Helsinki area	1.85	2.10	2.89	1.84	1.87	1.38	1.09	0.34	5.87
Socio-economic background									
Blue-collar worker	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lower-level white-collar worker	1.06	0.64	0.99	1.37	1.33	1.08	1.08	0.71	1.33
Upper-level white-collar worker	1.05	0.65	0.73	0.84	1.40	1.52	0.76	0.80	0.73
Self-employed	1.03	1.08	1.00	1.29	0.87	1.05	1.21	1.32	1.10
Other	0.88	0.62	0.82	1.22	1.17	0.75	1.39	1.75	1.20
Homeownership background									
Yes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
No	1.07	1.20	0.94	1.45	1.09	0.84	1.37	1.19	1.50
Family background									
Both parents	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
One parent and others	1.16	1.16	1.18	1.08	0.90	1.46	1.66	1.34	1.86
Number of siblings									
0	1.55	1.86	1.28	1.36	2.21	1.32	1.38	1.31	1.45
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.23	1.34	1.17	1.05	1.86	0.98	1.01	0.85	1.14
3+	1.17	0.91	0.80	0.81	2.32	1.34	0.91	0.91	0.90
Educational level									
Primary	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Secondary	0.63	0.56	0.66	0.50	0.74	0.68	0.70	0.67	0.74
Lowest tertiary	0.39	0.18	0.53	0.28	0.55	0.41	0.60	0.69	0.54
Lower-degree tertiary	0.25	0.14	0.14	0.43	0.04	0.46	0.51	0.52	0.49
Higher-degree tertiary	0.17	0.12	0.11	0.19	0.03	0.35	0.38	0.38	0.37
Marital status									
With partner	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Previously with partner	2.40	5.31	1.99	1.58	1.87	2.45	2.08	0.98	3.02
Never with partner	2.46	4.03	2.60	1.88	1.62	3.00	2.54	2.30	2.79
Unemployment experience									
None	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
At one census	1.44	1.53	1.13	1.10	1.90	1.53	1.71	1.43	1.93
At more than one census	2.44	4.18	1.20	1.64	2.04	3.23	1.53	1.36	1.67
Birth cohort									
1956-1960	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1961-1965	0.86	0.66	0.84	0.93	0.79	1.13	0.76	0.77	0.75
1966-1970	0.65	0.46	1.51	0.18	0.54	0.91	0.87	1.13	0.72
# deaths in unweighted sample	639	120	105	112	141	161	250	116	134

An underlined parameter means that a 95% confidence interval does not include 1.00.
Other causes for women refer to all other causes of death except codes 1-26 and 31-40.