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EFFECTS OF SOCIOECONOMIC STATUS AND SOCIODEMOGRAPHIC FEATURES ON CARDIOVASCULAR DISEASE MORTALITY AND MORBIDITY IN FINLAND

by

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To my family

ABSTRACT

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Effects of socioeconomic status and sociodemographic features on cardiovascular disease mortality and morbidity in Finland

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Despite declining trends in morbidity and mortality, cardiovascular diseases have a considerable impact on Finnish public health. A goal in Finnish health policy is to reduce inequalities in health and mortality among population groups. The aim of this study was to assess inequalities in cardiovascular diseases according to socioeconomic status (SES), language groups and other sociodemographic characteristics.

The main data source was generated from events in 35-99 year-old men and women registered in the population-based FINMONICA and FINAMI myocardial infarction registers during the years ranging from 1988-2002. Information on population group characteristics was obtained from Statistics Finland. Additional data were derived from the FINMONICA and FINSTROKE stroke registers and the FINRISK Study.

SES, measured by income level, was a major determinant of acute coronary syndrome (ACS) mortality. Among middle-aged men, the 28-day mortality rate of the lowest group of six income groups was 5.2 times and incidence 2.7 times as high when compared to the highest income group. Among women, the differences were even larger. Among the unmarried, the incidence of ACS was approximately 1.6 times as high and their prognosis was significantly worse than among married persons - both in men and women and independent of age. Higher age-standardized attack rates of ACS and stroke were found among Finnish-speaking compared to Swedish-speaking men in Turku and these differences could not be completely explained by SES. In these language groups, modest differences were found in traditional risk factor levels possibly explaining part of the found morbidity and mortality inequality.

In conclusion, there are considerable differences in the morbidity and mortality of ACS and stroke between socioeconomic and sociodemographic groups, in Finland. Focusing measures to reduce the excess morbidity and mortality, in groups at high risk, could decrease the economic burden of cardiovascular diseases and thus be an important public health goal in Finland.

Key words: cardiovascular disease, myocardial infarction, stroke, socioeconomic status, sociodemographic characteristics, Finland

TIIVISTELMÄ

Aino Lammintausta

Sosioekonomisen aseman ja sosiodemografisten tekijöiden vaikutus sydän- ja verisuonisairauksien kuolleisuuteen ja esiintyvyyteen Suomessa

Sisätautioppi, Turun yliopisto ja Tyks

Annales Universitatis Turkuensis, Medica-Odontologica, Turku, Suomi 2013.

Huolimatta laskevista sairastuvuus- ja kuolleisuustrendeistä, sydän- ja verisuonisairaudet ovat yhä merkittävä rasite Suomen kansanterveydelle. Yksi Suomen terveyspoliittinen tavoite on ollut pienentää väestöryhmien välisiä eroja terveydessä ja kuolleisuudessa. Tämän tutkimuksen tavoitteena oli tutkia väestöryhmittäisiä eroja sydän- ja verisuonisairauksien – erityisesti akuuttien sepelvaltimotapahtumien – sairastuvuudessa ja kuolleisuudessa Suomessa. Erityisesti pyrittiin selvittämään sosioekonomisen aseman, kieliryhmän ja muiden sosiodemografisten tekijöiden vaikutusta sydänsairastuvuuteen ja -kuolleisuuteen.

Pääasiallinen aineisto oli FINMONICA ja FINAMI -sydäninfarktirekistereihin vuosina 1988-2002 rekisteröidyt sepelvaltimotapahtumat 35-99 –vuotiailla naisilla ja miehillä. Tieto sosioekonomisista ja sosiodemografisista ominaisuuksista saatiin Tilastokeskuksesta. Lisäksi tutkimuksessa käytettiin FINMONICA- ja FINSTROKE- aivohalvausrekistereiden sekä FINRISKI-tutkimuksen tietoja.

Tuloluokka oli merkittävä akuuttien sepelvaltimotapahtumien kuolleisuuteen vaikuttava tekijä. Keski-ikäisillä alimman tulokuudenneksen miehillä kuolleisuus sepelvaltimotapahtumiin oli 5.2-kertaa ja ilmaantuvuus vastaavasti 2.7-kertaa suurempaa kuin ylimmän tulokuudenneksen miehillä. Naisilla erot olivat vielä suurempia. Naimattomilla sepelvaltimotapahtumien ilmaantuvuus oli noin 1.6-kertaa suurempaa ja ennuste huonompi sekä miehillä että naisilla iästä riippumatta. Suomenkielisillä miehillä oli suurempi ikävakioitu sepelvaltimotapahtumien ja aivohalvauksen esiintyvyys kuin ruotsinkielisillä miehillä Turussa. Erot eivät täysin selittyneet eroilla sosioekonomisessa asemassa. Perinteisten sydän- ja verisuonitautien riskitekijöiden tasoissa oli pieniä eroja kieliryhmien välillä, mikä voi osittain selittää eroja esiintyvyydessä ja kuolleisuudessa.

Tutkimus osoitti, että Suomessa on edelleen merkittäviä väestöryhmittäisiä eroja akuuttien sepelvaltimotapahtumien ja aivohalvauksen esiintymisessä ja kuolleisuudessa. Väestöryhmien väliset erot sydänterveydessä ovat edelleen terveyspoliittinen haaste Suomessa.

Avainsanat: sydän- ja verisuonitaudit, sydäninfarkti, aivoinfarkti, sosioekonominen asema, sosiodemografiset ominaisuudet, Suomi

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ABBREVIATIONS

ACS	acute coronary syndrome
AHA	American Heart Association
AMI	acute myocardial infarction
ASA	acetyl salicylic acid
BMI	body mass index
BP	blood pressure
CF	case fatality
CHD	coronary heart disease
CI	confidence interval
HDL	high-density lipoprotein
HR	hazard ratio
ICD	International Classification of Diseases
IHD	ischemic heart disease
LDL	low-density lipoprotein
MI	myocardial infarction
MONICA	MONItoring of trends and determinants of CArdiovascular disease
RR	Rate Ratio
SAH	subarachnoid hemorrhage
SES	socioeconomic status
WHO	World Health Organization

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original publications, which will be referred to in the text by the Roman numerals:

I. Lammintausta A, Immonen-Räihä P, Airaksinen J, Torppa J, Harald K, Ketonen M, Lehto S, Koukkunen H, Kesäniemi AY, Kärjä-Koskenkari P, Salomaa V and the FINAMI Study Group. Socioeconomic inequalities in the morbidity and mortality of acute coronary events in Finland: 1988 to 2002. *Ann Epidemiol*. 2012;22(2):87-93.

II. Lammintausta A, Airaksinen J, Immonen-Räihä P, Torppa J, Kesäniemi AY, Ketonen M, Koukkunen H, Kärjä-Koskenkari P, Lehto S, Salomaa V and the FINAMI Study Group. Prognosis of acute coronary events is worse in patients living alone: the FINAMI Myocardial Infarction Register Study. *Eur J Prev Cardiol*. Published online before print January 30, 2013. doi: 10.1177/2047487313475893

III. Lammintausta A, Lehtonen A, Immonen-Raiha P, Kaarisalo M, Torppa J, Airaksinen J, Salomaa V. Stroke morbidity in Swedish- and Finnish-speaking populations of Turku, Finland. *Scand Cardiovasc J*. 2009;43(2):117-22.

IV. Lammintausta A, Immonen-Räihä P, Lehtonen A, Räihä I, Harald K, Torppa J, Airaksinen J, Salomaa V. Myocardial infarction events and cardiovascular risk factor levels in Finnish- and Swedish-speaking populations of Finland. *Ann Med*. 2011;43(7):562-9.

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1. INTRODUCTION

Cardiovascular diseases are a serious health problem in developed countries. Coronary heart disease (CHD) and cerebrovascular diseases are the two leading causes of death globally (Lopez et al., 2006). Despite the declining trends observed in the incidence and mortality of both myocardial infarction (MI) (Pajunen et al., 2004), (Menotti et al., 2007), (Truelsen et al., 2003), (Salomaa et al., 2006) and stroke (Pajunen et al., 2005) in Finland, the impact of cardiovascular diseases on Finnish public health remains considerable.

The relationship between socioeconomic status (SES) and both mortality and health is well established (Antonovsky, 1967), (Townsend and Davidson, 1982). Knowledge pertaining to the contribution of different diseases related to socioeconomic inequalities has increased (Kunst et al., 1998), (Mackenbach et al., 1999), (van Rossum et al., 2000), (Huisman et al., 2005), (Dalstra et al., 2005). An inverse relationship of SES with morbidity and mortality, specifically from both MI (Salomaa et al., 2000), (Manderbacka et al., 2006), (Mackenbach et al., 2000), (Avendano et al., 2006), (Kivimäki et al., 2007), (Loucks et al., 2009), (Yarnell et al., 2005) and stroke, (Li et al., 2008), (Avendano et al., 2004), (Jakovljevic et al., 2001), (Jakovljevic et al., 2001) exists in many countries, including Finland. However, the socioeconomic gap in health and mortality is widening in Europe (Mackenbach et al., 2003), (White, Van Galen and Chow, 2003), (Palosuo et al., 2009). In fact, Tarkianen and colleagues show that the mortality gap between income groups widened also in Finland in the period 1988-2007 and that this was partly due to the slower decline in the rate of fatal coronary events in men in the lowest income groups (Tarkiainen et al., 2012). In both men and women, cardiovascular diseases account for the biggest proportion of the mortality inequalities between socioeconomic groups (Huisman et al., 2005).

Social relations and status associate with health and mortality. A variety of research shows lower mortality rates in married persons when compared to unmarried persons (Ben-Shlomo et al., 1993), (Kotler and Wingard, 1989), (Johnson et al., 2000). Data on the disparities in the prevalence of specific diseases according to sociodemographic characteristics in Finland is, however, obsolete and scarce.

The Swedish-speaking minority of Finland have a lower age-adjusted total mortality compared to the Finnish-speaking majority (Sipilä and Martikainen, 2009). However, more specific information on language-group differences in morbidity and mortality is lacking. Furthermore, information on the potential contribution of the better SES of the Swedish-speaking minority on mortality differences is not known.

A major goal of Finnish health policy is to reduce inequalities in health and mortality among different population groups in Finland (Valtioneuvoston periaatepäätös Terveys 2015 - kansanterveysohjelmasta, 2001). To achieve this goal, identification of which population groups are at a particular disadvantage and how inequalities develop must be ascertained. As cardiovascular diseases are major causes of death, it is important to study differences and trends in the morbidity and mortality of cardiovascular diseases in Finland, especially as reducing these could have an important impact on the public health burden.

The main objective of this thesis was to examine differences in cardiovascular disease morbidity and mortality occurring in various population groups in Finland. A focus on these, in language groups and according to socioeconomic status and sociodemographic characteristics, was defined. This was achieved based on FINMONICA and FINAMI MI Register data from years 1988-2002 and FINMONICA and FINSTROKE Stroke Register data from Turku in years 1988-1998. In addition, the population-based FINRISK Surveys conducted in years 1987, 1997 and 2002 provided information on cardiovascular risk factor levels according to language group.

2. REVIEW OF THE LITERATURE

2.1 Epidemiology of cardiovascular diseases in Finland

In the 1960's, Finland had the highest CHD mortality rates in the world. Since the 1970's, total cardiovascular disease mortality rates declined throughout Finland. Cardiovascular disease mortality decreased by over 60% from the late 1960's to the mid 1990's, owing to a decrease in both CHD mortality and cerebrovascular disease mortality (Puska et al., 1998). Furthermore, between 1972 and 2007, CHD mortality, in middle-aged men, declined by 80% (Vartiainen et al., 2010). In the study by Vartiainen et al., about 75% of this reduction in mortality accounted for improved risk factor levels. Until the mid 1980's, declining risk factor levels explained coronary mortality reduction, but this has later been swifter than predicted by the decreases in risk factor levels, owing partly to new treatments and invasive procedures (Laatikainen et al., 2005). However, in 2009, approximately 40% of deaths in Finland were still due to cardiovascular diseases with ischemic heart disease (IHD), the leading cause of death among men and women aged 65 or more (Statistics Finland, 2011).

In the late 1960's, stroke mortality rate was the highest in Finland compared to the rates in Western Europe (Tuomilehto et al., 1984). Stroke mortality and incidence declined in the latest decades (Sivenius et al., 2004) and Finland no longer has the highest stroke mortality rate (Sarti et al., 2000).

Although similar trends in cardiovascular mortality reduction occurred in most western countries from the 1970's to the late 2000's, the reductions observed in Finland are among the largest (Kesteloot, Sans and Kromhout, 2006). Nevertheless, socioeconomic disparities (according to educational level) in CHD mortality in Western European countries were most pronounced in the Nordic countries, including Finland, in the 1990's (Avendano et al., 2006), despite the fact that Finland has a government-subsidized health care system with a strong emphasis on egalitarian health care and wealth policies.

2.2 Risk factors for cardiovascular diseases

Atherosclerosis is a systemic disease affecting the large and medium-sized arteries in the systemic arterial tree. The risk factors of atherosclerosis, and thereby the risk factors of cardiovascular diseases, can be divided into modifiable and non-modifiable risk factors (age, gender, race and ethnicity, genetic factors).

The Global Case-Control Study of Risk Factors for Acute Myocardial Infarction-study indicated that nine modifiable risk factors (dyslipidemias, smoking, hypertension, diabetes, abdominal obesity, irregular consumption of fruits and vegetables, alcohol intake, physical inactivity and psychosocial factors) accounted for >90% of the risk for incident MI (Yusuf et al., 2004). A recent meta-analysis of 18 cohort studies, including both black and white men and women, further reinforced, not only the influence of traditional risk factors on the lifetime risk of cardiovascular disease, but also the importance of the prevention of developing risk factors rather than mere treatment of existing risk factors (Berry et al., 2012).

Socioeconomic and sociodemographic characteristics increase cardiovascular risk, but the mechanisms which cause this increase, are not fully known (Singh-Manoux et al., 2008), (Nielsen et al., 2006), (Empana et al., 2008). Traditional risk factors need to be considered when interpreting results on the disparities in cardiovascular health between population groups. The non-modifiable risk factors, SES, sociodemographic characteristics and official language can be used to identify persons at especially high risk for atherosclerosis and persons who may have the most benefit from treatment and control of the modifiable risk factors.

2.2.1 Modifiable risk factors

Dyslipidemias

Dyslipidemia is an abnormal concentration of lipids in the blood stream: high total cholesterol, high level of triglycerides, high level of low-density lipoprotein (LDL) cholesterol and/or low level of high-density lipoprotein (HDL) cholesterol. The hypothesis that serum cholesterol is an important determinant of CHD was formulated already in the 1950's and then confirmed by the analyses of the Seven Countries Study data (Karvonen et al., 1970). In the Seven Countries Study, marked differences in serum cholesterol distributions occurred and the average population cholesterol levels, associated positively with the incidence of CHD, after 5-years follow-up (Karvonen et al., 1970). Since then several studies link lipids and increased risk of CHD (*e.g.*) (Sharrett et al., 2001), (Wilson et al., 1998), IHD mortality (Lewington et al., 2007) and non-hemorrhagic stroke death (Iso et al., 1989). However, there may be an inverse association of serum cholesterol levels and hemorrhagic stroke (Iso et al., 1989). Furthermore, statins reduce the risk of both CHD and ischemic stroke without increasing the risk of intracranial hemorrhage (Amarenco et al., 2004).

The level of LDL-cholesterol correlates causally with cardiovascular disease risk (Ballantyne and Hoogeveen, 2003) and cardiovascular mortality, as the accumulation of oxidized LDL particles in the subendothelial matrix of arteries is an important step controlling the initiation of atherosclerosis. The most convincing evidence of a causal link between LDL-cholesterol and atherosclerosis resides in the results of the numerous controlled clinical trials of cholesterol lowering (*e.g.*) (Manninen et al., 1988), (Pedersen et al., 1998).

HDL-cholesterol, on the other hand, has an inverse association with the risk of CHD (Gordon et al., 1977), but this causal relationship remains unclear. There is evidence for a causal relationship between triglyceride-mediated pathways and CHD risk (Sarwar et al., 2010).

Hypertension

An association between arterial hypertension and risk of CHD exists (Kannel, Schwartz and McNamara, 1969). The relationship between blood pressure (BP) and subsequent complications is linear over a wide BP range and there is no clear threshold for the increased risk. Furthermore, hypertension connects with the risk of MI and cardiovascular death (Kannel, 1974) (O'Donnell et al., 1997).

A meta-analysis published in 2002, analyzing 61 prospective studies, showed that the relationship of stroke (all subtypes), mortality and BP is strong and linear (Lewington et al., 2002). This relationship is reinforced by the result that a genetic risk score, based on 29 genome-wide significant variants, associates with hypertension and both stroke and coronary artery disease. This may offer potential novel therapeutic pathways for cardiovascular disease prevention (Ehret et al., 2011).

Diabetes mellitus

The metabolic abnormalities that characterize type 2 diabetes (such as hyperglycemia, increased free fatty acids, and insulin resistance) induce atherosclerosis (Creager et al., 2003) and make diabetes an independent risk factor for cardiovascular diseases. Type 2 diabetes increases independently the risk of fatal and nonfatal CHD events and all stroke events twofold or even more compared to non-diabetic individuals (Kannel and McGee, 1979), (Stamler et al., 1993), (Sarwar et al., 2010). The results of a Finnish population-based study suggest that diabetic patients without previous MI have as high a risk of MI events as non-diabetic patients with previous MI (Haffner et al., 2001).

A high prevalence of, and mortality from, CHD in type 1 diabetes has been documented since the late 1970’s (Deckert, Poulsen and Larsen, 1978). In 1984, a registry study reported a 10-fold or greater CHD mortality in type 1 diabetics compared with that expected from U.S. national data (Dorman et al., 1984).

In addition, the CHD mortality risk is elevated among those classified as being glucose intolerant (Fuller et al., 1983), (Brunner et al., 2006), (Coutinho et al., 1999).

Obesity

Obesity, defined as a high body mass index (BMI), associates with a higher risk of CHD (Ajani et al., 2004), (Batty et al., 2006). A British study (Logue et al., 2011) found that obesity (in the Logue study, the BMI 30.0-39.9) associated with fatal, but not non-fatal, CHD after accounting for known cardiovascular risk factors and low SES, suggesting that obesity might have an independent role as a risk factor especially for fatal CHD. The Global Case-Control Study of Risk Factors for Acute Myocardial Infarction study investigators suggest, based on their multinational retrospective case-control study, that abdominal obesity measured by waist-to-hip ratio may be even more strongly associated with MI risk than BMI (Yusuf et al., 2005) but more recent analyses of 58 prospective studies have, in turn, shown that BMI, waist circumference, and waist-to-hip ratio each have a similar strength of association with cardiovascular disease risk (Wormser et al., 2011).

A high BMI increases the risk of ischemic and hemorrhagic strokes. A meta-analysis of prospective studies (2 million participants combined) reported of a 64% excess risk of ischemic stroke for obese and a 22% excess risk for overweight persons when compared with normal weight persons (Strazzullo et al., 2010). Paradoxically, obesity associates with improved short-term and long-term prognosis of stroke patients (Vemmos et al., 2011).

Smoking

In the 1970's, the British Medical Association reported a higher mortality, including cardiovascular mortality, among British doctors who smoked compared to doctors who do not smoke based on a study started in 1951 (Doll and Peto, 1976). In recent studies, smoking increases CHD risk and current smoking is associated with twofold or higher rates of acute myocardial infarction (AMI) compared to non-smokers (Teo et al., 2006), (Parish et al., 1995) and smoking cessation reduces the risk of CHD (Teo et al., 2006). Epidemiological studies indicate a dose-response relation between the number of cigarettes smoked per day and the risk of AMI (Teo et al., 2006).

Some studies report a higher risk of CHD in passive smokers (He et al., 1999), (Whincup et al., 2004). Results concerning the use of smokeless tobacco (snuff) and the risk of AMI are inconclusive with some studies linking snuff use with a higher risk of fatal AMI (Hergens et al., 2007) and some studies not supporting this finding (Janzon and Hedblad, 2009).

Several multivariate studies show that smoking approximately doubles the risk of stroke in a dose-response relationship. The connection is the strongest between smoking and ischemic stroke or subarachnoid hemorrhage (SAH). (Shinton and Beevers, 1989), (Goldstein et al., 2011)

Information on the effects of the novel nicotine delivery system, the “e-cigarette,” on cardiovascular risks is still lacking.

Physical inactivity

Regular physical activity is associated with lower rates of cardiovascular death and lower incidence of MI (Leon and Connett, 1991), (Lovasi et al., 2007), (Gillum, Mussolino and Ingram, 1996). Results of several longitudinal and cross-sectional studies show a similar association also for stroke (Gillum, Mussolino and Ingram, 1996), (O'Donnell et al., 2010). Results of a meta-analysis support this finding. A high level compared to low level leisure time physical activity protects against hemorrhagic stroke and ischemic stroke (Wendel-Vos et al., 2004). Vigorous exercise, on the other hand, has been associated with increased risk of sudden cardiac death (Siscovick et al., 1984) and it is a risk factor for SAH (Anderson et al., 2003).

Alcohol consumption

Light alcohol consumption protects from MI whilst binge drinking and heavy consumption of alcohol are risk factors for MI (Jackson, Scragg and Beaglehole, 1991), (McElduff and Dobson, 1997). The Prospective Epidemiological Study of Myocardial Infarction-study, for example, has found that the light alcohol consumption in French culture is protective against CHD whereas the heavy consumption in Irish culture increases this risk (Ruidavets et al., 2010). Heavy alcohol consumption and binge drinking are risk factors for both ischemic and hemorrhagic stroke (Iso et al., 2004), (Sundell et al., 2008).

Atrial fibrillation

Atrial fibrillation is a well known risk factor for ischemic stroke - mostly by cardioembolic mechanism (Hart et al., 2000). Besides the high attack rate of ischemic stroke, atrial fibrillation is linked with higher mortality rates of stroke and poorer neurological outcomes when compared to stroke-patients with no atrial fibrillation (Jorgensen et al., 1996).

Haemostatic factors, inflammation and infection

A number of circulating biomarkers that reflect inflammation, coagulation, impaired fibrinolysis, and increased blood viscosity are potential novel risk factors for the development of cardiovascular diseases (Smith et al., 2005), (Tzoulaki et al., 2007), (Libby et al., 2009). Studies suggest inflammation to be a regulatory process that links multiple risk factors for atherosclerosis and its complications with altered arterial biology. Countering these proinflammatory pathways may be a mechanism by which statins lower cardiovascular risk (Libby et al., 2009).

It has been proposed, that bacterial infections may play a role in the pathogenesis of coronary atherosclerosis (Mattila et al., 1993). Odds ratio analyses of a recent study indicated that among people with diabetes, periodontal infection may increase the likelihood of subclinical atherosclerotic heart disease and CHD (Southerland et al., 2012).

2.2.2 Non-modifiable risk factors

Age and Gender

Numerous studies show that the attack rates of AMI are greater among men than women (Lerner and Kannel, 1986), (Goldberg et al., 1993), (Tunstall-Pedoe et al., 1994). On average, women experience their first AMI 9 years later than men (Anand et al., 2008), as their risks increase after the menopause. The prevalence of obstructive CHD in women is, indeed, relatively low before the menopause (Lerner and Kannel, 1986), (Hochman et al., 1999). In general, comparable incidence rates are achieved for women who are 10 years older, so that the CHD rates of 55-year-old men are similar to that of 65-year-old women (Lerner and Kannel, 1986).

The risk of MI increases with advancing age in both genders (Goldberg et al., 1993), as does the risk of stroke (Manolio et al., 1996), (Shinton and Beevers, 1989). Men generally have higher age-adjusted incidence of stroke (all types) (Kissela et al., 2004), but in the oldest (age >85 years) and youngest age-groups, this incidence is higher among women (Kissela et al., 2004), (Sacco et al., 1998), (Goldstein et al., 2011).

The higher prevalence of cardiovascular diseases with increasing age is linked to other risk factors as long-term exposure to risk factors elevates the prevalence of atherosclerotic changes and, for example, the number of years lived with obesity is directly associated with cardiovascular disease mortality (Abdullah et al., 2011).

Ethnic characteristics

Canadian epidemiological studies show that, Canadians with a South Asian descent have a 45% to 50% higher proportional mortality from IHD, compared with patients of European descent, whereas Chinese patients have a 35% to 40% lower proportional mortality accordingly (Sheth et al., 1999). Results from the Global Case-Control Study of Risk Factors for Acute Myocardial Infarction-study indicated that people in South Asian countries also had a lower age at presentation of first AMI than people in other countries and this difference appeared to be largely explained by the higher prevalence of risk factors in native South Asians (Joshi et al., 2007). Conversely, in Canada, long-term-prognosis is improved among South-Asian in comparison to the white population (Khan et al., 2010). African-Americans, especially those under 65 years of age, have higher mortality rates of MI than the white population in the USA (Manhapra et al., 2004), (Jolly et al., 2010).

However, the population-based Multi-Ethnic Study of Atherosclerosis measured coronary calcification, as a marker for the presence and quantity of coronary atherosclerosis, in white, black, hispanic, and asian (Chinese) men and women with no clinical cardiovascular disease, using computed tomography (Bild et al., 2005). The study group found that, even after adjustment for coronary risk factors (also for education), the prevalence of coronary calcification was 22% and 15% lower, in blacks and Hispanics, respectively, than in whites, whereas in asian (Chinese), it was 8% lower than in whites.

Furthermore, American statistics show a higher incidence of strokes among black men and women compared to white men and women. At least part of this may be explained by the higher prevalence of traditional risk factors among the black population (Berry et al., 2012).

Genetic factors and family history

Twin studies and other epidemiological studies connect family history of early CHD with the risk of CHD and MI (Nora et al., 1980), (Marenberg et al., 1994), (Lloyd-Jones et al., 2004). Studies on the genetics of CHD and MI have identified more than twenty genetic loci related to CHD (Musunuru and Kathiresan, 2010), (Schunkert et al., 2011). However, these loci may explain only approximately 10% of the genetic risk of CHD and the majority of these loci seem to act through mechanisms that are independent of traditional risk factors (Schunkert et al., 2011). Furthermore, a multilocus genetic risk score, based on 13 single nucleotide polymorphisms from genome-wide association studies for MI and CHD, is linked to the first CHD event, with a relative risk estimate of 1.7 between the highest and lowest quintiles of genetic risk score in Finnish and Swedish people (Ripatti et al., 2010). Especially variants of 9p21 associate with the risk of CHD and MI (Helgadottir et al., 2007), (McPherson et al., 2007). A recent study linked these 9p21 variants to coronary disease *via* altered responses to inflammatory signaling (Harismendy et al., 2011).

A meta-analysis of cohort studies shows that a positive family history of stroke increases the risk of stroke by approximately 30%. Cardioembolic stroke appears to be the least heritable type of stroke compared with other ischemic stroke subtypes (Flossmann, Schulz and Rothwell, 2004). Specific genetic sequence variants, nonetheless, associate with ischemic stroke (Anderson et al., 2010), and also specifically with cardioembolic stroke (Gudbjartsson et al., 2009), (Lemmens et al., 2010). A positive family history is associated also with a higher risk of SAH, but the possible genetic mechanisms behind these associations are yet to be revealed (Kissela et al., 2002).

Recent epigenetic studies show that the gene-environment (for example: gene-diet) interactions influence the individual development of atherosclerotic diseases (Ordovás, Robertson and Cléirigh, 2011) and may explain part of the genetic risk for CHD not explained by the currently found loci.

2.3 Population groups and the risk of cardiovascular diseases

The population can be divided into groups according to many features, for example, by race, official language or social features. According to the World Health Organization's (WHO) definition, "the social determinants of health are the conditions in which people are born, grow, live, work and age. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels, which are themselves influenced by policy choices. The social determinants of health are mostly responsible for health inequities - the unfair and avoidable differences in health status seen within and between countries." In 2010, the WHO Regional Committee for Europe endorsed the development of a new European health policy, "Health 2020" and set up a European review of social determinants of health and the health divide according to social determinants (Jakab, 2011).

An important goal of the Finnish health policy is to reduce inequalities in health and mortality between various population groups (Valtioneuvoston periaatepäätös Terveys 2015 - kansanterveysohjelmasta, 2001). In Finland, since cardiovascular diseases are the major causes of death and morbidity, it is important to assess how differences in socioeconomic and sociodemographic features affect cardiovascular disease mortality and morbidity.

Here, we discuss the available information on the risk of cardiovascular diseases in the two official language groups of Finland and previous information from Finland and other Western countries on the risk of cardiovascular diseases in groups of different SES or sociodemographic characteristics.

2.3.1 Socioeconomic status

SES refers to an individual's relative position in the social hierarchy. A variety of approaches to the measurement of SES exist. Education, occupational level and income are the most used measures of SES. Each of these indicators measure various, often closely related aspects of SES, and may be relevant to different health outcomes at different stages in the life course (Galobardes et al., 2006).

The publication of the Black Report in Britain, in the beginning of the 1980's, was an important step for health inequality research (Townsend and Davidson, 1982) and had a major impact on the research and discussion about socioeconomic inequalities. It not only reported on occupational class mortality differences, but also offered an analysis of likely explanations for these differences and recommendations for further research and for a strategy to reduce the differences and their consequences.

Low SES (or “socioeconomic position” or “social status”) associates not only with higher total mortality (Stringhini et al., 2010), but also with increased risk of CHD death (Avendano et al., 2006), (Salomaa et al., 2000) and stroke death (Avendano et al. 2004) (Jakovljevic et al. 2001). An association with lower SES and higher incidence of CHD and stroke exists in many countries, including Finland. *E.g.* the Framingham Offspring Study from Boston linked education and occupation (Loucks et al., 2009), the European Prospective Epidemiological Study of Myocardial Infarction investigated education and unemployment status (Yarnell et al., 2005) and the Finnish research done by Silventoinen and colleagues linked education (Silventoinen et al., 2005) to CHD incidence. Furthermore, previous results of the FINMONICA MI Register linked both education and income to MI incidence (Salomaa et al., 2000). Li and colleagues connected income and occupation to stroke incidence in Sweden (Li et al., 2008) and Cesaroni and colleagues linked a combination SES index (education, occupation, home ownership, family composition and citizenship) to stroke incidence in Rome, Italy (Cesaroni et al., 2009). Furthermore, the FINMONICA Stroke register showed results from Finland regarding the association of income and education and not only ischemic stroke (Jakovljevic et al., 2001) but also SAH (Jakovljevic et al., 2001). Analyses on the previous FINMONICA MI Register data from years 1983-1992 has also revealed a higher case fatality (CF) (especially deaths before reaching the hospital – termed “prehospital” in this thesis) and poorer one-year prognosis in low income groups compared to higher income groups (Salomaa et al., 2001). However, no recent information on the trends or even more recent information on the magnitude of these socioeconomic disparities in MI morbidity or mortality exists.

SES-related variations in the prevalence of traditional cardiovascular risk factors are available but these differences explain only partly the socioeconomic differences in cardiovascular disease rates. A recent, large meta-analysis by Kerr et al. concluded a 50% decrease in additional risk of stroke for the lower SES group when adjusted for the cardiovascular risk factors (Kerr et al., 2011). Concerning CHD, the traditional risk factors have explained 14-31% of the socioeconomic differences in cardiac risk in recent studies (Singh-Manoux et al., 2008), (Lynch et al., 2006), (Kivimäki et al., 2007), (Harald et al., 2006). Recently published results from the Whitehall study, however, indicate that a population-wide, best-practice intervention would reduce the difference in CHD mortality between socioeconomic groups (measured here by occupational status) in the UK by 69% (Kivimäki et al., 2008). These studies suggest that low SES could be considered a modifiable risk factor for CHD and stroke, as the socioeconomic gap cannot fully be explained by inequalities in traditional risk factors.

Low SES, in childhood corresponds with adulthood risk factor status (Kivimäki et al., 2006) and CHD incidence (Kittleson et al., 2006) independent of adulthood SES. The Aberdeen Children of the 1950’s Study reported a connection between childhood SES and cardiovascular disease risk in adulthood, independent of intrauterine and childhood growth or educational attainment (Lawlor et al., 2006). Most studies use parental occupation as a measure of childhood SES (Galobardes et al., 2006).

Between 1991-1995, Finland suffered from a severe economic recession. Economic output declined and reached its lowest point in early 1993 with less than 90% output compared to that of 1990. Due to this recession, Finland's unemployment rate increased from 3.4% in 1990 to 18.4% in 1994. Manual workers were more susceptible to unemployment than non-manual workers and therefore it can be hypothesized that the socioeconomic differences in CHD mortality and morbidity may also have widened during the recession.

Measurement of socioeconomic status

Education is a measure of SES that takes into account the person's nonmaterial resources (*e.g.* knowledge and problem-solving skills). Education can be measured by years of education or the highest educational degree completed, but it is, nevertheless, easy to categorize and obtain and can be measured whether employed or unemployed. In addition, education is usually fixed after early adulthood, and therefore unlikely to be affected by possible poor health of adulthood. In some countries, possibly including Finland (Hakovirta and Rantalaiho, 2012), education can be influenced by family income and it is plausible that poor health in childhood could influence the amount or quality of education received. Furthermore, the mean level of education has risen in past decades and this has resulted in large birth cohort differences in levels of education. The value of education, as a measure of SES, may also differ in different population groups. For example, the mean income level of white adults is significantly higher than the mean income level of black adults with similar educational level in the USA (Braveman et al., 2005).

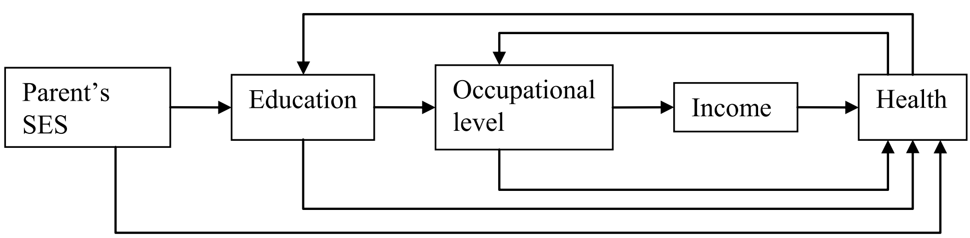
Occupational class is an important measure of status and prestige in modern societies and it reflects material conditions. It relates people to social structure. There are different approaches to the categorization of occupation: *e.g.* graded hierarchies according to prestige, skills or manual versus nonmanual work. All occupational measures, however, present challenges for classifying persons outside the labor force (*e.g.* housewives and the chronically ill). Furthermore, there are large birth cohort differences in occupational distributions. For example, the proportion of farmers is significantly smaller in Finland today than it was a few decades ago. Current occupation may be identified by previous disease and the measurement of both past and present occupation should possibly be preferred. For example, the Whitehall Study, originating from the 1960's, reports on CHD mortality inequalities, according to employment grade within an occupation (Marmot et al., 1978).

Income is an important measure of SES. Income provides material resources and determines purchasing power. Income contributes to resources needed to maintain good health (*e.g.* healthy food, physical exercise opportunities and medical care). It can be measured as individual income or household income. Income is, however, a measure considered sensitive and private and may therefore have a high nonresponse rate in surveys. Furthermore, as it reflects occupation, income may as well be influenced by previous disease. Therefore, the measurement of wealth could be preferred. Wealth – the long-term accumulation of material resources – can buffer the impact of temporarily low income. However, wealth is also often considered even more private than income and can, in addition, be laborious to calculate. Therefore, some studies have used such surrogate measures of wealth as car or home ownership as measures of SES (Wannamethee and Shaper, 1997).

Using a surrogate marker of SES (*e.g.* neighborhood-level SES) and area-based measures have been proposed as alternate indicators of SES in studies of individuals when individual-level measures are unavailable. Researchers from the USA analyzed the relation between area-level and individual-level indicators of SES (Diez-Roux et al., 2001). They found that, although area-level and individual-level SES measures were associated, there was evidence of significant heterogeneity in area of residence within individual-level income or education categories. Furthermore, regardless of their income or education, blacks participating in the studies were more likely to live in more disadvantaged areas than their white counterparts.

The measurement of SES is complex and multifactorial. All conventional measures of SES have a clear gradient, paralleling health, but parts of the effects of each of these indicators are explained through the other indicators of SES (Lahelma et al., 2004). The indicators of SES are interdependent, as demonstrated also in Figure 1. Nevertheless, most studies on SES and health (and cardiovascular diseases) have used only one marker of SES.

Figure 1. Pathways among the most widely used indicators of SES and health.



Explanations for the socioeconomic health difference

The Black Report introduced a typology for the explanations of socioeconomic health inequalities that still has major significance. It divided possible explanations into four main categories: artifact explanations, theories of natural/social selection, materialist/structural explanations and cultural/behavioral explanations.

The artifact explanation suggests that there is no real relationship between SES and health and that the observed inequalities are due to weaknesses in study design and data. Nowadays the socioeconomic health inequalities are, however, so widely reported that there is a consensus about their existence.

The theories on natural/social selection imply that health determines socioeconomic position in society or at least contributes to it. Health can impact SES directly or indirectly. Direct selection means that a person ends up in a certain social class based on his/her health status. Indirect selection means that some social or other factor related to health status influences the placement in a social class. An example of such factors is health behavior which affects one's health and thus influences SES.

The materialist/structural explanation emphasizes the role of physical and psychosocial features associated with SES in influencing health and contributing to observed socioeconomic gradients in health.

The cultural/behavioral explanations suggest that health damaging behaviors such as smoking are differentially distributed across socioeconomic groups and thus contribute to the observed differences and gradients in health. (Townsend and Davidson, 1982), (Macintyre, 1997)

2.3.2 Sociodemographic groups

The sociodemographic characteristics considered in this study include marital status and household size. British doctor William Farr was the first to report on this mortality disparity according to marital status in 1858.

The first published Finnish research on the protective effect of marriage from death originates from the 1970's. Koskenvuo et al. reported then on a 1.77–fold variation of IHD mortality rates by marital status in men. The highest mortality rate was found among divorced and the lowest among married men who also had better one-year prognosis and a smaller proportion of out-of hospital deaths (Koskenvuo et al., 1981). Another study conducted in North Karelia in the same decade concluded that unmarried men had over a twofold risk of death due to both CHD and stroke compared to married men (Salonen, 1982).

In other Western countries, similar results on CHD (Malyutina et al., 2004), (Engström et al., 2004), (Engström et al., 2006), (Gerward et al., 2010), (Venters et al., 1986) and stroke (Venters et al., 1986), (Engström et al., 2004), (Ohlgren et al., 2000) exist. A fairly recent study from the USA reported on a higher risk of sudden cardiac death for unmarried compared to married persons (Empana et al., 2008). The protective effect of marriage on CHD has, however, in some of these studies been more consistent among men than women (Malyutina et al., 2004), (Gerward et al., 2010). A Finnish study proposed that the male/female difference in CHD mortality rate according to marital status is even fourfold (Koskenvuo et al., 1986). Furthermore, the risk of CHD among never married women compared to married women also varies (Venters et al., 1986). Some differences have been found in cardiovascular risk factor levels according to marital status. The risk factor profiles favor mainly married men, but the results are variable (Venters et al., 1986), (Empana et al., 2008), (Molloy et al., 2009).

A Danish study by Nielsen et al. has reported that living alone is associated with a greater risk of incident ACS (Nielsen et al., 2006) and death during the first year after the onset of the attack (Nielsen et al., 2007) among 30-69 year old men and women. Similarly, living alone seems to be an independent risk factor for all-cause long-term mortality after MI, especially for men (Nielsen and Mard, 2010), (Schmaltz et al., 2007).

It has been suggested, that the relationship between marital status and health can be formed by two different mechanisms: direct or indirect selection or there may be a causal relationship. In direct selection, people with poor health do not get married or get divorced and, in indirect selection, the people with poorer lifestyle (*e.g.* high alcohol consumption) do not find a partner or find it harder to maintain a stable relationship (Martikainen et al., 2005). Causal mechanisms explaining are based on three different models. According to the marital resource model, marriage provides social, psychological, and economic resources that in turn promote physical health and longevity. The stress model suggests that the strains of marital dissolution undermine the health of the divorced, the separated, and the widowed, which in turn leads to marital status differences in health. The convergence model suggests that health differentials between the married and other marital groups have narrowed as the population and its norms have changed over time. (Liu and Umberson, 2008)

Previous Finnish studies on the effect of marital status on the morbidity and mortality of MI are obsolete and the rates of CHD show a decreasing trend. Furthermore, the composition of marital status has changed as divorces have become more common. The effect of household size on morbidity and mortality and information on the effect of these sociodemographic characteristics on the prognosis of MI in Finland is lacking.

2.3.3 Language groups in Finland

Different ethnic groups are predisposed to develop cardiovascular diseases at different rates giving rise to a higher prevalence of these diseases in certain populations. Significant differences, for example, in the presence and severity of coronary calcification (as a marker of coronary atherosclerosis) according to ethnicity occur in countries with a diverse population (Bild et al., 2005).

Despite belonging to the same ethnic group, previous Finnish epidemiological health surveys demonstrate not only lower total mortality but also lower total cardiovascular mortality among the Swedish-speaking minority compared to the Finnish-speaking majority (Valkonen, 1982), (Näyhä, 1989), (Sipilä and Martikainen, 2009). Mortality differences between the language groups have not been studied in more detail. Published data on morbidity differences is almost nonexistent. This information is crucial if the mortality of the Finnish-speaking majority is desired to approximate the mortality of the Swedish-speaking minority.

Until the early nineteenth century Finland and Sweden together comprised the Kingdom of Sweden. Swedish was the only official language of this country and the language of the nobility, administration and education. It was as late as 1892 that Finnish became one of the country's official languages, equal to Swedish. Nowadays, Finland is an officially bilingual country with a Swedish-speaking minority of less than 6% of the total population. This minority lives mainly in the western coastal regions and the Helsinki metropolitan area. Besides lower total mortality, the position of this Swedish-speaking minority is also in many other respects very unique, possibly affecting their health. They are an integral part of Finnish culture but in many realms of life (schools, mass media, organizations, religion, *etc.*) they have their own institutions and in addition a better SES than the Finnish speaking majority (Saarela and Finnäs, 2003), (Saarela and Finnäs, 2004). It seems, in fact, that this unique minority cannot quite be compared to any other language group or minority of western countries.

Improved health in the Swedish-speaking minority may be due to several factors. The structural explanation model suggests that the low mortality among the Swedish-speaking minority may be due to a favorable population structure with regard to sociodemographic or socioeconomic factors. The cultural hypothesis suggests that being a member of a linguistic group affects several aspects of one's social environment and cultural habits which impact overall health. Additionally, psychosocial factors, such as social support, may differ between language groups. The genetic explanation model suggests that genetic characteristics produce mortality differences. (Koskinen and Martelin, 2003)

3. AIMS OF THE STUDY

The aims of this study were:

I. To assess socioeconomic differences in ACS morbidity and mortality in Finland and the impact on these by the 1990's economic recession.

II. To study ACS morbidity and prognosis among sociodemographic groups (according to marital status and household size) in Finland.

III. To determine if differences in stroke and ACS morbidity and mortality or in the levels of the traditional cardiovascular risk factors exist between the Swedish- and Finnish-speaking people in Turku, Finland.

IV. To examine if variations in cardiovascular morbidity and mortality, between the two language groups, can be explained by variations in SES.

4. MATERIAL AND METHODS

4.1 The FINMONICA and FINAMI Myocardial Infarction Registers (Studies I, II, IV)

The FINMONICA MI Register was the Finnish contribution to the MI registers of the WHO MONICA (multinational MONItoring of trends and determinants of CArdiovascular disease) Project. The 10-year period of the FINMONICA Project covered the years 1983 to 1992. The monitored areas were the provinces of North Karelia and Kuopio in eastern Finland and the Turku/Loimaa area in southwestern Finland.

The FINAMI MI Register has continued the work of the FINMONICA MI register since year 1993, with comparable data collection procedures. The main difference is that during the FINMONICA project, the upper age limit of registration was 64 years. This was removed in 1993. The FINAMI register study aims to evaluate all suspected MI events among the 35-99 year-old permanent residents of four geographical areas in Finland. The geographical areas, where the register operated in 1993-2002, were the town of Turku in southwestern Finland, the town of Kuopio in eastern Finland, the town of Joensuu and some surrounding rural areas in the former province of North Karelia (Ilomantsi, Juuka and Lieksa) and the town of Oulu in northwestern Finland. The combined population aged ≥35 of the FINAMI areas was ~233,000 in the period 1993-2002.

Trained nurses, together with register physicians, collected the information from hospital documents, death certificates, autopsy reports, and medico-legal documents, using standardized data collection protocols. Sources of case finding were the hospital admission and discharge diagnoses and death certificates of each area. The local registration teams sent the collected data to the coordinating centre at the National Institute for Health and Welfare in Helsinki, where the data were checked for logical errors. The data were further cross-checked, annually, for completeness with the National Causes of Death Register and the National Hospital Discharge register. These registers cover all deaths of Finnish residents and every personal hospitalization event in Finland. International Classification for Diseases (ICD)-9 codes 410–414 and 798, and ICD-10 codes I20-I25, R96, R98, I46.1, and I46.9 were used for cross-checking with the National Causes of Death Register. ICD-9 was used in Finland until the end of 1995 and ICD-10 thereafter. Events identified by cross-checking and not included in the register were sent back to the local registration teams, which retrieved the necessary documents and evaluated the event for possible inclusion in the register.

The events were classified using a computerized algorithm on the basis of symptoms, electrocardiogram, biomarker findings and possible autopsy results as suggested in the American Heart Association (AHA) Scientific Statement of 2003 (Luepker et al., 2003). All the register data used in this study, regardless of registration year, was classified according to AHA 2003 criteria. Definite, probable, and possible fatal and non-fatal MI events were included in the study. The time period of one event was 28 days, during which the most severe findings were recorded. The biomarkers used in each case were determined according to the usual practices of the hospital in question. The values of the troponins were classified as diagnostic, normal, or missing on the basis of the limits given by the hospital's laboratory. The local register physician evaluated the relevance of troponin elevations using all available clinical information. If the troponin value was considered non-relevant, it was recorded as missing. The other biomarkers were classified according to the recommendations of the AHA statement mentioned above (Luepker et al., 2003).

The event was considered incident if there was no indication of a previous, clinically recognized MI in the patient's history. Attack rate was defined as the sum of first and recurrent MI events. Information on 28-day deaths was collected as part of the FINAMI register. Deaths, during the rest of the 1-year follow-up, were identified through the National Causes of Death Register. Information on treatment-seeking time was collected only until year 1998.

MI morbidity and mortality data according to language group in the bilingual town of Turku (Study IV) comprises the MI events occurring in persons aged 35 to 99 years who had permanent residence in Turku during the eleven-year period of 1988-1998. The data of the first five years of the report originate from the FINMONICA MI register and data of the last six years originate from the FINAMI MI register. In the FINMONICA MI register events among persons aged <65 years were recorded, as mentioned previously. In years 1993 and 1994, events among persons aged <75 years were recorded in Turku. In years 1995-1997, all events, among persons aged 35 to 99 years, were recorded. In 1998, all events were recorded in persons aged 35 to 75 years and in persons aged >75 years events were recorded for those whose birthday was an odd number.

Studies I and II comprise the whole FINAMI MI register data of years 1993-2002. Oulu collected data for the years 1993, 1997, 1999, 2001 and 2002. Regarding other register areas, data was available for the whole 10-year period except for Turku for the year 1999 and Kuopio for the year 1998. No registration was done in the rural areas of Ilomantsi, Lieksa and Juuka in 1998-1999. Events in persons aged ≥75 years old were registered consistently from the year 1995 onwards. However, as mentioned previously, Turku recorded events in persons aged >75 years only from those whose birthday was an odd number in 1998, 2000, 2001 and 2002. The final number of events in this age group in Turku was obtained by multiplying the registered numbers by two. Previous data from years 1988-1992 (Salomaa et al., 2000) was used in some of the analyses, to get a clearer view on the trends in event rates. For clarification, the registration areas and registered age-groups of the FINMONICA (1988-1992) and FINAMI (1993-2002) MI registers in years 1988-2002 can be seen in Table 1.

The FINMONICA and FINAMI studies have been approved by the Ethical Committee of the National Public Health Institute and the studies were carried out according to the principles outlined in the Declaration of Helsinki.

Table 1. The registration areas and registered age-groups of the FINMONICA (1988-1992) and FINAMI (1993-2002) MI registers in years 1988-2002 used as data in the analyses.

	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Joensuu	35-64	35-64	35-64	35-64	35-64	35-74	35-74	35-99	35-88	35-99	35-99	35-99	35-99	35-99	35-99
Juuka, Ilomantsi, Lieksa	35-64	35-64	35-64	35-64	35-64	35-74	35-74	35-99	35-99	35-99			35-99	35-99	35-99
Kuopio	35-64	35-64	35-64	35-64	35-64	35-99	35-99	35-99	35-99	35-99		35-99	35-99	35-99	35-99
Oulu						35-99				35-99		35-99		35-99	35-99
Turku	35-64	35-64	35-64	35-64	35-64	35-74	35-74	35-99	35-99	35-99	35-99*		35-99*	35-99*	35-99*

* events in persons aged >75 years only from those whose birthday was an odd number

4.2 The FINMONICA and FINSTROKE Stroke Registers (Study III)

Stroke morbidity and mortality was studied according to language group in the citizens of Turku in 1988-1998 from the data of the FINMONICA and FINSTROKE stroke registers (Study III). The FINMONICA stroke register operated from 1983 to 1992. The investigators, together with the National Public Health Institute, decided to continue the register under the name FINSTROKE from 1993 to 1998 in Turku (and the town of Kuopio) according to the same registration principles.

The main sources of information for the registration of stroke events in the stroke register were admission diagnoses to the hospitals and wards of health centers; diagnosis from hospital discharge records and from death certificates were also checked routinely. All patients with symptoms and signs suggesting acute cerebrovascular disease, aged 25 to 74 years, and permanently residing in Turku, were evaluated for the registration. Events occurring in persons aged ≥ 75 years were also recorded in 1988-1992 and 1996-1998. The data were collected and coded by nurses trained specially for the registration of stroke events. After 28 days from the onset of the attack, the stroke record form was filled in for information concerning the 28-day attack period. For fatal cases, the causes of death, duration of survival, and possible autopsy findings were recorded. Finally, the local stroke-register physician checked the forms and assigned the diagnostic category of stroke and the type of stroke according to the criteria of the WHO MONICA study. During the entire registration period, all cases within each area were reviewed and classified by one physician only. The physicians of the registration areas met regularly to discuss coding problematics and other topics to make sure that the coding practices among them were consistent. At the National Public Health Institute, the stroke register data were annually cross-checked with the computerized National Death Register for completeness. Routine stroke mortality data (ICD-8 and -9, codes 430 through 438) were obtained from the National Statistical Office after the underlying cause of death was established.

According to the definition of the WHO MONICA project, the diagnosis of stroke was based on "sudden onset of clinical signs of focal or global disturbance of cerebral function lasting more than 24 hours (except in cases of sudden death or if the development of symptoms is interrupted by a surgical intervention) with no apparent cause other than a vascular origin." Stroke was classified as a first-ever event if there was no evidence of a previous stroke event in the patient's history. If the patient suffered from another acute cerebrovascular attack within 28 days from the onset of the first event, the recurrent attack was considered to belong to the same event. If the first episode had occurred more than 28 days before the onset of the new attack, the event was classified as recurrent stroke and a new register form was filled in.

Each event was assigned to one of the three diagnostic categories by the local physician: definite stroke, no stroke or unclassifiable. The category unclassifiable was used for fatal events, especially for cases of sudden death without necropsy but sometimes also for suspected stroke cases with insufficient supporting evidence of stroke for which the diagnosis of stroke could not be entirely excluded. Nonfatal events could be classified into this category if it was impossible to say whether the symptoms were from stroke or some other disease or whether the patients had symptoms and/or clinical findings otherwise typical of a stroke but for which information on duration was not available. Because the category of insufficient information represented less than 1% of all registered events, events classified as definite stroke and unclassifiable were both included in the calculation of rates. A computed tomography scan was performed for over 80% of the patients aged 25-74 years and for nearly 60% of those aged 75 years or more. In addition, an MRI was performed for 22% of the youngest, 25-54 year-old patients, but to a lesser degree for the older.

The current data comprises all registered stroke events occurring in persons aged 25 years or more in 1988-1998 with a permanent residence in Turku.

One -and 5 –year case fatalities (CF) were identified by record linkage of the stroke register data with the National Causes of Death Register.

Turku has a population of 175,000 inhabitants. During our study period the average 25-99 year-old population living in Turku included 110,323 Finnish-speaking people (49,673 men and 60,650 women) and 6,047 Swedish-speaking people (2,778 men and 3,269 women).

The FINMONICA and FINSTROKE studies have been approved by the Ethical Committee of the National Public Health Institute and the studies were carried out according to the principles outlined in the Declaration of Helsinki.

4.3 The FINRISK Study (Study IV)

Because the numbers of Swedish-speaking participants in FINMONICA/FINAMI MI Register Studies were limited, statistical power was insufficient for thorough prospective cohort analyses on risk factors and MI events. Therefore, data from the FINRISK surveys was used to study differences in cardiovascular risk factor levels in the two language groups.

The FINRISK data used in Study IV comprises of people aged 25-74 years living in the Turku/Loimaa-area or the Helsinki metropolitan area (consisting of the cities of Helsinki and Vantaa) and participating in the FINRISK survey in years: 1987, 1997 or 2002. Data from year

1992 was not included, because no information on official language had been incorporated in that year's analyses. Only people aged 25-64 years participated in the study in 1987. The Helsinki metropolitan area did not yet participate in the study in 1987. Thereby, a total of 9,913 Finnish-speaking and 519 Swedish-speaking people participated in the FINRISK study in areas included in these analyses.

For each survey, an independent random sample was drawn from the national population register. Since 1982, the survey methodology has closely followed the WHO MONICA protocol (WHO Monica Project Principal Investigators, 1988). In the 2002 survey, some more detailed recommendations of the European Health Risk Monitoring project were adopted (Tolonen et al. 2002). The study protocol for the FINRISK surveys included a questionnaire on health behavior (smoking, use of alcohol, eating habits and physical exercise) and a personal health examination including measurements of blood pressure, height, weight and total serum cholesterol.

The questionnaire, together with the invitation to the health examination, was sent by mail to all the selected subjects. Participants were asked to fill in the questionnaire and bring it to the survey site where the health examination was performed. If a person did not appear at the survey site, he/she was contacted by phone to provide a new survey date. Physical measurements and blood sampling were carried out in local health centers or other survey sites by specially trained nurses.

BP was measured by the mercury sphygmomanometer in all surveys. The cuff length was 40-cm. Measurements were made from the right arm of the subject in sitting position. Before the measurements, the participant was requested to rest for at least 5 minutes. The first phase of Korotkoff sounds was recorded as systolic BP and the fifth phase as diastolic BP.

The venous blood samples were centrifuged in the field survey sites and the sera were mailed daily for cholesterol measurements to the laboratory of the National Public Health Institute. The analyses were carried out using an enzymatic method. The laboratory in the National Public Health Institute has taken part in both national and international quality assurance systems first with WHO centre in Prague and last two surveys with the Center for Disease Control in Atlanta.

Weight and height were measured by trained nurses according to a standardized protocol. Smoking was assessed in the questionnaire and those subjects who were currently smoking (cigarettes, cigars or pipe) were classified as smokers. Alcohol consumption was asked in the questionnaire as the number of alcoholic drinks consumed during the preceding week and the results were expressed as grams of alcohol. The proportion of heavy users (average daily alcohol consumption of ≥ 3 alcohol portions in men or ≥ 2 alcohol portions in women, when one alcohol portion = 12 g of pure alcohol) was assessed. The FINRISK questionnaire included a question: "Has a doctor ever told you that you have diabetes or latent diabetes?" People, who answered "yes" to one of these, were considered diabetic in the analysis.

The surveys were approved by the ethics committee, conducted according to the ethical rules of the National Public Health Institute and carried out in accordance with the Declaration of Helsinki.

4.4 The indicators of population group

Individual level data on the indicators of SES (taxable income, profession and education), sociodemographic characteristics (marital status and household size) and native language were obtained by record linkage of the FINMONICA, FINAMI and FINSTROKE register data with the files of Statistics Finland on the basis of the personal identification number. Corresponding information on the indicators of SES, marital status and native language was obtained also for the background population to be used in the denominators. Information on household size was not available for the background population. The closest records of the patient's indicators of SES and sociodemographic characteristics before the first event were used. In the FINRISK Study, information on native language was obtained from the Population Register Center when the random sample was drawn in order to send the questionnaire in the person's native language. In the FINRISK Study, information on the indicators of SES was also obtained from the files of Statistics Finland as described above.

Taxable income consists of wages, capital income and taxable income transfers and excludes some non-taxable transfers such as child benefits and certain housing allowances. For the analyses, income data were adjusted for inflation and classified into six categories. In some of the analyses these categories were combined to form three broad categories: low, middle and high. In Study I, the highest and the lowest tertiles were further divided to two groups to create five income categories with 17%, 17%, 33%, 17% and 17% of inhabitants in them, where the yearly income cutpoints for these five categories were 9,000 €, 13,000 €, 20,000 € and 26,000 €, converted to the monetary value of the year 2000. The same income categories were used for men and women but for the age group $\geq$60 years, 20% lower values were used.

Data on profession was divided into five groups: higher-level white-collar; lower-level white-collar; entrepreneurs/farmers; blue-collars; and others (mainly students and unemployed persons) (Tilastokeskus, 1989). In some analyses, these groups were combined to form three broad categories: blue-collar, white-collar and others (mainly students and unemployed persons). For retired persons, earlier profession was used.

Furthermore, education was stratified into four categories: basic (≤ 9 years of full-time education), vocational school, upper secondary school and academic. The three last categories combined formed the group secondary or higher education (> 9 years of full-time education). In some of the analyses, the groups: basic, middle (9-12 years of full-time education, *i.e.* vocational school or upper secondary school) and higher education (>12 years of full-time education) were used.

Marital status was divided into two categories: married and unmarried. The latter was further divided into two subcategories: previously married (divorced or widowed) and never married. Moreover, the data was divided into three categories on the basis of household size: >2 people living in household, 2 people living in household or living alone.

Information on the indicators of SES was otherwise 100% complete but for the year 2002, data on earlier profession was not available for a large proportion of retired individuals. In study I, the year 2002 was excluded from the analyses done according to profession. Accordingly, in analyses on profession the last study year was 2001 and the numbers were correspondingly slightly smaller than for the other SES indicators. Information on marital status was not available for 32 events of the total events in 1993-2002 and these events were excluded from the analyses on marital status in Study II.

The distribution of the background population of FINAMI areas by age group, sex, study area and the socioeconomic indicators and marital status is presented in Table 2 (corresponding to the situation in year 1996).

Annual population counts in each language group were obtained from the National Population Information System.

In the FINRISK data, SES was measured by household income level and education level. Income was defined as total household income per year and adjusted for family size using the OECD (Organisation for Economic Co-operation and Development) equivalence scale (Organisation for Economic Co-Operation and Development, 1982), where the first adult in the household was weighted as 1.0, other adults as 0.7 and children under 18 years old as 0.5.

Table 2. Populations (n or %) of the FINAMI areas by age, sex, study area and indicators of socioeconomic status and marital status (H-L= Higher level, L-L= lower-level). (Corresponding to the situation in 1996)

		Men							Women						
		Age group			Study area				Age group			Study area			
		35-64	65-74	75-99	Turku	Kuopio	Joensuu	Oulu	35-64	65-74	75-99	Turku	Kuopio	Joensuu	Oulu
Number		83340	14434	7073	40079	19677	21237	23854	87753	22356	18331	51344	24245	24267	28584
Income (%)	Low	26	10	19	20	23	33	22	27	15	33	23	25	34	23
	Middle	31	27	34	30	32	34	30	33	32	34	33	33	33	32
	High	42	63	47	50	45	33	48	41	53	33	45	42	33	45
Education(%)	Academic	15	10	10	15	14	10	17	12	6	5	10	9	7	11
	Upper secondary	13	8	8	11	14	10	13	16	5	6	11	15	10	14
	Vocational	35	11	10	29	31	31	30	35	14	11	25	32	31	29
	Basic	37	70	72	44	41	49	40	37	75	81	54	53	52	46
Profession (%)	Entrepreneur	9	7	7	8	9	9	9	5	5	6	6	5	5	5
	Farmer	2	6	13	1	4	10	1	2	6	10	1	4	12	2
	H-L white-collar	19	14	13	19	19	12	22	15	10	9	13	13	10	15
	L-L white-collar	20	18	21	20	21	18	21	48	32	27	41	45	38	45
	Blue collar	47	52	48	49	46	50	46	29	45	44	37	31	33	32
	Other	2	2	2	2	1	2	2	2	2	5	3	2	2	2
Marital status (%)	Never married	26	8	5	21	20	24	22	20	11	13	18	18	15	18
	Married	59	75	72	62	66	62	64	60	53	26	50	55	56	56
	Widower	14	17	24	17	14	14	14	20	36	61	32	27	29	26

4.5 Statistical methods

The data of all four FINAMI study areas were pooled for the analyses of Study I and II. The data of all analyses was divided into three age-groups: the 35-64 year-olds, the 65-74 year-olds and the 75-99 year-olds.

Incidence, attack rates and mortality rates were expressed per 100,000 inhabitants of each population group per year, calculated for each age-group separately and age-standardized to the European standard population (Waterhouse, Muir and Correa, 1976). 95% confidence intervals (CI) for the rates were calculated using normal approximation of the Poisson distribution for the number of events in different age groups.

The methods of the earlier registration period 1988-1992 (Salomaa et al. 2000) were essentially the same as from the year 1993 onwards. The rates were fairly stable and no smoothing was used in the trend analyses. The trends in event rates in 1988-2002 by socioeconomic or marital status were determined for 35-64 year-old men and women using Poisson regression analysis with the natural logarithm of age-standardized rate as the dependent variable and the year as an independent variable. The regression coefficient of year multiplied by 100 gave the average annual change in percents. The 95% CIs of these trend estimates were calculated from the standard error of the regression coefficient. Changes in socioeconomic differences over time were tested using interaction terms between the socioeconomic category and the study year. To further test the changes in socioeconomic differences over time, the 15-year study period 1988 – 2002 was divided into three 5-year periods, 1988-1992, 1993-1997 and 1998-2002, describing the time periods before, during and after the economic recession, respectively. The town of Oulu was excluded from these analyses because no data was collected there before year 1993. Data from the five-year period of 1988-1992 (Salomaa et al. 2000) included data on only 35-64 year-old men and women and therefore data on older age-groups are not included in the trend analyses.

Poisson regression analysis was used for computing rate ratios (RR) and 95% CIs of incident and recurrent ACS events and ACS deaths in the lower income sixths compared with the highest income sixth, taking the event year and study area into account. Age-standardized RRs comparing the ACS attack rates of the Swedish-speaking inhabitants with those of the Finnish-speaking inhabitants and RRs comparing the attack rates of ischemic and hemorrhagic strokes in Swedish-speaking inhabitants with those in Finnish-speaking inhabitants and 95% CIs for these ratios were also computed similarly. These comparisons were adjusted for study year and the indicators of SES as follows: study year only (model A), study year and taxable income (model B), study year and education (model C), study year and profession (model D).

CF was determined as the proportion of fatal events of all events at different time points (before hospital, on the first day, 28 days and one year after the onset of the event). The CF proportions of the three age groups were age-standardized with the direct method and the distribution of MONICA events as the standard (Tunstall-Pedoe et al., 1999). CF proportions, at mentioned time points, were calculated according to the sociodemographic characteristics for Study II. For Study III and Study IV, 28-day CF proportions of stroke and MI patients were calculated accordingly. The 95% CIs for all the CF proportions were calculated on the basis of normal approximation of the binomial distribution for the number of deaths.

For Study III, the 1-year and 5-year prognoses after the stroke event were estimated by using Cox proportional hazards regression analyses. The Swedish-speaking population was the reference category and the Finnish-speaking were compared with them.

The proportion of ACS patients with a treatment-seeking time of less than 4 hours was assessed from the number all patients reaching the hospital alive in 1993-1998 and the proportion of patients undergoing revascularization (percutaneous angioplasty or coronary bypass surgery) from the number of patients reaching the hospital alive in 1993-2002. The proportion of patients receiving thrombolysis was assessed from the number of all events in 1993-2002. To minimize confounding factors, the proportion of patients with a treatment-seeking time of less than four hours and proportions of patients receiving thrombolysis or early revascularization were assessed only for those aged 35-64–years at the time of the event.

The characteristics of the stroke patients [proportions of first stroke, history of MI, diabetes, history of hypertension, current smoking, history of atrial fibrillation, the usage of acetyl salicylic acid (ASA), type of work, income tertile and education] were also age-standardized to the European standard population. The 95% CIs were calculated using the normal approximation of Poisson distribution for the number characteristics in the different age groups.

The average values for total cholesterol, HDL-cholesterol, triglycerides, systolic BP, diastolic BP and BMI as well as the proportions of heavy alcohol users, smokers and diabetic persons were calculated for the Finnish- and Swedish-speaking FINRISK participants. Differences between the language groups were tested using analysis of covariance for continuous variables and log-linear models for categorical variables.

P values under 0.05 were considered statistically significant. The statistical analyses were carried out using the SAS software, version 8 (SAS Institute Inc, Cary; NC; USA).

5. RESULTS

5.1 Socioeconomic status and acute coronary events (I)

The data of Study I comprised of a total of 15,374 acute coronary events registered in years 1993-2002. These events are shown according to the indicators of SES in Table 2 in Study I.

The incidence rates of acute coronary events showed significant socioeconomic differences in all age groups. The SES differences in incidence were largest in the youngest age groups of 35-64 year-old men and women, where the incidence got lower by higher income group and education. In the youngest age group, men in a higher-level white-collar profession had a lower incidence than men in other profession groups and women in lower- or higher-level white-collar professions had a lower incidence than women in blue-collar professions. The relative variations between the income- and education groups became smaller by age but remained significant among men even in the highest age group of 75-99 years. However, when profession was used as the indicator of SES, the differences in incidence between men in blue-collar professions and upper-level white collar professions were no longer significant after the age of 75 years. Among women, no significant difference between the two education groups existed in the highest age group of 75-99 years. The incidence rates of acute coronary events are shown by age group and SES indicators in Table 3 of Study I.

Similarly, in all age groups, the 28-day mortality rates of acute coronary events showed significant differences. Among socioeconomic groups, these differences were largest in the youngest age group, with 28-day mortality rates favoring 35-64 year-old men and women with higher income, secondary or higher education or a white-collar profession in comparison to a blue-collar profession. The variation between higher-level white-collar females and blue-collar females aged 65-74 years was nonsignificant as the 95% CIs were wide. Similarly, as in incidence rates previously, differences according to profession were not significant among 74-99 year-old men and the differences according to education were not significant among 74-99 year-old women. The 28-day mortality rates are presented by age group and the indicators of SES in Table 3.

Table 3. Age-standardized 28-day mortality rates by taxable income, education and profession in the FINAMI MI Register during 1993 to 2002. The rates are expressed per 100,000 inhabitants per year. The 95% CIs are in parenthesis.

		Men			**Women**		
		35-64 years	**65-74 years**	**75-99 years**	**35-64 years**	**65-74 years**	**75-99 years**
Income level	Low	318 (286-350)	1796 (1569-2023)	5875 (5354-6369)	63 (49-77)	758 (655-861)	3599 (3409-3789)
	Middle	180 (159-201)	1583 (1440-1726)	3512 (3200-3824)	31 (23-39)	425 (371-479)	1971 (1828-2114)
	High	91 (81-101)	759 (697-821)	2846 (2601-3091)	9 (6-12)	215 (187-243)	1601 (1472-1730)
Education	Basic	201 (185-217)	1217 (1142-1292)	3879 (3655-4103)	33 (27-39)	400 (367-433)	2466 (2367-2565)
	Secondary or higher	125 (113-137)	786 (697-875)	3050 (2732-3368)	19 (14-24)	243 (199-287)	2232 (2043-2421)
Profession	Blue-collar	202 (185-219)	1234 (1141-1327)	3983 (3679-4287)	37 (29-45)	414 (367-461)	2577 (2428-2726)
	Entrepreneur/farmer	183 (149-217)	1176 (995-1357)	3825 (3338-4312)	39 (21-57)	442 (347-537)	2544 (2293-2795)
	Lower-level white-collar	138 (116-160)	981 (843-1119)	3322 (2900-3744)	18 (13-23)	283 (238-328)	2150 (1977-2323)
	Higher-level white-collar	83 (65-101)	707 (572-842)	3181 (2666-3696)	13 (5-21)	284 (201-367)	2047 (1757-2337)
	Other	281 (161-401)	2045 (1323-2767)	4098 (2459-5737)	49 (1-97)	1229 (799-1659)	2616 (2168-3056)

When examining the RRs of the youngest age group, where the socioeconomic differences in incidences and mortality rates seemed to be widest, the results showed that among 35-64 year-old men, the mortality rate of the lowest income group was 5.2 times as high and the incidence and attack rate 2.7 and 2.9 times as high, respectively, compared to the highest income group (Table 4 in Study I). Among 35-64 year-old women, the differences were even larger. The incidence of acute coronary events in the lowest income sixth was 4.6 times as high and the attack rate and mortality rate 5.1 and 11.1 times as high as the corresponding rates of the highest income sixth.

When looking at possible reasons for these previously described socioeconomic differences, no socioeconomic differences were found in the proportion of 35-64 year-old men reaching the hospital within four hours, but men in the highest income tertile received thrombolysis [30% (95% CI: 27 to 33) *versus* 21% (95% CI: 19 to 24)] and underwent early revascularization more often [22% (95% CI: 18 to 25) versus 14% (95% CI: 11 to 17)] than men of the lowest income tertile. No significant socioeconomic differences were seen in 35-64 year-old women in the proportions of patients receiving thrombolysis or undergoing revascularization. (Table 4)

Table 4. Proportions (%) of 35-64 year-old patients without delays in treatment seeking and patients treated with thrombolysis or revascularization in the FINAMI Register in 1993-2002. The 95% CIs are in parenthesis.

			Delay < 4 hours	**Thrombolysis**	**Revascularization**
Men	**Income level**	High	62 (57, 67)	30 (27, 33)	22 (18, 25)
		Middle	62 (57, 67)	27 (24, 30)	19 (16, 22)
		Low	59 (53, 64)	21 (19, 24)	14 (11, 17)
	Education	Academic	60 (47, 73)	26 (19, 32)	16 (9, 22)
		Upper secondary	71 (62, 79)	28 (22, 33)	30 (24, 36)
		Vocational school	61 (56, 67)	26 (23, 29)	19 (16, 22)
		Basic	59 (56, 63)	26 (24, 28)	17 (15, 19)
	Profession	H-L white collar*	64 (55, 72)	32 (27, 38)	18 (13, 23)
		L-L white-collar*	58 (51, 64)	29 (25, 33)	18 (14, 22)
		Entrepreneur/farmer	67 (60, 74)	25 (21, 30)	16 (11, 20)
		Blue-collar	60 (56, 63)	26 (24, 28)	14 (12, 16)
		Other	67 (46, 87)	27 (17, 38)	6 (1, 11)
Women	**Income level**	High	58 (48, 68)	25 (18, 32)	16 (10, 21)
		Middle	59 (49, 69)	19 (14, 25)	14 (9, 19)
		Low	55 (45, 65)	22 (17, 27)	13 (8, 18)
	Education	Academic	61 (47, 75)	19 (6, 33)	8 (0, 18)
		Upper secondary	79 (62, 96)	35 (20, 49)	12 (1, 23)
		Vocational school	52 (40, 64)	23 (17, 30)	16 (10, 22)
		Basic	54 (47, 61)	22 (18, 27)	16 (11, 20)
	Profession	H-L white collar*	44 (24, 65)	33 (12, 55)	19 (0, 39)
		L-L white-collar*	61 (52, 70)	23 (16, 29)	14 (9, 19)
		Entrepreneur/farmer	46 (29, 62)	15 (6, 25)	8 (0, 15)
		Blue-collar	57 (48, 66)	22 (17, 28)	12 (7, 16)
		Other	20 (2, 39)	19 (8, 30)	19 (4, 35)

* H-L = Higher-level, L-L = Lower-level

5.1.1 The effect of the economic recession

During the 15-year period of 1988-2002, the attack rates and 28-day mortality rates of 35-64 year-old men and women declined significantly in all socioeconomic groups (Table 5) – as did the incidence rates. The interaction between socioeconomic group and study year was generally nonsignificant. However, a statistically significant interaction occurred between income level and study year for the attack rate trend in women, suggesting a steeper decline in attack rate in women with high income. Another significant p-value was observed for the education by study year interaction regarding the mortality rate of women. However, the CIs of the trend estimates were wide and no consistent differences were observed between the socioeconomic groups.

The effect of the economic recession was further analyzed by dividing the 15-year period of 1988-2002 into three five-year periods (1988-1992; 1993-1997; 1998-2002) describing the time before, during and after the economic recession. Incidence and mortality rates for the age group 35-64 years are classified by income in Table 6 in Study I. Among men, the incidence RR between the lowest and the highest income tertile was 2.5 before the recession and 2.0 after the recession. The corresponding mortality RRs were 3.3 and 3.3. Among women, the corresponding incidence RRs were 2.9 and 3.4, and mortality RRs 4.3 and 5.9. Results associating with profession and education were consistent with those associations based on income.

Table 5. Trends (% per year) in age-standardized attack rates, incidences and 28-day mortality rates (per 100,000 inhabitants) by income level, education and profession among 35-64 year-old men and women in the FINAMI Register in 1988-2002. The 95% CIs for the trends are given in parentheses. The p-values are for the interaction between the socioeconomic indicator and study year.

		Attack rate		**Incidence**		**Mortality rate**	
		Trend, Men	**Trend, Women**	**Trend, Men**	**Trend, Women**	**Trend, Men**	**Trend, Women**
Income	High	-5.6 (-6.7, -4.4)	-7.2 (-9.9, -4.5)	-3.9 (-5.3, -2.6)	-5.5 (-8.5, -2,6)	-7.2 (-9.2, -5.2)	-9.1 (-14.7, -3.6)
level	Middle	-4.9 (-6.1, -3.8)	-3.5 (-5.9, -1.1)	-3.2 (-4.7, -1.8)	-2.1 (-5.0, 0.8)	-7.2 (-9.2, -5.2)	-4.7 (-9.2, -0.2)
	Low	-5.2 (-6.4, -4.1)	-3.1 (-5.5, -0.8)	-4.0 (-5.4, -2.6)	-2.3 (-4.9, 0.4)	-5.3 (-7.0, -3.5)	-5.7 (-9.5, -1.9)
		p>0.20	p=0.044	p>0.20	p=0.165	p>0.20	p>0.20
Education	Academic	-2.9 (-5.7, -0.1)	-3.9 (-11.4, -3.7)	-1.5 (-4.7, 1.7)	-1.4 (-9.8, 7.1)	-4.0 (-9.0, 1.1)	-6.8 (-23.9, 10.3)
	Upper secondary	-6.1 (-8.4, -3.9)	-1.6 (-7.4, 4.1)	-3.8 (-6.4, -1.2)	0.2 (-6.1, 6.5)	-7.4 (-11.4, -3.5)	4.8 (-5.1, 14.6)
	Vocational school	-4.7 (-6.0, -3.4)	-0.2 (-3.2, 2.8)	-2.4 (-4.0, -0.8)	-1.1 (-4.6, 2.3)	-6.1 (-8.4, -3.9)	5.8 (-0.6, 12.2)
	Basic	-3.7 (-4.6, -2.8)	-3.4 (-5.1, -1.6)	-2.5 (-3.6, -1.5)	-1.5 (-3.5, 0.6)	-4.8 (-6.2, -3.4)	-5.5 (-8.7, -2.4)
		p=0.144	p>0.20	p>0.20	p>0.20	p>0.20	p=0.004
Profession	H-L white collar*	-5.2 (-7.5, -2.7)	-5.1 (-11.4, 1.3)	-3.5 (-6.2, -0.7)	-1.9 (-9.2, 5.3)	-6.0 (-10.1, -1.8)	-9.5 (-21.5, 2.5)
	L-L white-collar*	-4.5 (-6.2, -2.6)	-5.0 (-7.7, -2.2)	-1.9 (-3.9, 0.2)	-2.8 (-6.0, 0.3)	-5.3 (-8.4, -2.2)	-2.0 (-7.5, 3.5)
	Entrepreneur/farmer	-2.8 (-4.7, -0.7)	-2.6 (-7.9, 2.6)	-0.4 (-2.8, 2.0)	-4.2 (-10.0, 1.7)	-3.2 (-6.7, 0.3)	-4.1 (-12.9, 4.6)
	Blue-collar	-4.8 (-5.8, -3.8)	-2.8 (-5.1, -0.4)	-3.5 (-4.7, -2.2)	-0.8 (-3.4, 1.8)	-5.4 (-7.0, -3.8)	-4.2 (-8.2, -0.2)
		p>0.20	p>0.20	p=0.116	p>0.20	p>0.20	p>0.20

* H-L = Higher-level, L-L = Lower-level

5.2 Marital status and acute coronary events (II)

Table 6 represents the distribution of the events recorded in 1993-2002 according to marital status. Most of the events were incident. The event numbers of unmarried women are larger than the event numbers of married women, due to larger number of events in the previously unmarried group in the oldest age group (74-99 year-old women).

Table 6. The number (and %) of incident events, all events and deaths within 28 days and their distributions by marital status among men and women aged 35 to 99 years in the FINAMI MI Register during 1993 to 2002.

	Men			**Women**		
	Incident	All	Deaths	Incident	All	Deaths
All	5023	8137	3897	4623	7193	3806
Married	3126 (62)	5132 (63)	2246 (58)	1178 (25)	1783 (25)	720 (19)
Unmarried	1897 (38)	3005 (37)	1651 (42)	3445 (75)	5410 (75)	3086 (81)
Previously married	1264 (25)	2106 (26)	1153 (29)	2846 (62)	4537 (63)	2568 (67)
Never married	633 (13)	899 (11)	498 (13)	599 (13)	873 (12)	518 (14)

The age-standardized incidences of acute coronary events were approximately 58-66% higher among unmarried men and 60-65% higher in unmarried women than among married men and women in all age groups (Table 7). The differences in attack rates and 28-day mortality were even larger. The 28-day mortality rates of all acute coronary events were 60-168% higher in unmarried men and 71-175% higher in unmarried women. The rates of the previously married and never married did not differ significantly except in the attack rate of 75-99 year-old men and women and 65-74 year-old women, but the rates of the never married tended to be lower in other groups.

Table 7. The age-standardized incidence, attack rate and 28-day mortality of 35-99 year-old men and women by marital status in the FINAMI register in 1993-2002. The rates are expressed per 100,000 persons per year and the 95% CIs are shown in parenthesis.

Men		**35-64 years**	**65-74 years**	**75-99 years**
Incidence	Married	269 (254-284)	1140 (1071-1209)	2661 (2471-2851)
	Unmarried	442 (411-473)	1888 (1725-2051)	4196 (3846-4546)
	Previously married	472 (427-517)	1914 (1712-2116)	4324 (3934-4714)
	Never married	437 (389-485)	1838 (1562-2114)	3503 (2652-4354)
Attack rate	Married	365 (347-383)	2025 (1934-2116)	4953 (4694-5212)
	Unmarried	621 (584-658)	3140 (2930-3350)	7703 (7226-8180)
	Previously married	682 (628-736)	3277 (3013-3541)	7984 (7449-8519)
	Never married	574 (519-629)	2874 (2528-3220)	6129 (5024-7234)
Mortality	Married	109 (99-119)	866 (806-926)	3049 (2841-3257)
	Unmarried	292 (266-318)	1792 (1633-1951)	4843 (4467-5219)
	Previously married	297 (262-332)	1772 (1578-1966)	4891 (4478-5304)
	Never married	291 (251-331)	1816 (1542-2090)	4353 (3413-5293)
Women				
Incidence	Married	55 (48-62)	478 (435-521)	1654 (1476-1832)
	Unmarried	90 (78-102)	765 (706-824)	2733 (2624-2842)
	Previously married	103 (87-119)	807 (736-878)	2821 (2698-2944)
	Never married	69 (51-87)	648 (540-756)	2342 (2108-2576)
Attack rate	Married	68 (60-76)	689 (637-741)	2841 (2609-3073)
	Unmarried	117 (104-130)	1144 (1072-1216)	4414 (4276-4552)
	Previously married	130 (112-148)	1228 (1141-1315)	4618 (4461-4775)
	Always unmarried	92 (71-113)	894 (767-1021)	3512 (3226-3798)
Mortality	Married	16 (12-20)	247 (216-278)	1577 (1397-1757)
	Unmarried	44 (36-52)	493 (446-540)	2667 (2561-2773)
	Previously married	47 (36-58)	520 (464-576)	2759 (2639-2879)
	Never married	39 (25-53)	415 (329-501)	2261 (2034-2488)

The CFs of incident acute coronary events among 35-64 year-old unmarried men and women were higher before hospital admission, on the first day and 28 days after the onset of the event than the CFs of married men and women (Table 2 in Study II). The 1-year prognosis of men who never married was significantly worse (55%, 95% CI: 50 to 60) than the prognosis of previously married men (44%, 95% CI: 40 to 49).

The CFs of 65-74 year-old men and women did not differ much from the CFs of the younger age-group (Table 8). The CFs of 75-99 year old men and women differed from the CFs of the younger age groups. The CF of 75-99 year-old married men was lower than the CF of the never married men, before reaching the hospital, on the first day and 28 days after the onset of the event. The CF of never married 75-99 year-old women was higher on the first day after the event than the CF of the previously married but no other significant differences according to marital status existed in the CFs of women in this oldest age group.

Married men were treated with thrombolysis more often than unmarried men, but in women there were no such differences in the use of reperfusion therapies (Table 3 in Study II).

The attack rates, incidences and 28- day mortality rates of 35-64 year-old men and women showed mainly a declining trend during the 15-year period. The only exception was the rising trend in attack rate and incidence of never married women (Table 4 in Study II). The 95% CIs of the trend estimates were mainly wide and overlapping, but the attack rate of married women declined while the attack rate of never married women had a rising trend. The 28-day mortality rates of married men also declined significantly more than the 28-day mortality rates of never married men.

Table 8. The case fatalities (%) of incident events among the 65-74- and 75-99 year-old men and women at different time points according to marital status in the FINAMI Register during 1993-2002. The 95% CIs are in parenthesis.

Men		**Before hospital**	**First day**	**28-day mortality**	**1 year**
65-74 years	Married	21 (19, 23)	26 (23, 28)	41 (38, 44)	46 (43, 49)
	Never married	47 (39, 54)	53 (45, 61)	66 (59, 73)	74 (67, 81)
	Previously married	36 (31, 42)	41 (36, 47)	53 (48, 59)	60 (55, 65)
75-99 years	Married	24 (21, 27)	34 (31, 38)	61 (58, 64)	71 (68, 74)
	Never married	42 (30, 53)	53 (42, 65)	77 (67, 87)	82 (73, 91)
	Previously married	29 (25, 33)	41 (36, 45)	63 (59, 67)	73 (69, 77)
Women					
65-74 years	Married	15 (11, 18)	18 (15, 22)	32 (28, 36)	36 (32, 41)
	Never married	29 (21, 36)	36 (27, 44)	50 (42, 58)	57 (49, 66)
	Previously married	23 (20, 27)	27 (24, 31)	42 (38, 46)	48 (44, 53)
75-99 years	Married	21 (17, 25)	33 (28, 37)	58 (53, 62)	67 (63, 71)
	Never married	27 (23, 32)	42 (37, 47)	66 (61, 71)	76 (71, 80)
	Previously married	23 (21, 25)	33 (31, 35)	59 (57, 61)	68 (66, 71)

5.3 Household size and the case fatality and treatment of acute coronary events (II)

The CF of 35-64 year-old single living men and women was higher at all time points than the CF of those living with one or more people (Table 2 in Study II).

Among 65-74 year-old men, the CF of those living alone was higher at all time points. Among 65-74 year-old women, the prehospital CF of those living with one person was lower than the CF of those living alone. No significant differences existed at other time points according to household size among 65-74 year-old women (Table 9).

The CF of 75-99 year-old men living with one person was lower on the first day and the CF of single men was lower 28-days after the onset of the event than the CF of those living with two or more people. Among 75-99 year-old women the CFs of those living with two or more persons were higher at all time points than the CFs of those living alone or with one person. (Table 9)

Table 9. The case fatalities (%) of incident events among the 65-74- and 75-99 year-old men and women at different time points according to household size in the FINAMI Register during 1993-2002. The 95% CIs are in parenthesis.

Men		**Before hospital**	**First day**	**28-day mortality**	**1 year**
65-74 years	>2 people	22 (17, 27)	30 (24, 36)	46 (39, 52)	51 (45, 57)
	2 people	22 (20, 25)	27 (24, 30)	42 (38, 45)	47 (44, 50)
	Living alone	41 (36, 46)	45 (40, 50)	58 (53, 63)	64 (60, 69)
75-99 years	>2 people	32 (26, 38)	46 (39, 52)	73 (67, 79)	80 (74, 85)
	2 people	23 (20, 26)	33 (30, 36)	61 (57, 79)	71 (67, 74)
	Living alone	30 (25, 34)	41 (36, 46)	61 (56, 66)	71 (66, 75)
Women					
65-74 years	>2 people	23 (16, 30)	26 (19, 34)	45 (37, 54)	51 (43, 60)
	2 people	16 (13, 19)	21 (17, 24)	34 (30, 39)	39 (35, 44)
	Living alone	24 (20, 28)	28 (24, 32)	41 (37, 46)	47 (43, 52)
75-99 years	>2 people	32 (28, 37)	46 (41, 51)	76 (71, 80)	83 (79, 87)
	2 people	20 (17, 23)	31 (28, 35)	59 (56, 63)	68 (65, 72)
	Living alone	22 (20, 24)	34 (33, 36)	55 (53, 58)	66 (64, 68)

Men living alone received thrombolysis less often than men living with one or more people, but among women there were no such differences in the use of reperfusion therapies (Table 3 in Study II).

5.4 Language group and the risk of cardiovascular diseases

5.4.1 Stroke (III)

A total of 5,135 stroke events were registered in Turku during the eleven-year period of 1988-1998. These events comprised the data of study III. Of these stroke events, 4,251 (~83%) were ischemic and 884 (~17%) hemorrhagic. Approximately 94% of the events were observed in Finnish-speaking inhabitants and the rest in Swedish-speaking inhabitants.

The age-standardized attack rate of ischemic stroke was higher among Finnish-speaking men than among Swedish-speaking men [370 (95% CI: 352 – 389) versus 270 (95% CI: 214 - 326)]. Among women, the difference in the attack rates of ischemic stroke between the language groups did not reach statistical significance. The rate of hemorrhagic stroke was higher among Finnish-speaking women than among Swedish-speaking women but the 95% CIs were wide and overlapping. No differences were observed in the rates of hemorrhagic stroke in men or in the 28-day CF of any type of stroke.

The 1- and 5-year CFs of ischemic stroke did not differ between the language groups. The 1- and 5-year CFs of hemorrhagic strokes tended to be in favor of Swedish-speaking men and women but the 95% CIs were overlapping, except for the 1-year CF in women. Furthermore, the hazard ratios (HR) for the 1- and 5-year CFs after any kind of stroke, counted for men and women together, were not significant: 1.10 (95% CI: 0.92-1.31) and 1.10 (95% CI: 0.95-1.26), respectively.

The exact numbers of ischemic and hemorrhagic stroke events, age-standardized average annual attack rates and CFs by native language and gender are presented in Table 1 in Study III.

Potential differences in stroke risk factors and SES among the stroke patients in Turku by language group were evaluated to find possible causes for the lower stroke attack rate of the Swedish-speaking population.All clinical risk factors (diabetes, hypertension, smoking, and prior MI) tended to be more frequent among Finnish-speaking stroke patients than among Swedish-speaking patients, but the 95% CIs were overlapping (Table 2 in Study III). History of atrial fibrillation was more frequent among Finnish-speaking than among Swedish-speaking men and the registered stroke was more often first among Swedish-speaking women than among Finnish-speaking women. The most marked differences were, however, observed in the indicators of SES. A greater proportion of Finnish-speaking men was manual workers, belonged to the lowest income tertile or had basic education only and a greater proportion of Finnish-speaking women was manual workers or had only basic education. Similarly a greater proportion of Finnish-speaking women was manual workers or had basic education only. Among women, the differences in income between the language groups did not quite reach significance.

When examining the impact the differences in SES as a factor explaining the differences in stroke rates, age-standardized RRs comparing the attack rates of ischemic and hemorrhagic strokes in the Swedish-speaking inhabitants with those in the Finnish-speaking inhabitants were calculated and adjusted for the indicators of SES (Table 3 in Study III). When adjusted for study year only, Swedish-speaking men had almost 30% less ischemic strokes than Finnish-speaking men. This difference decreased after adjusting for the indicators of SES, but remained statistically significant and Swedish-speaking men still had over 20% less ischemic strokes than Finnish-speaking men. No significant differences were observed among women in the RRs of ischemic stroke. When adjusted for study year only, Swedish-speaking women had 25% less hemorrhagic strokes than Finnish-speaking women. This trend was also seen after adjusting for the indicators of SES but these differences were not statistically significant. Among men, the 95% CIs of the RRs of hemorrhagic stroke were wide.

5.4.2 Acute coronary events (IV)

A total of 4,845 acute coronary events were recorded among 35-99 year-old inhabitants of Turku during the eleven-year study period 1988-1998. However, the FINMONICA Study data included information only on 35-64 year-old people. The distribution of these events by language group, age and sex is presented in Table 1 of Study IV.

The attack rates, incidences, 28-mortality rates and their ratios between the two language groups are presented in Table 2 of Study IV. In the youngest age group (35-64 years), the attack rate of acute coronary events was higher among Finnish-speaking men and women than among Swedish-speaking men and women. The 28-day mortality rate of this age group was also higher among Finnish-speaking men than among Swedish-speaking men. Furthermore, the incidence was higher among Finnish-speaking women than among Swedish-speaking women in the oldest age group (75-99 years). The comparisons of attack rates, incidences and 28-day mortality rates among the other age groups of women and men showed a trend towards the same direction but the results were mainly not statistically significant.

The 28-day CFs tended to be lower among Swedish-speaking 35-74 year-old men than among Finnish-speaking men in the same age groups. The 95% CIs of the 28-day CFs were, however, overlapping in both sexes and in all age groups. The exact CF results are presented in Table 3 in Study IV.

Table 4 in Study IV presents the age-standardized RRs comparing the attack rates and the 28-day mortality rates of the Swedish-speaking men and women with those of the Finnish-speaking men and women. When adjusted for study year only, the Swedish-speaking men had almost 30% less acute coronary events than the Finnish-speaking men. After adjusting for the indicators of SES, this difference decreased but remained significant. Furthermore, when adjusted for study year only, Swedish-speaking women had almost 20% less acute coronary events than Finnish-speaking women. This trend could also be seen when adjusted for the indicators of SES, but the results of these comparisons were not significant. When adjusted for study year only, the coronary mortality of Swedish-speaking men was almost 30% lower than the mortality of Finnish-speaking men. The difference, however, did not remain significant after adjusting for the indicators of SES. No significant differences could be seen in the mortality of acute coronary events among women.

Differences in cardiovascular risk factors between the language groups were then examined from the FINRISK data, as these differences might explain the observed differences in acute coronary event rates. A total of 9,913 Finnish-speaking and a total of 519 Swedish-speaking people participated in the FINRISK study in the areas included in the analysis. Of the Swedish-speaking participants, 31.4% belonged to the lowest income tertile of the total FINRISK population, 30.4% to the middle income tertile and 38.2% to the highest tertile. In the Finnish-speaking population, the corresponding proportions were 33.5%, 33.5% and 33.0%. Of the Finnish-speaking people 35.4% and of the Swedish-speaking people 33.0% had basic education only.

The Swedish-speaking participants had higher HDL-cholesterol, lower serum triglyceride concentration, lower diastolic BP and lower BMI than the Finnish-speaking participants. These differences remained significant after adjusting for household income and education. A higher proportion of the Finnish-speaking seemed to be current smokers, but the difference did not reach statistical significance. There was no statistically significant difference in the proportion of heavy alcohol users, diabetic persons or the level of total cholesterol or systolic BP between the language groups. The average values and prevalence of the classical risk factors of MI are presented in Table 5 in Study IV.

6. DISCUSSION

An important goal of the Finnish health policy is to reduce inequalities in health and mortality between different population groups in Finland (Valtioneuvoston periaatepäätös Terveys 2015 -kansanterveysohjelmasta, 2001). To achieve this goal, it is important to understand how inequalities develop and which population groups are at particular disadvantage. This study found disparities in coronary and stroke morbidity and mortality among several population groups.

Previous analyses of the FINMONICA MI register data from years 1983-1992 show inequalities in ACS incidence and mortality according to income and education among 35-64 year-old men and women (Salomaa et al., 2000). This new data, from years 1993-2002, yielded similar results, but revealed also, that similar inequalities exist in older age groups as well, and that the inequalities are even larger than previously reported when examining the extremities of income groups. Furthermore, the inequalities showed no signs of reduction in 1988-2002. Interestingly, the economic recession of the 1990's did not widen socioeconomic inequalities.

Secondly, being unmarried increases the risk of ACS and ACS death in both genders at all ages. In contrast to some previous studies (Malyutina et al., 2004), (Gerward et al., 2010), (Koskenvuo et al., 1986), the results were similar in both men and women. The disparities in ACS morbidity and mortality by marital status tended to widen during the study period. Single living and being unmarried were also associated with higher CF of incident ACS. Most of this difference seemed to be due to a greater susceptibility to sudden prehospital coronary deaths among people living alone but the difference in mortality remained significant at least one year after the attack. As in the recent results of the Reduction of Atherothrombosis for Continued Health Register study indicating a higher four-year cardiovascular mortality among middle-aged people living alone but not among the elderly (Udell et al., 2012), advancing age modified also the associations of household size and CF in our study possibly due to the higher proportion of people no longer living at home (*e.g.* living in a nursing home) and therefore classified as living with two or more people. Furthermore, marriage seemed to protect women greater than men from out-of-hospital ACS death.

Thirdly, significant differences were found in the morbidity and mortality of both acute coronary events and stroke according to language group, with the rates favoring the Swedish-speaking people.

Discussing and further researching the possible reasons behind the observed disparities between population groups in cardiovascular morbidity and mortality in Finland is the key to reducing these inequalities. In the following section possible explanations and explanations found in this study for the found inequalities between population groups are presented.

6.1 Differences according to socioeconomic status

Differences in traditional risk factor levels explain part of the socioeconomic differences in CHD rates (Kivimäki et al., 2007), (Singh-Manoux et al., 2008), (Vartiainen et al., 1998). A study from the FINRISK data showed that modifiable risk factors explained one third of the excess CHD mortality in manual workers when compared to upper-level employees in Finnish men (Harald et al., 2006) and smoking was considered to be one of the most important risk factors explaining the socioeconomic inequalities in CHD deaths in Finland. Unfortunately, the prevalence of smoking has increased in the lower occupational and income groups among women in Finland (Harald et al., 2008). Results from the FINRISK data show that changes in risk factor levels no longer provide a good explanation for the changes in socioeconomic differences in CHD mortality (Harald et al., 2008).

The socioeconomic disparities in the morbidity of acute coronary events could also be due to inequalities in primary prevention, but minimal research has focused on socioeconomic differences in CHD primary prevention in Finland. Interestingly, regarding primary prevention, both the Framingham and SCORE CHD risk scores provide better risk stratification among British men with a higher SES (measured in the study by occupational status) (Ramsay et al., 2011). People with a lower income might be less prone to seek a doctor's appointment in health centers or private offices because of monetary reasons. Secondly, Finland has a comprehensive occupational health care system which probably improves the health of working people compared to those not in the coverage of this service.

Socioeconomic differences in the attack rate of acute coronary events could also be influenced by differences in secondary prevention. Previous FINMONICA data showed that fewer men in the low income group were prescribed β-blockers at hospital discharge than men in higher income groups (Salomaa et al., 2001). A Finnish survey study reports differences in statin use by income level among men (Manderbacka et al., 2008), but people with a lower level of education were more likely than others to be nonrespondents, possibly affecting the result. In line with these findings, a recent large international study (the PURE Study) showed that the low educational level cut down use of statins and antiplatelet drugs (Yusuf et al., 2011).

Another factor affecting the use of primary and secondary preventive medication in Finland could be patient compliance to treatment. Data on this is, however, missing.

In Study I, the most marked socioeconomic differences were found in the mortality rate of ACS events. The analyses revealed that the mortality rate of middle-aged (35-64 year-old) men and women was 5.2 and 11.1 as high in the lowest income sixth as in the highest income sixth in men and women, respectively. Such large differences according to income are surprising in Finland, where the income gap is smaller than in many other Western countries. In addition to inequalities in the prevalence and treatment of risk factors, differences in treatment may contribute to these mortality inequalities. Investigators of two large, multinational, randomized trials of fibrinolytic therapy from the USA have previously found that low educational level had a negative impact on treatment-seeking time (Gibler et al., 2002). This finding was not confirmed by our study, possibly due to small numbers and lack of power, but mortality differences according to educational status were found, as mentioned. Furthermore, the Atherosclerosis Risk in Communities -Study showed that even low neighbourhood income level was independently associated with a longer prehospital delay in MI patients (Foraker et al., 2008). Detailed research on socioeconomic differences in delay-times in Finland is missing.

Among men, SES was found to be related to the probability of being treated with thrombolysis and undergoing early revascularization. However, it should be acknowledged, that information on the contraindications of thrombolysis was not collected as part of the MI Register data and therefore, the analyses could not be restricted to those eligible for thrombolysis. However, it is very unlikely that such differences in eligibility exist. The result, nevertheless, concurs with earlier findings that patients in the higher socioeconomic groups have had better access to the cardiac procedures (Salomaa et al., 2001). Regardless of the increase in the number of cardiac procedures in the past decades, socioeconomic inequalities persist in the use of cardiac operations relative to need (Hetemaa et al., 2004), (Hetemaa et al., 2003). We did not have information on possible co-morbid conditions which could also affect the prognosis of ACS patients and thereby also socioeconomic differences in prognosis.

Already in 1984, the β-Blocker Heart Attack Trial showed that male patients classified as being socially isolated and having a high degree of life stress had more than four times the risk of death after MI compared to men with low levels of both stress and isolation (Ruberman et al., 1984). In the β-Blocker Heart Attack Trial, high levels of stress and social isolation were most prevalent among the least-educated men, which may be due to social selection or reflect the psychosocial conditions often associated with SES.

All in all, when considering the typology of explanations for socioeconomic health differences that the Black report introduced, the cultural and materialist explanations would seem most important. Selection based on cardiovascular health is unlikely to affect our results, as the closest record of the patient's indicators of SES before the first event was used.

The effect of the economic recession

In the late 1980's, the economy of Finland boomed, but the situation turned into a labor market crisis in the beginning of the 1990's. Results from Study I showed, that this economic crisis did not, however, lead to the widening of socioeconomic differences in the morbidity or mortality of MI and acute CHD events. This is an interesting result in the fluctuating national and international economic situation.

Our results, however, differ from the results published by Tarkiainen and colleagues (Tarkiainen et al., 2012). They found that the life expectancy differences by income group widened in 1988-2007 in Finland and that the slower decline in mortality due to IHD among men in the lowest income quintile was one of the factors increasing the mortality gap. Our analyses of the effects of the recession on the mortality and morbidity of acute CHD events extend only to the year 2002, and it can be argued that the follow-up period should be longer, as in the study by Tarkiainen and colleagues, to include later effects of the recession. Furthermore, Tarkiainen and colleagues analyzed mortality trends according to income quintiles and our analyses were made according to income tertiles with differing events inclusion criteria, which may also affect the differing results. Valkonen and colleagues, in turn, found that in the years of recession (in their study years 1991-1995), the relative differences by occupation in total mortality continued to rise, but not as rapidly as earlier and among middle-aged men the increase in absolute differences even ended. In their study, a major reason for this development was that cardiovascular mortality diminished more in the manual than in the non-manual labor class during the recession (Valkonen et al., 2000).

Ilmo Keskimäki studied how the economic recession of the 1990's in Finland affected the socioeconomic differences in hospital care (Keskimäki, 2003). He found that the distribution of coronary revascularisations clearly inclined towards high-income groups in year 1988 but by year 1996 this distribution changed to a more equal use of procedures. However, differing from our trend analyses, the data of Ilmo Keskimäki´s study included people aged 25-74 years and this data was analyzed according to income quintiles.

6.2 Differences according to sociodemographic group

Traditionally, married men are healthier than married women, but this was not the case in our study. On the contrary, in our study, marriage seemed to protect women even more than men from out-of-hospital ACS death.

One possible explanation for the observed differences in morbidity and mortality by marital status could again be differences in the prevalence of traditional cardiovascular risk factors. The differences previously observed in risk profiles have mainly favored married men compared to unmarried men, but these results have not been consistent (Ben-Shlomo et al., 1993), (Empana et al., 2008), (Venters et al., 1986), (Molloy et al., 2009).

Secondly, the higher acute coronary event rates of the unmarried may also be a simple question of selection. Persons with poorer health may be more prone to staying unmarried or to be divorced. In our study, however, cardiovascular health is unlikely to affect the results as the record of sociodemographic characteristics prior to first event was used. Furthermore, according to a study by Marika Jalovaara, couples in which the husband, the wife, or both partners are unemployed have an elevated risk of divorce, and employment and occupational level is thereby linked to the risk of divorce (Jalovaara, 2003). On the other hand, marriage may have or reflect a protective effect as the married seem to have better health habits and higher levels of social support compared to the unmarried, thereby promoting their overall health. Adjusting for socioeconomic characteristics partly accounts for selection into marriage, while household size partly mediates the effects of marriage on mortality. Martikainen et al. have made such analyses and found that differences in mortality by marital status in the late 1970s and in the late 1990s attenuated after adjusting for socioeconomic characteristics and household composition, supporting the assumption that these mortality differences are partly attributable to the non-married groups being disadvantaged in socioeconomic status and household composition. (Martikainen et al., 2005).

Social support is the perception that one is cared for, has assistance available from other people, and that one has a supportive social network. Lack of this social support (possibly more common among the unmarried) associates with an increased risk of cardiac morbidity and mortality, independent of the traditional risk factors (Rosengren, Wilhelmsen and Orth-Gomér, 2004), (Horsten et al., 2000). Furthermore, Inaba and colleagues found unmarried people to be more likely depressed (Inaba et al., 2005). Depression, in turn, seems to increase the risk of incident acute coronary events (Nabi et al., 2010) and has an adverse effect on cardiovascular mortality rates after MI (Frasure-Smith, Lespérance and Talajic, 1995), (Barefoot et al., 1996). A meta-analysis also found significant associations between depression and CHD, but concluded that it remains unclear if the association is causal (Nicholson, Kuper and Hemingway, 2006). Nevertheless, very high levels of social support (again possibly more common among the married) buffer the impact of post-MI-depression on mortality after MI (Frasure-Smith et al., 2000). Thus, the aspect of social support links sociodemographic groups to the language group health inequalities, discussed later.

Another potential mechanism suggested to be mediating the effects of psychosocial factors and CHD is disturbed autonomic balance. Decreased heart rate variability is a sign of autonomic imbalance, and associates with both the risk of nonfatal and fatal CHD (Liao et al., 1997) and with being unmarried (Randall, Bhattacharyya and Steptoe, 2009).

In Study II, most of the variations in prognosis - between both the married and the unmarried and those living with someone or alone - arose already in the prehospital phase. It may be assumed that resuscitation or calling for help may be initiated faster or more often among those married or cohabiting.

No previous research evaluated potential differences in access to invasive coronary operations according to marital status. Living alone (Bouma et al., 1999) and being unmarried (Atzema et al., 2011) associates with a longer treatment-seeking time after MI, which may increase the likelihood of prehospital deaths in these sociodemographic groups. In Study II, no significant differences by sociodemographic characteristics were found in the proportion of patients reaching the hospital in less than 4 hours. However, a larger proportion of married and cohabiting men received thrombolysis at acute stage, which may contribute to their better survival after hospitalization.

Investigators from the USA report a lower adherence to secondary preventive medication (ASA, statins, beta-blockers, angiotensin-converting enzyme inhibitors or angiotensin receptor blockers) of CHD among the unmarried one year after the prescription of the drugs (Kulkarni et al., 2006). Lower adherence to secondary preventive medication may be a factor impairing the prognosis of unmarried men and women also in Finland.

6.3 Differences according to language group

Results from Studies III and IV, respectively, showed that the attack rates of both ischaemic stroke and acute coronary events were lower among Swedish-speaking men than among Finnish-speaking men in Turku. When adjusted for year of study only, the attack rates of both ischemic strokes and acute coronary events among Swedish-speaking men were of almost 30% lower than among Finnish-speaking men.

Language-group differences in the mortality risk of cardiovascular diseases were found also by Sipilä and Martikainen, (Sipilä and Martikainen, 2009) and researchers from the Finnish University, Åbo Akademi, have also investigated mortality differences between the language groups. The results of the Åbo Akademi study group, published also in 2009, showed that the CHD mortality risk of Swedish-speakers in the coastal and Helsinki metropolitan areas tended to be lower but the difference to Finnish-speakers was not significant (Saarela and Finnäs, 2009). Neither of these, however, studied the morbidity of cardiovascular diseases.

The better health of a minority is a rare situation. Especially ethnic differences have, in previous studies, usually been in favour of the majority. For example, a report from New York City, USA, reported a considerable increase in mortality rates from several causes, including CHD, among Asians compared to white inhabitants (Freeman et al., 2011). In Jerusalem, Israel, coronary event rates were much higher among Arabs than among the Jewish population (Kark et al., 2006). Against this background, the position of the Swedish-speaking minority in Finland is unique. Similar and even greater differences in cardiovascular disease risk exist between the Finns moving to Sweden and the Swedish population (Alfredsson, Ahlbom and Theorell, 1982). To our knowledge, no other population group in other parts of the world can be compared to the unique Swedish-speaking population of Finland *per se*. However, one quite similar group is the English-speaking minority of Quebec, Canada. The life-expectancy of this minority is longer than the life-expectancy of the French-speaking majority in Quebec (Auger et al., 2012). However, these language groups clearly have different ancestors as the language groups originate from colonies of different European countries. Furthermore, the Flemish people in the Netherlands have a longer life-expectancy than the French-speaking (Van Oyen, Tafforeau and Roelands, 1996), however, this language group is a majority in Belgium.

Significant differences in the presence and severity of coronary calcification (as a marker of coronary atherosclerosis) according to ethnicity, independent of atherosclerotic risk factors occur in countries with more diverse population (Bild et al., 2005). These results suggest differences in genetic susceptibility especially between racial groups. Genetic studies have shown the Swedish-speaking population of Finland to have a Finnish admixture of about 60% in their genes (Virtaranta-Knowles, Sistonen and Nevanlinna, 1991). A more recent genome-wide structure analysis of single nucleotide polymorphisms indicates that the Finnish population who are Swedish-speaking has an increased Swedish contribution in their genetic profile compared to non-Swedish-speaking Finns (Salmela et al., 2008). Thus, although the Finnish- and Swedish-speaking people in Finland belong to the same race and ethnic group, differences in genetic makeup may play a role in the differences in mortality and morbidity.

The other hypothesis was that these differences are due to the previously noted better SES of the Swedish-speaking minority. However, in this study, improved SES of the Swedish-speaking men did not fully explain their lower cardiovascular morbidity since the differences decreased but remained significant after adjusting for SES. The measurement of SES is inevitably somewhat crude and therefore, we cannot totally exclude the possibility of residual confounders. Together these results, nevertheless, suggest that in addition to SES and the factors related to SES discussed in the following chapter, there are other factors, influencing the lower coronary morbidity and mortality of the Swedish-speaking population.

Differences in cardiovascular risk factor levels might contribute to our observations. Study IV provided information on the classical risk factors of MI (BP, BMI, cholesterol, smoking and alcohol consumption) among the Finnish- and Swedish-speaking inhabitants of Turku, Loimaa and the Helsinki metropolitan area in the FINRISK data. Swedish-speaking people had higher levels of serum HDL-cholesterol, lower levels of triglycerides, lower diastolic BP and lower BMI than Finnish-speaking people. The magnitude of these differences was, however, modest and their clinical significance is uncertain. However, all differences were to the expected direction suggesting higher risk among Finnish-speakers and thus results were consistent with the observed differences in coronary and stroke mortality and morbidity. Swedish-speaking people had higher education and greater household income levels, but the differences in the risk factors were independent of the differences in the socioeconomic factors**.** In addition, in a previous study, however, the Swedish-speaking people have reported lower rates of daily smoking (Nyqvist et al., 2008). According to a questionnaire study, Finnish-speaking people are more prone to binge drinking (Paljärvi et al., 2009), but this finding was not confirmed in the present study.

The Swedish-speaking population of Turku - and Finland - has the same health services available and the same health service costs as the Finnish-speaking population and therefore differences in health services are unlikely to cause health differences in other mechanisms than possibly *via* socioeconomic differences and the mechanisms related to this, as previously discussed but is nevertheless unlikely to explain differences unrelated to SES. However, information on possible differences in the use of private clinics' services is not available.

The longer life expectancy and better health of the Swedish-speaking minority in Finland have previously been suggested to be mediated by the larger amount of social capital of the Swedish-speaking community (Hyyppä and Mäki, 2001). Social capital can be defined as an individual- or community-level social feature that is reflected in the structure of social relationships. Structural forms of social capital relate to social structures such as networks and associations. Cognitive forms of social capital relate to the more subjective or intangible elements such as trust and norms of reciprocity (Baum and Ziersch, 2003). Hyyppä and Mäki studied the population of Ostrobothnia in Finland and found that the Swedish-speaking population of this area showed more reciprocal confidence and civic engagement than the Finnish-speaking population (Hyyppä and Mäki, 2001).

Social capital has, indeed, been suggested to be a beneficial mediator in population health as social capital associates with a lower risk of death (of any cause) (Kawachi et al., 1997). Social capital has been defined as a collective feature that may promote health through community-level processes. Analyses on the Finnish Mini-Finland Health Survey data reveal that leisure participation (as a measure of individual-level social capital) is associated with lower risk of death even after adjustment for age, gender, tobacco smoking, alcohol use, obesity, self-rated health and diagnosed chronic disease (Hyyppä et al., 2006). However, results from the same study on the association of social capital and cardiovascular mortality were mainly statistically insignificant when household income and other cardiovascular risk factors were adjusted for (Hyyppä et al., 2007). Rosengren et al. have, in turn, reported from a rather small prospective study, with the study data consisting of 741 Swedish men, that low social integration was predictive of coronary morbidity, independently of other risk factors (Rosengren, Wilhelmsen and Orth-Gomér, 2004). Furthermore, Eng et al. (Eng et al., 2002) shows, from a larger prospective study (n= 28,369), that socially isolated men had an increased risk of fatal CHD compared to socially, well-integrated men (multivariate RR 1.82, 95% CI 1.02 to 3.23) but the incidence of total CHD, nonfatal MI, and sudden cardiac death was not significantly increased among socially isolated men. However, the data consisted of health professionals and therefore the results may not be generalized to men with lower SES.

This social capital may promote the health and longevity of the Swedish-speaking population. However, the Health and Social Support (HeSSup) Study demonstrates that the Swedish-speaking people living intermingled with Finnish-speaking people (instead of living as a community as in the studies by Hyyppä and Mäki) do not necessarily possess more social capital attributable to human connections compared to the Finnish-speaking people (Volanen et al., 2006). Instead, the HeSSup Study links childhood adversities with a higher risk of cardiovascular diseases (Korkeila et al., 2010) and reports that the Swedish-speakers may have less childhood adversities (Volanen et al., 2006). However, the HESSup Study had a response rate of only 40%, possibly affecting the results and social capital was measured merely by close social connection and social support, possibly representing only one aspect of social capital and not quite directly comparable to the measurement of social capital in the Mini-Finland Survey, discussed previously.

In their analyses of the Ostrobothnian population, Hyyppä and Mäki have also found, that a higher proportion of Swedish-speaking than Finnish-speaking men living in this area were married or cohabiting (Hyyppä and Mäki, 2001). This may also be a factor influencing our language group results through ways discussed previously.

6.4 Strengths and limitations

The main data source of the study, the FINAMI MI register data, is a population-based large study and a large number of events have been recorded in the register. These are major strengths of the study. One limitation of the FINAMI study is that only few rural municipalities are included around the town of Joensuu. Therefore, these results may not be fully representative for the rural areas of Finland.

The age group, included in the data, changed when the register changed from FINMONICA to FINAMI. However, this change in the registered age groups does not affect our analyses as only the age group that was consistently registered (persons aged 35-64 years-old) is included in the trend analyses. Furthermore, in the period of the FINAMI register, the registration area has expanded and several urban areas are included. However, as the area is included as covariate in the analyses, the change in registration areas should not affect the trend results and as Loimaa - a rural area near Turku – was included in the FINMONICA register but not in the FINAMI register, it was not included in the trend analyses.

The adoption of new and more sensitive biomarkers of myocardial injury, such as cardiac troponins, during the latter half of the 1990's, posed challenges on consistent monitoring of trends in cardiac coronary events. It is known that because of their greater sensitivity, troponins detect MIs that cannot be detected with the enzymatic markers of myocardial injury (Kontos et al., 2003) and that this effect hid the declining trends in the incidence of coronary events in the FINAMI study in 1993-2002 (Salomaa et al., 2006). However, in our study, trend analyses of years 1988-2002 were made according socioeconomic and sociodemographic characteristics. Therefore, the adoption of troponins would only have affected our results if the use of troponin tests had significant socioeconomic or sociodemographic inequalities. It is very unlikely that such inequalities existed in Finland. The registration procedure in itself is also unlikely to affect the analyses as it can be assumed that the physicians maintaining the register analyzed the electrocardiograms of different socioeconomic or sociodemographic groups, objectively.

Record linkage of the data at individual level with the files of Statistics Finland provided us with accurate information on SES. The use of individual level data on taxable income, education and profession leads to less misclassification than the use of surrogate markers and therefore gives a more correct view on the health differences between socioeconomic groups. Recent results from Tarkiainen and colleagues emphasize the importance of studying disparities between income groups as their research showed an increase in the relative excess mortality among the lowest income groups over time and this could not be attributed to the changing socio-demographic composition between income groups (*i.e.* changing proportions of people living in a single household and being unemployed or out of the workforce) (Tarkiainen, Martikainen and Laaksonen, 2013). It should, however, be acknowledged, that in our study, the classification of unemployed and students to the group "others" may have caused apparent distinct differences according to profession, because the persons in this group may be previously sick or handicapped, therefore affecting their treatment and prognosis. Furthermore, working life has changed during the time period used in the trend analyses and the valuation and commonness of different occupations has changed as well as the job descriptions. Some published studies indicate that there are minimal differences if only one measure or multiple indicators are used to capture SES (Foraker et al., 2011). In the current data, however, individual-level measures of SES were used and the relative differences between the income groups and education groups were lessened by age but remained significant among men even in the highest age group of 75-99 years. However, when profession was used as the indicator of SES, the differences in incidence between men in blue-collar professions and upper-level white collar professions were no longer significant after the age of 75 years. Among women, no significant difference between the two education groups was seen in the highest age group of 75-99 years. As the results were not the same according to every SES measure and every age group, it was important to take them all into consideration. Furthermore, the measures of SES are interrelated, as discussed in chapter 2.3.1.

Previous studies relate childhood SES with CHD morbidity (Kittleson et al., 2006) and mortality (Smith et al., 1998), and cardiovascular risk factors (Kivimäki et al., 2006). The hypothesis about the fetal origins of cardiovascular disease is suggested to be one reason behind the socioeconomic health differences. This hypothesis suggests that children with a low birth weight have an increased risk of coronary heart disease later in life. The risk is further increased by low weight gain during infancy and rapid weight gain after the age of one (Eriksson et al., 2001). Because a low birthweight has been more common in children of parents with low SES, it is possible that the adverse effects of low SES on coronary heart disease mortality begins early in life and is not directly proportional to the SES of adult life. Therefore, it would also had been interesting to take childhood SES into account – in addition to adulthood SES – but unfortunately we had no information on childhood living conditions nor childhood health status. When interpreting the results and suggesting measures to reduce socioeconomic inequalities, it should therefore be acknowledged, that in studies I, III and IV, SES was measured at one time point and no information on life-course patterns of SES was available. Subjective social or socioeconomic status – instead of objective SES – is independently linked with poor health and for example angina pectoris in the Whitehall II Study (Singh-Manoux, Adler and Marmot, 2003) and with other outcomes thereafter. This would have also been an interesting measure to study, but unfortunately no access to such information was available. From a public health perspective, the measurement of objective SES and thereby the targeting of possible measures to reduce inequalities is more readily available and more realistic to execute and research on inequalities by objective measures could therefore be considered more important.

Furthermore, we had no information on possible marital transitions allowing more accurate analyses, as it has been studied earlier, that remarried men have a higher total mortality risk than those in a consistent marriage but have lower mortality risks than the divorced or widowed (Blomgren et al., 2012). Furthermore, we do not know the proportion of unmarried cohabiting couples in our data.

Stroke is a disease of older people and, as the majority of the elderly are women, the number of stroke events is higher among women. This difference should not affect our comparisons between the language groups, since the rates are age-standardized and shown separately for both genders. The incorporation of older age-groups into the same analyses (Studies III and IV) could be argued, as differences in income level and prestige diminish after the retirement and with aging. However, the importance of SES to cardiovascular risk does not completely vanish with age but remains to a lesser degree even among the oldest (Avendano et al., 2006). Furthermore, we had no information on the prevalence of stroke risk factors in the Finnish- and Swedish-speaking background populations of Turku, which prevented us from including these factors in our Poisson regression models.

The non-independence of recurrent events was not taken into account in the attack rate analyses, which is the usual way to present this kind of population-based analyses in the literature. However, our results include and focus mainly on incidence and mortality, which both are one-time events for a person.

We found socioeconomic- and –demographic differences in the proportion of patients receiving thrombolysis. Unfortunately, as mentioned earlier, information on all contraindications of thrombolysis was not collected in the FINAMI Register data, but data on treatment-seeking time was collected and regarding that, no significant differences were found.

6.5 Future aspects

To reveal pathways between sociodemographic characteristics and the found higher morbidity and poorer prognosis of acute coronary events, further research should be done on cardiovascular risk factor profiles according to sociodemographic characteristics in Finland.

The formation of socioeconomic differences in cardiovascular health in childhood should be paid special attention to because the indicators of socioeconomic status in adulthood are related to factors in childhood and these inequalities may start to form early. In these at risk individuals, prevention of the development of risk factors and social isolation should be implemented in disadvantaged groups.

Unfortunately, data in this thesis had no information on possible differences in dietary habits between the language groups. This is, however, an interesting topic that has not been studied yet by anyone in detail and needs further study in the future. The risk factor profiles of Finnish-speakers need special attention for the MI and stroke morbidity and mortality of the Finnish-speakers to reach the lower level of the Swedish-speakers.

The association of social capital and social support to the cardiovascular morbidity and mortality disparities between socioeconomic and sociodemographic groups and language groups in Finland needs further research and measures to prevent the social isolation of the youth should be considered.

7. CONCLUSIONS

In conclusion:

I) Socioeconomic differences in ACS morbidity and mortality were still found in all age groups among both men and women and these differences were not affected by the economic recession of the 1990's.

II) Being unmarried increases the risk of having a heart attack both in men and women regardless of age and living single or unmarried worsened the prognosis of acute coronary events.

III) Significant variations were found in stroke and ACS morbidity and mortality between the Swedish- and Finnish-speaking people in Turku, Finland. Some disparities were found also in risk factor levels between the language groups in the FINRISK data. The Swedish-speaking participants had a higher HDL-cholesterol, lower serum triglyceride concentration, lower diastolic BP and lower BMI than the Finnish-speaking participants and these differences remained significant after adjusting for the indicators of SES (household income and education). These differences may partly explain the language group discrepancies found in stroke and ACS morbidity and mortality.

IV) The incongruity in cardiovascular morbidity and mortality between the two language groups could not be explained fully by differences in SES.

Some socioeconomic and sociodemographic variances were found also in the treatment of MIs in Finland. Middle-aged men in the highest income tertile received thrombolysis and underwent early revascularization more often than men in the lowest income tertile. Middle-aged, single living or unmarried men received thrombolysis less often than others. These results may partly explain the found mortality differences between socioeconomic and sociodemographic groups, but most of the excess mortality in single living and unmarried appeared already before hospital admission and therefore seems not to be related to differences in the treatment of ACS.

In addition, to differences in risk factor profiles, primary and secondary prevention and treatment, several psychosocial aspects (prevalence of depression, social isolation, lack of social support and social capital, *etc.*) may play a role in causing population group differences in cardiovascular disease morbidity and mortality but these aspects require further research.

In conclusion, implementing strategies to reduce differences in socioeconomic, sociodemographic and language groups in the morbidity and mortality of cardiovascular diseases could decrease the public health burden this disease group causes.

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9. REFERENCES

Abdullah, A., Wolfe, R., Stoelwinder, J., de Courten, M., Stevenson, C., Walls, H. and Peeters, A. (2011) 'The number of years lived with obesity and the risk of all-cause and cause-specific mortality', *Int J Epidemiol*, vol. 40, no. 4, pp. 985-96.

Ajani, U., Lotufo, P., Gaziano, J., Lee, I., Spelsberg, A., Buring, J., Willett, W. and Manson, J. (2004) 'Body mass index and mortality among US male physicians', *Ann Epidemiol*, vol. 14, no. 10, pp. 731-9.

Alfredsson, L., Ahlbom, A. and Theorell, T. (1982) 'Incidence of myocardial infarction among male Finnish immigrants in relation to length of stay in Sweden', *Int J Epidemiol*, vol. 11, no. 3, pp. 225-8.

Amarenco, P., Labreuche, J., Lavallée, P. and Touboul, P. (2004) 'Statins in Stroke Prevention and Carotid Atherosclerosis. Systematic Review and Up-to-Date Meta-Analysis', *Stroke*, vol. 35, no. 12, pp. 2902-9.

Anand, S., Islam, S., Rosengren, A., Franzosi, M., K, S., Yusufali, A., Keltai, M., Diaz, R., Rangarajan, S., Yusuf, S. and Investigators, I. (2008) 'Risk factors for myocardial infarction in women and men: insights from the INTERHEART study', *Eur Heart J*, vol. 29, no. 7, pp. 932-40.

Anderson, C., Biffi, A., Rost, N., Cortellini, L., Furie, K. and Rosand, J. (2010) 'Chromosome 9p21 in ischemic stroke: population structure and meta-analysis', *Stroke*, vol. 41, no. 6, pp. 1123-31.

Anderson, C., Ni Mhurchu, C., Scott, D., Bennett, D., Jamrozik, K. and Hankey, G. (2003) 'Triggers of subarachnoid hemorrhage: role of physical exertion, smoking, and alcohol in the Australasian Cooperative Research on Subarachnoid Hemorrhage Study (ACROSS)', *Stroke*, vol. 34, no. 7, pp. 1771-6.

Antonovsky, A. (1967) 'Social class, life expectancy and overall mortality', *Milbank Mem Fund Q*, vol. 45, no. 2, pp. 31-73.

Atzema, C., Austin, P., Huynh, T., Hassan, A., Chiu, M., Wang, J. and Tu, J. (2011) 'Effect of marriage on duration of chest pain associated with acute myocardial infarction before seeking care', *CMAJ*, vol. 183, no. 13, pp. 1482-91.

Auger, N., Harper, S., Barry, A., Trempe, N. and Daniel, M. (2012) 'Life expectancy gap between the Francophone majorty and Anglophone minority of Canadian population', *Eur J Epidemiol*, no. 27, pp. 27-38.

Avendano, M., Kunst, A., Huisman, M., Lenthe, F., Bopp, M., Regidor, E., Glickman, M., Costa, G., Spadea, T., Deboseere, P., Borrell, C., Valkonen, T., Gisser, R., Borgan, J., Gadeyne, S. and Mackenbach, J. (2006) 'Socioeconomic status and ischaemic heart disease mortality in 10 western European populations during the 1990s', *Heart*, vol. 92, no. 4, pp. 461-7.

Avendano, M., Kunst, A., Huisman, M., van Lenthe, F., Bopp, M., Borrell, C., Valkonen, T., Regidor, E., Costa, G., Donkin, A., Borgan, J., Deboseere, P., Gadeyne, S., Spadea, T., Andersen, O. and Mackenbach, J. (2004) 'Educational level and stroke mortality: a comparison of 10 European populations during the 1990s', *Stroke*, vol. 35, no. 2, pp. 432-7.

Ballantyne, C. and Hoogeveen, R. (2003) 'Role of lipid and lipoprotein profiles in risk assessment and therapy.', *Am Heart J*, vol. 146, no. 2, pp. 227-33.

Barefoot, J., Helms, M., Mark, D., Blumenthal, J., Califf, R., Haney, T., O'Connor, C., Siegler, I. and Williams, R. (1996) 'Depression and long-term mortality risk in patients with coronary artery disease', *Am J Cardiol*, vol. 78, no. 6, pp. 613-7.

Batty, G., Shipley, M., Jarrett, R., Breeze, E., Marmot, M. and Davey Smith, G. (2006) 'Obesity and overweight in relation to disease-specific mortality in men with and without existing coronary heart disease in London: the original Whitehall study', *Heart*, vol. 92, no. 7, pp. 886-92.

Baum, F. and Ziersch, A. (2003) 'Social capital', *j Epidemiol Community Health*, vol. 57, no. 5, pp. 320-3.

Ben-Shlomo, Y., Smith, G., Shipley, M. and Marmot, M. (1993) 'Magnitude and causes of mortality differences between married and unmarried men', *J Epidemiol Community Health*, vol. 47, no. 3, pp. 200-5.

Berry, J., Dyer, A., Cai, X., Garside, D., Ning, H., Thomas, A., Greenland, P., Van Horn, L., Tracy, R. and Lloyd-Jones, D. (2012) 'Lifetime Risks of Cardiovascular Disease', *N Engl J Med*, vol. 366, no. 4, pp. 321-9.

Bild, D., Detrano, R., Peterson, D., Guerci, A., Liu, K., Shahar, E., Ouyang, P., Jackson, S. and Saad, M. (2005) 'Ethnic differences in coronary calcification: the Multi-Ethnic Study of Atherosclerosis (MESA)', *Circulation*, vol. 111, no. 10, pp. 1313-20.

Blomgren, J., Martikainen, P., Grundy, E. and Koskinen, S. (2012) 'Marital history 1971-91 and mortality 1991-2004 in England & Wales and Finland', *J Epidemiol Community Health*, vol. 66, no. 1, pp. 30-6.

Bouma, J., Broer, J., Bleeker, J., van Sonderen, E., Meyboom-de Jong, B. and DeJongste, M. (1999) 'Longer pre-hospital delay in acute myocardial infarction in women because of longer doctor decision time', *J Epidemiol Community Health*, vol. 53, no. 8, pp. 459-64.

Braveman, P., Cubbin, C., Egerter, S., Chideya, S., Marchi, K., Metzler, M. and Posner, S. (2005) 'Socioeconomic status in health research: one size does not fit all', *JAMA*, vol. 294, no. 22, pp. 2879-88.

Brunner, E., Shipley, M., Witte, D., Fuller, J. and Marmot, M. (2006) 'Relation between blood glucose and coronary mortality over 33 years in the Whitehall Study', *Diabetes Care*, vol. 29, no. 1, pp. 26-31.

Cesaroni, G., Agabiti, N., Forastiere, F. and Perucci, C. (2009) 'Socioeconomic differences in stroke incidence and prognosis under a universal healthcare system', *Stroke*, vol. 40, no. 8, pp. 2812-9.

Coutinho, M., Gerstein, H., Wang, Y. and Yusuf, S. (1999) 'The relationship between glucose and incident cardiovascular events. A metaregression analysis of published data from 20 studies of 95,783 individuals followed for 12.4 years', *Diabetes Care*, vol. 22, no. 2, pp. 233-40.

Creager, M., Lüscher, T., Cosentino, F. and Beckman, J. (2003) 'Diabetes and vascular disease: pathophysiology, clinical consequences, and medical therapy: Part I', *Circulation*, vol. 108, no. 12, pp. 1527-32.

Dalstra, J., Kunst, A., Borrell, C., Breeze, E., Cambois, E., Costa, G., Geurts, J., Lahelma, E., Van Oyen, H., Rasmussen, N., Regidor, E., T, S. and Mackenbach, J. (2005) 'Socioeconomic differences in the prevalence of common chronic diseases: an overview of eight European countries.', *Int J Epidemiol*, vol. 34, no. 2, pp. 316-26.

Deckert, T., Poulsen, J. and Larsen, M. (1978) 'Prognosis of diabetics with diabetes onset before the age of thirty-one. II. Fators influencing the prognosis.', *Diabetologia*, vol. 14, pp. 371-7.

Diez-Roux, A., Kiefe, C., Jacobs, D.J., Haan, M., Jackson, S., Nieto, F., Paton, C. and Schulz, R. (2001) 'Area characteristics and individual-level socioeconomic position indicators in three population-based epidemiologic studies', *Ann Epidemiol*, vol. 11, no. 6, pp. 395-405.

Doll, R. and Peto, R. (1976) 'Mortality in relation to smoking: 20 years' observations on male British doctors', *BMJ*, no. 2, pp. 1525-36.

Dorman, J., LaPorte, L.E., Kuller, L., Cruickshanks, K., Orchard, T., Wagener, D., Becker, D., Cavender, D. and Drash, A. (1984) 'The Pittsburg Insulin-Dependent Diabetes Mellitus (IDDM) Morbidity and Mortality Study: mortality results.', *Diabetes*, vol. 33, pp. 271-6.

Ehret, G., Munroe, P., Rice, K., Bochud, M., Johnson, A., Chasman, D., Smith, A., Tobin, M., GC, V., Hwang, S., Pihur, V., Vollenweider, P., O'Reilly, P., Amin, N., Bragg-Gresham, J., Teumen, A., Glazer, N., Launer, L., Zhao, J., Aulchenko, Y. et al. (2011) 'Genetic variants in novel pathways influence blood pressure and cardiovascular disease risk.', *Nature.*, vol. 478, no. 7367, pp. 103-9.

Empana, J., Jouven, X., Lemaitre, R., Sotoodehnia, N., Rea, T., Raghunathan, T., Simon, G. and Siscovick, D. (2008) 'Marital status and risk of out-of-hospital sudden cardiac arrest in the population', *Eur J Cardiovasc Prev Rehabil*, vol. 15, no. 5, pp. 577-82.

Eng, P., Rimm, E., Fitzmaurice, G. and Kawachi, I. (2002) 'Social ties and change in social ties in relation to subsequent total and cause-specific mortality and coronary heart disease incidence in men', *Am J Epidemiol*, vol. 155, no. 8, pp. 700-9.

Engström, G., Hedblad, B., Rosvall, M., Janzon, L. and Lindgärde, F. (2006) 'Occupation, marital status, and low-grade inflammation: mutual confounding or independent cardiovascular risk factors?', *Arterioscler Thromb Vasc Biol*, vol. 26, no. 3, pp. 643-8.

Engström, G., Khan, F., Zia, E., Jerntorp, I., Pessah-Rasmussen, H., Norrving, B. and Janzon, L. (2004) 'Marital dissolution is followed by an increased incidence of stroke', *Cerebrovasc Dis*, vol. 18, no. 4, pp. 318-24.

Eriksson, G., Forsén, T., Tuomilehto, J., Osmond, C. and Barker, D. (2001) 'Early growth and coronary disease in later life: longitydinal study', *BMJ*, pp. 949-53.

Flossmann, E., Schulz, U. and Rothwell, P. (2004) 'Systematic review of methods and results of studies of the genetic epidemiology of ischemic stroke', *Stroke*, vol. 35, no. 1, pp. 212-27.

Foraker, R., Rose, K., Kucharska-Newton, A., Ni, H., Suchindran, C. and Whitsel, E. (2011) 'Variation in rates of fatal coronary heart disease by neighborhood socioeconomic status: the atherosclerosis risk in communities surveillance (1992-2002)', *Ann Epidemiol*, vol. 21, no. 8, pp. 580-8.

Foraker, R., Rose, K., McGinn, A., Suchindran, C., Goff, D.J., Whitseal, E., Wood, J. and Rosamond, W. (2008) 'Neighborhood income, health insurance, and prehospital delay for myocardial infarction: the atherosclerosis risk in communities study', *Arch Intern Med*, vol. 168, no. 17, pp. 1974-9.

Frasure-Smith, N., Lespérance, F., Gravel, G., Masson, A., Juneau, M., Talajic, M. and Bourassa, M. (2000) 'Social support, depression, and mortality during the first year after myocardial infarction', *Circulation*, vol. 101, no. 16, pp. 1919-24.

Frasure-Smith, N., Lespérance, F. and Talajic, M. (1995) 'Depression and 18-month prognosis after myocardial infarction', *Circulation*, vol. 91, no. 4, pp. 999-1005.

Freeman, K., Zonszein, J., Islam, N., Blank, A. and Strelnick, A. (2011) 'Mortality Trends and Disparities Among Racial/Ethnic and Sex Subgroups in New York City, 1990 to 2000', *J Immigr Minor Health*, vol. 13, no. 3, pp. 546-54.

Fuller, J., Shipley, M., Rose, G., Jarrett, R. and Keen, H. (1983) 'Mortality from coronary heart disease and stroke in relation to degree of glycaemia: the Whitehall Study', *Br Med J*, vol. 287, no. 6396, pp. 867-70.

Galobardes, B., Shaw, M., Lawlor, D., Lynch, J. and Davey Smith, G. (2006) 'Indicators of socioeconomic position (part 1)', *J Epidemiol Community Health*, vol. 60, no. 1, pp. 7-12.

Gerward, S., Tydén, P., Engström, G. and Hedblad, B. (2010) 'Marital status and occupation in relation to short-term case fatality after a first coronary event--a population based cohort', *BMC Public Health*, vol. 10, pp. 235-42.

Gibler, W., Armstrong, P., Ohman, E., Weaver, W., Stebbins, A., Gore, J., Newby, L., Califf, R. and Topol, E. (2002) 'Persistence of delays in presentation and treatment for patients with acute myocardial infarction: The GUSTO-I and GUSTO-III experience', *Ann Emerg Med*, vol. 39, no. 2, pp. 123-30.

Gillum, R., Mussolino, M. and Ingram, D. (1996) 'Physical activity and stroke incidence in women and men. The NHANES I Epidemiologic Follow-up Study', *Am J Epidemiol*, vol. 143, no. 9, pp. 860-9.

Goldberg, R., Gorak, E., Yarzebski, J., Hosmer, D., P, D., Gore, J., Alperts, J. and Dalen, J. (1993) 'A communitywide perspective of sex differences and temporal trends in the incidence and survival rates after acute myocardial infarction and out-of-hospital deaths caused by coronary heart disease', *Circulation*, vol. 87, no. 6, pp. 1947-53.

Goldstein, L., Bushnell, C., Adams, R., Appel, L., Braun, L., Chaturvedi, S., Creager, M., Culebras, A., Eckel, R., Hart, R., Hinchey, J., Howard, V., Jauch, E., Levine, S., Meschia, J., Moore, W., Nixon, J., Pearson, T., Council, o.b.o.t.A.H.A.S., Nursing, C.o.C. et al. (2011) 'Guidelines for the

Primary Prevention of Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association', *Stroke*, vol. 42, no. 2, pp. 517-84.

Gordon, T., Castelli, W., Hjortland, M., Kannel, W. and Dawber, T. (1977) 'High density lipoprotein as a protective factor against coronary heart disease. The Framingham Study', *Am J Med*, vol. 62, no. 5, pp. 707-14.

Gudbjartsson, D., Holm, H., Gretarsdottir, S., Thorleifsson, G., Walters, G., Thorgeirsson, G., Gulcher, J., Mathiesen EB, N.I.N.A.W.T., Hald EM, H.K.S.C.K.G., Stubblefield T, C.S.R.D.N.M.B.L., So WY, W.K.C.J.G.C.W.H., Gschwendtner A, D.M.K.G., Berger K, R.E.B.S.M.H., Kostulas K, H.J.S.S., Valdimarsson EM, L.M.M.R., Darbar D, K.A.A.D.T.U. and K, S. (2009) 'A sequence variant in ZFHX3 on 16q22 associates with atrial fibrillation and ischemic stroke', *Nat Genet*, vol. 41, no. 8, pp. 876-8.

Haffner, S., Lehto, S., Rönnemaa, T., Pyörälä, K. and Laakso, M. (2001) 'Mortality From Coronary Heart Disease In Subjects With Type 2 Diabetes And In Nondiabetic Subjects With And Without Prior Myocardial Infarction', *N Engl J Med*, vol. 344, no. 18, pp. 1343-50.

Hakovirta, M. and Rantalaiho, M. (2012) *Taloudellinen eriarvoisuus lasten arjessa*, Kela.

Harald, K., Koskinen, S., Jousilahti, P., Torppa, J., Vartiainen, E. and Salomaa, V. (2008) 'Changes in traditional risk factors no longer explain time trends in cardiovascular mortality and its socioeconomic differences', *J Epidemiol Community Health*, vol. 62, no. 3, pp. 251-7.

Harald, K., Pajunen, P., Jousilahti, P., Koskinen, S., Vartiainen, E. and Salomaa, V. (2006) 'Modifiable risk factors have an impact on socio-economic differences in coronary heart disease events', *Scand Cardiovasc J*, vol. 40, no. 2, pp. 87-95.

Harismendy, O., Notani, D., Song, X., Rahim, N., Tanasa, B., Heintzman, N., Ren, B., Fu, X., Topol, E., Rosenfeld, M. and Frazer, K. (2011) '9p21 DNA variants associated with coronary artery disease impair interferon-γ signalling response', *Nature*, vol. 470, no. 7333, pp. 264-8.

Hart, R., Pearce, L., Miller, V., Anderson, D., Rothrock, J., Albers, G. and Nasco, E. (2000) 'Cardioembolic vs. noncardioembolic strokes in atrial fibrillation: frequency and effect of antithrombotic agents in the stroke prevention in atrial fibrillation studies', *Cerebrovasc Dis*, vol. 10, no. 1, pp. 39-43.

Helgadottir, A., Thorleifsson, G., Manolescu, A., Gretarsdottir, S., Blondal, T., Jonasdottir, A., Sigurdsson, A., Baker, A., Palsson, A., Masson, G., Gudbjartssob, D., MAgnusson, K., Andersen, K., Levey, A., Backman, V., Matthiasdottir, S., Jonsdottir, T., Palsson, S., Einarsdottir, H., Gunnarsdottir, S. et al. (2007) 'A common variant on chromosome 9p21 affects the risk of myocardial infarction', *Science*, vol. 316, no. 5830, pp. 1491-3.

Hergens, M., Alfredsson, L., Bolinder, G., Lambe, M., Pershagen, G. and Ye, W. (2007) 'Long-term use of Swedish moist snuff and the risk of myocardial infarction amongst men', *J Intern Med*, vol. 262, no. 3, pp. 351-9.

Hetemaa, T., Keskimäki, I., Manderbacka, K., Leyland, A. and Koskinen, S. (2003) 'How did the recent increase in the supply of coronary operations in Finland affect socioeconomic and gender equity in their use', *J Epidemiol Community Health*, vol. 57, no. 3, pp. 178-85.

Hetemaa, T., Keskimäki, I., Salomaa, V., Mähönen, M., Manderbacka, K. and Koskinen, S. (2004) 'Socioeconomic inequities in invasive cardiac procedures after first myocardial infarction in Finland in 1995', *J Clin Epidemiol*, vol. 57, no. 3, pp. 301-8.

He, J., Vupputuri, S., Allen, K., Prerost, M., Hughes, J. and Whelton, P. (1999) 'Passive smoking and the risk of coronary heart disease--a meta-analysis of epidemiologic studies', *N Engl J Med*, vol. 340, no. 12, pp. 920-6.

Hochman, J., Tamis, J., Thompson, T., Weaver, W., HD, W., Van de Werf, F., Aylward, P., Topol, E. and Califf, R. (1999) 'Sex, clinical presentation, and outcome in patients with acute coronary syndromes. Global Use of Strategies to Open Occluded Coronary Arteries in Acute Coronary Syndromes IIb Investigators', *N Engl J Med*, vol. 341, no. 4, pp. 226-32.

Horsten, M., Mittleman, M., Wamala, S., Schenk-Gustafsson, K. and Orth-Gomér, K. (2000) 'Depressive symptoms and lack of social integration in relation to prognosis of CHD in middle-aged women. The Stockholm Female Coronary Risk Study', *Eur Heart J*, vol. 21, no. 13, pp. 1072-80.

Huisman, M., Kunst, A., Bopp, M., Borgan, J., Borrell, C., Costa, G., P, D., S, G., Glickman, M., Marinacci, C., Minder, C., Regidor, E., Valkonen, T. and Mackenbach, J. (2005) 'Educational inequalities in cause-specific mortality in middle-aged and older men and women in eight western European populations', *Lancet*, vol. 365, no. 9457, pp. 493-500.

Hyyppä, M. and Mäki, J. (2001) 'Individual-level relationships between social capital and self-rated health in a bilingual community', *Prev Med*, vol. 32, no. 2, pp. 148-55.

Hyyppä, M. and Mäki, J. (2001) 'Why do Swedish-speaking Finns have longer active life? An area for social capital research', *Health Promotion Intern*, vol. 16, pp. 55-64.

Hyyppä, M., Mäki, J., Impivaara, O. and Aromaa, A. (2006) 'Leisure participation predicts survival: a population-based study in Finland', *Health Promot Int*, vol. 21, no. 1, pp. 5-12.

Hyyppä, M., Mäki, J., Impivaara, O. and Aromaa, A. (2007) 'Individual-level measures of social capital as predictors of all-cause and cardiovascular mortality: a population-based prospective study of men and women in Finland', *Eur J Epidemiol*, vol. 22, no. 9, pp. 589-97.

Inaba, A., Thoits, P., Ueno, K., Gove, W., Evenson, R. and Sloan, M. (2005) 'Depression in the United States and Japan: gender, marital status, and SES patterns', *Soc Sci Med*, vol. 61, no. 11, pp. 2280-92.

Iso, H., Baba, S., Mannami, T., Sasaki, S., Okada, K., Konishi, M., Tsugane, S. and Group, J.S. (2004) 'Alcohol consumption and risk of stroke among middle-aged men: the JPHC Study Cohort I', *Stroke*, vol. 35, no. 5, pp. 1124-9.

Iso, H., Jacobs, D., Wentworth, D., Neaton, J. and Cohen, J. (1989) 'Serum cholesterol levels and six-year mortality from stroke in 350,977 men screened for the multiple risk factor intervention trial', *N Engl J Med*, vol. 320, no. 14, pp. 904-10.

Jackson, R., Scragg, R. and Beaglehole, R. (1991) 'Alcohol consumption and risk of coronary heart disease', *BMJ*, vol. 303, no. 6796, pp. 211-6.

Jakab, Z. (2011) 'Message from the WHO Regional Director for Europe: Embarking on Developing the New European Health Policy - Health 2020', *Eur J Public Health*, vol. 21, no. 1, p. 131.

Jakovljevic, D., Sarti, C., Sivenius, J., Torppa, J., Mähönen, M., Immonen-Räihä, P., Kaarsalo, E., Alhainen, K., Kuulasmaa, K., Tuomilehto, J., Puska, P. and Salomaa, V. (2001) 'Socioeconomic status and ischemic stroke: The FINMONICA Stroke Register', *Stroke*, vol. 32, no. 7, pp. 1492-8.

Jakovljevic, D., Sivenius, J., Sarti, C., Torppa, J., Mähönen, M., Immonen-Räihä, P., Kaarsalo, E., Alhainen, K., Tuomilehto, J., Puska, P. and Salomaa, V. (2001) 'Socioeconomic inequalities in the incidence, mortality and prognosis of subarachnoid hemorrhage: the FINMONICA Stroke Register', *Cerebrovasc Dis*, vol. 12, no. 1, pp. 7-13.

Jalovaara, M. (2003) 'The joint effects of marriage partnersä socioeconomic position on the risk of divorce', *Demography*, vol. 40, no. 1, pp. 67-81.

Janzon, E. and Hedblad, B. (2009) 'Swedish snuff and incidence of cardiovascular disease. A population-based cohort study', *BMC Cardiovasc Disord*, vol. 9.

Johnson, N., Backlund, E., Sorlie, P. and Loveless, C. (2000) 'Marital status and mortality: the national longitudinal mortality study', *Ann Epidemiol*, vol. 10, no. 4, pp. 224-38.

Jolly, S., Vittinghoff, E., Chattopadhay, A. and Bibbins-Domingo, K. (2010) 'Higher cardiovascular disease prevalence and mortality among younger blacks compared to whites', *Am J Med*, vol. 123, no. 9, pp. 811-8.

Jorgensen, H., Nakayama, H., Reith, J., Raaschou, H. and Olsen, T. (1996) 'Acute stroke with atrial fibrillation. The Copenhagen Stroke Study', *Stroke*, vol. 27, no. 10, pp. 1765-9.

Joshi, P., Islam, S., Pais, P., Reddy, S., Dorairaj, P., Kazmi, K., Pandey, M., Hague, S., Mendis, S., Rangarajan, S. and Yusuf, S. (2007) 'Risk factors for early myocardial infarction in South Asians compared with individuals in other countries', *JAMA*, vol. 297, no. 3, pp. 286-94.

Kannel, W. (1974) 'Role of blood pressure in cardiovascular morbidity and mortality', *Prog Cardiovasc Dis.*, p. 5.

Kannel, W. and McGee, D. (1979) 'Diabetes and cardiovascular disease. The Framingham study', *JAMA*, vol. 241, no. 19, pp. 2035-8.

Kannel, W., Schwartz, M. and McNamara, P. (1969) 'Blood pressure and risk of coronary heart disease: the Framingham study', *Dis Chest*, vol. 56, no. 1, pp. 43-52.

Kark, J., Fink, R., Goldberger, N. and Goldman, S. (2006) 'The incidence of coronary heart disease among Palestinians and Israelis in Jerusalem', *Int J Epidemiol*, vol. 35, no. 2, pp. 448-57.

Karvonen, M., Orma, E., Punsar, S., Kallio, V., Arstila, M., Luomanmäki, K. and Takkunen, J. (1970) 'Coronary heart disease in seven countries. VI. Five-year experience in Finland', *Circulation*, vol. 41, no. 4, pp. I52-62.

Kawachi, I., Kennedy, B., Lochner, K. and Prothrow-Stith, D. (1997) 'Social capital, income inequality and mortality', *Am J Public Health*, vol. 87, no. 9, pp. 1491-8.

Kerr, G., Slavin, H., Clark, D., Coupar, F., Langhorne, P. and Stott, D. (2011) 'Do vascular risk factors explain the association between socioeconomic status and stroke incidence: a meta-analysis', *Cerebrovasc Dis*, vol. 31, no. 1, pp. 57-63.

Keskimäki, I. (2003) 'How did Finland's economic recession in the early 1990s affect socio-economic equity in the use of hospital care?', *Soc Sci Med*, vol. 56, no. 7, pp. 1517-30.

Kesteloot, H., Sans, S. and Kromhout, D. (2006) 'Dynamics of cardiovascular and all-cause mortality in Western and Eastern Europe between 1970 and 2000', *Eur Heart J*, vol. 27, no. 1, pp. 107-13.

Khan, N., Grubisic, M., Hemmelgarn, B., Humphries, K., King, K. and Quan, H. (2010) 'Outcomes after acute myocardial infarction in South Asian, Chinese, and white patients', *Circulation*, vol. 122, no. 16, pp. 1570-7.

Kissela, B., Sauerbeck, L., Woo, D., Khoury, J., Carrozzella, J., Pancioli, A., Jauch, E., Moomaw, C., Shukla, R., Gebel, J., Fontaine, R. and Broderick, J. (2002) 'Subarachnoid hemorrhage: a preventable disease with a heritable component', *Stroke*, vol. 33, no. 5, pp. 1321-6.

Kissela, B., Schneider, A., Kleindorfer, D., Khoury, J., Miller, R., Alwell, K., Woo, D., Szaflarski, J., Gebel, J., Moomaw, C., Pancioli, A., Jauch, E., Shukla, R. and Broderick, J. (2004) 'Stroke in a biracial population: the excess burden of stroke among blacks', *Stroke*, vol. 35, no. 2, pp. 426-31.

Kittleson, M., Meoni, L., Wang, N., Chu, A., Ford, D. and Klag, M. (2006) 'Association of childhood socioeconomic status with subsequent coronary heart disease in physicians.', *Arch Intern Med*, vol. 166, no. 21, pp. 2356-61.

Kivimäki, M., Lawlor, D., Davey Smith, G., Kouvonen, A., Virtanen, M., Elovainio, M. and Vahtera, J. (2007) 'Socioeconomic position, co-occurrence of behavior-related risk factors, and coronary heart disease: the Finnish Public Sector study', *Am J Public Health*, vol. 97, no. 5, pp. 874-9.

Kivimäki, M., Shipley, M., Ferrie, J., Singh-Manoux, A., Batty, G., Chandola, T., Marmot, M. and Smith, G. (2008) 'Best-practice interventions to reduce socioeconomic inequalities of coronary heart disease mortality in UK: a prospective occupational cohort study', *Lancet*, vol. 372, no. 9650, pp. 1648-54.

Kivimäki, M., Smith, G., Juonala, M., Ferrie, J., Keltikangas-Järvinen, L., Elovainio, M., Pulkki-Råback, L., Vahtera, J., Leino, M., Viikari, J. and Raitakari, O. (2006) 'Socioeconomic position in childhood and adult cardiovascular risk factors, vascular structure, and function: cardiovascular risk in young Finns study', *Heart*, vol. 92, no. 4, pp. 474-80.

Kontos, M., Fritz, L., Anderson , F., Tatum, J., Ornato, J. and Jesse, R. (2003) 'Impact of the troponin standard on the prevalence of acute myocardial infarction', *Am Heart J*, no. 146, pp. 446-52.

Korkeila, J., Vahtera, J., Korkeila, K., Kivimäki, M., Sumanen, M., Koskenvuo, K. and Koskenvuo, M. (2010) 'Childhood adversities as predictors of incident coronary heart disease and cerebrovascular disease', *Heart*, vol. 96, no. 4, pp. 298-303.

Koskenvuo, M., Kaprio, J., Lönnqvist, J. and Sarna, S. (1986) 'Social factors and the gender difference in mortality', *Soc Sci Med*, vol. 23, no. 6, pp. 605-9.

Koskenvuo, M., Kaprio, J., Romo, M. and Langinvainio, H. (1981) 'Incidence and prognosis of ischaemic heart disease with respect to marital status and social class', *J Epidemiol Community Health*, vol. 35, no. 3, pp. 192-6.

Koskinen, S. and Martelin, T. (2003) 'Why is mortality low among the Swedish-Speaking Minority in Finland?', *Yearbook of Population Research in Finland*, vol. 39, pp. 15-31.

Kotler, P. and Wingard, D. (1989) 'The effect of occupational, marital and parental roles on mortality: the Alameda County Study', *Am J Public Health*, vol. 79, no. 5, pp. 607-12.

Kulkarni, S., Alexander, K., Lytle, B., Heiss, G. and Peterson, E. (2006) 'Long-term adherence with cardiovascular drug regimens', *Am Heart J*, vol. 151, no. 1, pp. 185-91.

Kunst, A., Groenhof, F., Mackenbach, J. and Health, E.W.G.o.S.I.i. (1998) 'Occupational class and cause specific mortality in middle aged men in 11 European countries: comparison of population based studies.', *BMJ*, vol. 30, no. 316, pp. 1636-42.

Laatikainen, T., Critchley, J., Vartiainen, E., Salomaa, E., Ketonen, M. and Capewell, S. (2005) 'Explaining the decline in coronary heart disease mortality in Finland between 1982 and 1997', *Am J Epidemiol*, vol. 162, no. 8, pp. 764-73.

Lahelma, E., Martikainen, P., Laaksonen, M. and Aittomäki, A. (2004) 'Pathways between socioeconomic determinants of health', *J Epidemiol Community Health*, vol. 58, no. 4, pp. 327-32.

Lawlor, D., Ronalds, G., Macintyre, S., Clark, H. and Leon, D. (2006) 'Family socioeconomic position at birth and future cardiovascular disease risk: findings from the Aberdeen Children of the 1950s cohort study', *Am J Public Health*, vol. 96, no. 7, pp. 1271-7.

Lemmens, R., Buysschaert, I., Geelen, V., Fernandez-Cadenas, I., Montaner, J., Schmidt, H., Schmidt, R., Attia, J., Maguire, J., Levi, C., Jood, K., Blomstrand, C., Jern, C., Wnuk, M., Slowik, A., Lambrechts, D., Thijs, V. and Consortium, I.S.G. (2010) 'The association of the 4q25 susceptibility variant for atrial fibrillation with stroke is limited to stroke of cardioembolic etiology', *Stroke*, vol. 41, no. 9, pp. 1850-7.

Leon, A. and Connett, J. (1991) 'Physical activity and 10.5 year mortality in the Multiple Risk Factor Intervention Trial (MRFIT)', *Int J Epidemiol*, vol. 20, no. 3, pp. 690-7.

Lerner, D. and Kannel, W. (1986) 'Patterns of coronary heart disease morbidity and mortality in the sexes: a 26-year follow-up of the Framingham population', *Am Heart J*, vol. 111, no. 2, pp. 383-90.

Lewington, S., Clarke, R., Qizilbash, N., Peto, R., Collins, R. and Collaboration, P.S. (2002) 'Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies', *Lancet*, vol. 360, no. 9349, pp. 1903-13.

Lewington, S., Whitlock, G., Clarke, G., Sherlicker, P., Emberson, J., Halsey, J., Qizilbash, N., Peto, R. and Collins, R. (2007) 'Blood cholesterol and vascular mortality by age, sex and blood pressure: a meta-analysis of individual data from 61 prospective studies with 55,000 vascular deaths.', *Lancet*, vol. 370, no. 9602, pp. 1892-39.

Liao, D., Cai, J., Rosamond, W., Barnes, R., Hutchinson, R., Whitseal, E., Rautaharju, P. and Heiss, G. (1997) 'Cardiac autonomic function and incident coronary heart disease: a population-based case-cohort study. The ARIC Study. Atherosclerosis Risk in Communities Study', *Am J Epidemiol*, vol. 145, no. 8, pp. 696-706.

Libby, P., Ridker, P., Hansson, G. and Atherothrombosis, L.T.N.o. (2009) 'Inflammation in atherosclerosis: from pathophysiology to practice', *J Am Coll Cardiol*, vol. 54, no. 23, pp. 2129-38.

Li, C., Hedblad, B., Rosvall, M., Buchwald, F., Khan, F. and Engström, G. (2008) 'Stroke incidence, recurrence, and case-fatality in relation to socioeconomic position: a population-based study of middle-aged Swedish men and women', *Stroke*, vol. 39, no. 8, pp. 2191-6.

Liu, H. and Umberson, D. (2008) 'The times they are changin': marital status and health differentials from 1972 to 2003', *J Health Soc Behav*, vol. 49, no. 3, pp. 239-53.

Lloyd-Jones, D., Nam, B., D'Agostino, R., Levy, D., Murabito, J., Wang, T., Wilson, P. and O'Donnell, C. (2004) 'Parental cardiovascular disease as a risk factor for cardiovascular disease in middle-aged adults: a prospective study of parents and offspring', *JAMA*, vol. 291, no. 18, pp. 2204-11.

Logue, J., Murray, H., Welsh, P., Shepherd, J., Packard, C., Macfarlane, P., Cobbe, S., Ford, I. and Sattar, N. (2011) 'Obesity is associated with fatal coronary heart disease independently of traditional risk factors and deprivation', *Heart*, vol. 97, no. 7, pp. 564-8.

Lopez, A., Mathers, C., Ezzati, M., Jamison, D. and Murray, C. (2006) 'Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data.', *Lancet*, vol. 27, no. 367, pp. 1747-57.

Loucks, E., Lynch, J., Pilote, L., Fuhrer, R., Almeida, N., Richard, H., Agha, G., Murabito, J. and Benjamin, E. (2009) 'Life-course socioeconomic position and incidence of coronary heart disease: the Framingham Offspring Study', *Am J Epidemiol*, vol. 169, no. 7, pp. 829-36.

Lovasi, G., Lemaitre, R., Siscovick, D., Dublin, S., Bis, J., Lumley, T., Heckbert, S., Smith, N. and Psaty, B. (2007) 'Amount of leisure-time physical activity and risk of nonfatal myocardial infarction', *Ann Epidemiol*, vol. 17, no. 6, pp. 410-6.

Luepker, R., Apple, F., Christenson, R., Crow, R., Fortmann, S., Goff, D., Goldberg, R., Hand, M., Jaffe, A., Julian, D., Levy, D., Manolio, T., Mendis, S., Mensah, G., Pajak, A., Prineas, R., Reddy, K., Roger, V., Rosamond, W., Shahar, E. et al. (2003) 'Case definitions for acute coronary heart disease in epidemiology and clinical research studies.', *Circulation*, vol. 108, no. 20, pp. 2543-9.

Lynch, J., Davey Smith, G., Harper, S. and Bainbridge, K. (2006) 'Explaining the social gradient in coronary heart disease: comparing relative and absolute risk approaches', *J Epidemiol Community Health*, vol. 60, no. 5, pp. 436-41.

Macintyre, S. (1997) 'The Black Report and beyond: what are the issues?', *Soc Sci Med*, vol. 44, no. 6, pp. 723-45.

Mackenbach, J., Bos, V., Andersen, O., Cardano, M., Costa, G., Harding, S., Reid, A., Hemström, O., Valkonen, T. and Kunst, A. (2003) 'Widening socioeconomic inequalities in mortality in six Western European countries', *Int J Epidemiol*, vol. 32, no. 5, pp. 830-7.

Mackenbach, J., Cavelaars, A., Kunst, A. and Groenhof, F. (2000) 'Socioeconomic inequalities in cardiovascular disease mortality; an international study', *Eur Heart J*, vol. 21, no. 14, pp. 1141-51.

Mackenbach, J., Kunst, A., Groenhof, F., Borgan, J., Costa, G., Faggiano, F., Józan, P., Leinsalu, M., Martikainen, P., Rychtarikova, J. and Valkonen, T. (1999) 'Socioeconomic inequalities in mortality among women and among men: an international study', *Am J Public Health*, vol. 89, no. 12, pp. 1800-6.

Malyutina, S., Bobak, M., Simonova, G., Gafarov, V., Nikitin, Y. and Marmot, M. (2004) 'Education, marital status, and total and cardiovascular mortality in Novosibirsk, Russia: a prospective cohort study', *Ann Epidemiol*, vol. 14, no. 4, pp. 244-9.

Manderbacka, K., Hetemaa, T., Keskimäki, I., Luukkainen, P., Koskinen, S. and Reunanen, A. (2006) 'Are there socioeconomic differences in myocardial infarction event rates and fatality among patients with angina pectoris?', *J*

Epidemiol Community Health, vol. 60, no. 5, pp. 442-7.

Manderbacka, K., Keskimäki, I., Reunanen, A. and Klaukka, T. (2008) 'Equity in the use of antithrombotic drugs, beta-blockers and statins among Finnish coronary patients', *Int J Equity Health*, vol. 30, no. 7, p. 16.

Manhapra, A., Canto, J., Vaccarino, V., Parsons, L., Kiefe, C., Barron, H., Rogers, W., Weaver, W. and Borzak, S. (2004) 'Relation of age and race with hospital death after acute myocardial infarction', *Am Heart J*, vol. 148, no. 1, pp. 92-8.

Manninen, V., Elo, M., Frick, M., Haapa, K., Heinonen, O., Heinsalmi, P., Helo, P., Huttunen, J., Kaitaniemi, P. and Koskinen, P. (1988) 'Lipid alterations and decline in the incidence of coronary heart disease in the Helsinki Heart Study', *JAMA*, vol. 260, no. 5, pp. 641-51.

Manolio, T., Kronmal, R., Burke, G., O'Leary, D. and Price, T. (1996) 'Short-term predictors of incident stroke in older adults. The Cardiovascular Health Study', *Stroke*, vol. 27, no. 9, pp. 1479-86.

Marenberg, M., Risch, N., Berkman, L., Floderus, B. and de Faire, U. (1994) 'Genetic susceptibility to death from coronary heart disease in a study of twins', *N Engl J Med*, vol. 330, no. 15, pp. 1041-6.

Marmot, M., Rose, G., Shipley, M. and Hamilton, P. (1978) 'Employment grade and coronary heart disease in British civil servants', *J Epidemiol Community Health*, vol. 32, no. 4, pp. 244-9.

Martikainen , P., Martelin, T., Nihtilä, E., Majamaa, K. and Koskinen, S. (2005) 'Differences in mortality by marital statu in Finland from 1976 to 2000: Analyses of changes in marital-status distributions, socio-demographic and household composition and cause of death.', *Population Studies*, vol. 59, no. 1, pp. 99-115.

Mattila, K., Valle, M., Nieminen, M., Valtonen, V. and Hietaniemi, K. (1993) 'Dental infections and coronary atherosclerosis', *Atherosclerosis*, vol. 103, no. 2, pp. 205-11.

McElduff, P. and Dobson, A. (1997) 'How much alcohol and how often? Population-based case-control study of alcohol consumption and risk of a major coronary event', *BMJ*, vol. 314, no. 7088, pp. 1159-64.

McPherson, R., Pertsemlidis, A., Kavaslar, N., Stewart, A., Roberts, R., Cox, D., Hinds, D., Pannachio, L., Tybjaerg-Hansen, A., Folsom, A., Boerwinkle, E., Hobbs, H. and Cohen, J. (2007) 'A common allele on chromosome 9 associated with coronary heart disease', *Science*, vol. 316, no. 5830, pp. 1488-91.

Menotti, A., Lanti, M., Kromhout, D., Blackburn, H., Nissinen, A., Dontas, A., Kafatos, A., Nedeljikovic, S. and Adachi, H. (2007) 'Forty-year coronary mortality trends and changes in major risk factors in the first 10 years follow-up in the seven countries study.', *Eur J Epidemiol*, vol. 22, no. 11, pp. 747-54.

Molloy, G., Stamatakis, E., Randall, G. and Hamer, M. (2009) 'Marital status, gender and cardiovascular mortality: behavioural, psychological distress and metabolic explanations', *Soc Sci Med*, vol. 69, no. 2, pp. 223-8.

Musunuru, K. and Kathiresan, S. (2010) 'Genetics of coronary artery disease', *Annu Rev Genomics Hum Genet*, vol. 22, no. 11, pp. 91-108.

Nabi, H., Kivimäki, M., Suominen, S., Koskenvuo, M., Singh-Manoux, A. and Vahtera, J. (2010) 'Does depression predict coronary heart disease and cerebrovascular disease equally well? The Health and Social Support Prospective Cohort Study', *Int J Epidemiol*, vol. 39, no. 4, pp. 1016-24.

Nicholson, A., Kuper, H. and Hemingway, H. (2006) 'Depression as an auetiologic and prognsic factor in coronary heart disease: a meta-analysis of 6362 events among 146 538 participants in 54 observational studies', *Eur Heart J*, vol. 27, no. 23, pp. 2763-74.

Nielsen, K., Faergeman, O., Larsen, M. and Foldspang, A. (2006) 'Danish singles have a twofold risk of acute coronary syndrome: data from a cohort of 138 290 persons', *J Epidemiol Community Health*, vol. 60, no. 8, pp. 721-8.

Nielsen, K., Larsen, M., Foldspang, A. and Faergeman, O. (2007) 'Living alone and atypical clinical presentation are associated with higher mortality in patients with all components of the acute coronary syndrome', *Eur J Cardiovasc Prev Rehabil*, vol. 14, no. 1, pp. 152-4.

Nielsen, F. and Mard, S. (2010) 'Single-living is associated with increased risk of long-term mortality among employed patients with acute myocardial infarction', *Clin Epidemiol*, vol. 2, pp. 91-8.

Nora, J., Lortschner, R., Spangler, R., Nora, A. and Kimberling, W. (1980) 'Genetic--epidemiologic study of early-onset ischemic heart disease', *Circulation*, vol. 61, no. 3, pp. 503-8.

Nyqvist, F., Finnäs, F., Jakobsson, G. and Koskinen, S. (2008) 'The effect of social capital on health: The case of two language groups in Finland', *Health Place*, vol. 14, no. 2, pp. 347-60.

Näyhä, S. (1989) 'Geographic variations in cardiovascular mortality in Finland 1961-1985', *Scand J Soc Med Suppl*, vol. 40, pp. 1-48.

O'Donnell, C., Ridker, P., Glynn, R., Berger, K., Ajani, U., Manson, J. and Hennekens, C. (1997) 'Hypertension and borderline isolated systolic hypertension increase risks of cardiovascular disease and mortality in male physicians', *Circulation*, vol. 95, no. 5, pp. 1132-7.

O'Donnell, M., Xavier, D., Liu, L., Zhang, H., Chin, S., Rao-Melacini, P., Rangarajan, S., Islam, S., Pais, P., McQueen, M., Mondo, C., Damasceno, A., Lopez-Jaramillo, P., Hankey, G., Dans, A., Yusoff, K., Truelsen, T., Diener, H., Sacco, R., Ryglewicz, D. et al. (2010) 'INTERSTROKE investigators. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study.', *Lancet*, vol. 376, no. 9735, pp. 112-23.

Ohlgren, B., Weinehall, L., Stegmayr, B., Boman, K., Hallmans, G. and Wall, S. (2000) 'What else adds to hypertension in predicting stroke? An incident case-referent study', *J Intern Med*, vol. 248, no. 6, pp. 475-82.

Ordovás, J., Robertson, R. and Cléirigh, E. (2011) 'Gene-gene and gene-environment interactions defining lipid-related traits', *Curr Opin Lipidol*, vol. 22, no. 2, pp. 129-36.

Organisation for Economic Co-Operation and Development (1982) *The OECD list of social indicators*, Paris: OECD.

Pajunen, P., Pääkkönen, R., Hämäläinen, H., Keskimäki, I., Laatikainen, T., Niemi, M., Rintanen, H. and Salomaa, V. (2005) 'Trends in fatal and nonfatal strokes among persons aged 35 to > or =85 years during 1991-2002 in Finland', *Stroke*, vol. 36, no. 2, pp. 244-8.

Pajunen, P., Pääkkönen, R., Juolevi, A., Hämäläinen, H., Keskimäki, I., Laatikainen, T., Motchanov, V., Niemi, M., Rintanen, H. and Salomaa, V. (2004) 'Trends in fatal and non-fatal coronary heart disease events in Finland during 1991-2001.', *Scand Cardiovasc J.*, vol. 38, no. 6, pp. 340-4.

Paljärvi, T., Suominen, S., Koskenvuo, M., Winter, T. and Kauhanen, J. (2009) 'The differences in drinking patterns between Finnish-speaking majority and Swedish-speaking minority in Finland', *Eur J Public Health*, vol. 19, no. 3, pp. 278-84.

Palosuo, H., Koskinen, S., Lahelma, E., Kostianen, E., Prättälä, R., Martelin, T., Ostamo, A., Keskimäki, I., Sihto, M. and Linnanmäki, E. (2009) *Health inequalities in Finland. Trends in socioeconomic health differences 1980-2005.*, Helsinki: Ministry of Social Affairs and Health.

Parish, S., Collins, R., Peto, R., Youngman, L., Barton, J., Jayne, K., Clarke, R., Appleby, P., Lyon, V., Cederholm-Williams, S., Marshall, J. and Sleight, P. (1995) 'Cigarette smoking, tar yields and non-fatal myocardial infarction: 14 000 UK cases and 32 000 controls', *BMJ*, vol. 311, no. 7003, pp. 471-7.

Pedersen, T., Olsson, A., Faergeman, O., Kjekshus, J., Wedel, H., Berg, K., Wilhelmsen, L., Haghfelt, T., Thorgeirsson, G., Pyörälä, K. and Miettinen, T. (1998) 'Lipoprotein changes and reduction in the incidence of major coronary heart disease events in the Scandinavian Simvastatin Survival Study (4S)', *Circulation*, vol. 97, no. 15, pp. 1453-60.

Puska, P., Vartianen, E., Tuomilehto, J., Salomaa, V. and Nissinen, A. (1998) 'Changes in premature deaths in Finland: successful long-term prevention of cardiovascular diseases', *Bull World Health Organ*, vol. 76, no. 4, pp. 419-25.

Ramsay, S., Morris, R., Whincup, P., Papacosta, A., Thomas, M. and Wannamethee, S. (2011) 'Prediction of coronary heart disease risk by Framingham and SCORE risk assessments varies by socioeconomic position: results from a study in British men', *Eur J Cardiovasc Prev Rehabil*, vol. 18, no. 2, pp. 186-93.

Randall, G., Bhattacharyya, M. and Steptoe, A. (2009) 'Marital status and heart rate variability in patients with suspected coronary artery disease', *Ann Behav Med*, vol. 38, no. 2, pp. 115-23.

Ripatti, S., Tikkanen, E., Orho-Melander, M., Havulinna, A., Silander, K., Sharma, A., Guidacci, C., Perola, M., Jula, A., Sinisalo, J., Lokki, M., Nieminen, M., Melander, O., Salomaa, V., Peltonen, L. and Kathiresan, S. (2010) 'A multilocus genetic risk score for coronary heart disease: case-control and prospective cohort analyses', *Lancet*, vol. 376, no. 9750, pp. 1393-400.

Rosengren, A., Wilhelmsen, L. and Orth-Gomér, K. (2004) 'Coronary disease in relation to social support and social class in Swedish men. A 15 year follow-up in the study of men born in 1933', *Eur Heart J*, vol. 25, no. 1, pp. 56-63.

Ruberman, W., Weinblatt, E., Goldberg, J. and Chaudhary, B. (1984) 'Psychosocial influences on mortality after myocardial infarction', *N Engl J Med*, vol. 311, no. 9, pp. 552-9.

Ruidavets, J., Ducimetière, P., Evans, A., Montaye, M., Haas, B., Bingham, A., Yarnell, J., Amouyel, P., Arveiler, D., Kee, F., Bongard, V. and Ferrières, J. (2010) 'Patterns of alcohol consumption and ischaemic heart disease in culturally divergent countries: the Prospective Epidemiological Study of Myocardial Infarction (PRIME)', *BMJ*, vol. 341.

Saarela, J. and Finnäs, F. (2003) 'Social background and education of Swedish and Finnish speakers in Finland', *Eur J Education*, vol. 38, no. 4, pp. 445-56.

Saarela, J. and Finnäs, F. (2004) 'Interethnic wage variation in the Helsinki Area', *Finnish Economics Papers*, vol. 17, no. 1, pp. 35-48.

Saarela, J. and Finnäs, F. (2009) 'Geographic ancestry and mortality from ischemic heart disease: evidence from the Finnish population register', *Popul Rev*, vol. 48, pp. 64-82.

Sacco, R., Boden-Albala, B., Gan, R., Chen, X., Kargman, D., Shea, S., Paik, M. and Hauser, W. (1998) 'Stroke incidence among white, black, and Hispanic residents of an urban community: the Northern Manhattan Stroke Study', *Am J Epidemiol*, vol. 147, no. 3, pp. 259-68.

Salmela, E., Lappalainen, T., Fransson, I., Andersen, P., Dahlman-Wright, K., Fiebig, A., Sistonen, P., Savontaus, M., Schreiber, S., Kere, J. and Lahermo, P. (2008) 'Genome-wide Analysis of Single Nucleotide Polymorphisms Uncovers Population Structure in Northern Europe', *Plos ONE*, vol. 3, no. 10, p. e3519.

Salomaa, V., Ketonen, M., Koukkunen, H., Immonen-Räihä, P., Lehtonen, A., Torppa, J., Kuulasmaa, K., Kesäniemi, Y., Pyörälä, K. and Group, F.S. (2006) 'The effect of correcting for troponins on trends in coronary heart disease events in Finland during 1993-2002: the FINAMI study', *Eur Heart J*, vol. 27, no. 20, pp. 2394-9.

Salomaa, V., Miettinen, H., Niemelä, M., Ketonen, M., Mähönen, M., Immonen-Räihä, P., Lehto, S., Vuorenmaa, T., Koskinen, S., Palomäki, P., Mustaniemi, H., Kaarsalo, E., Arstila, M., Torppa, J., Kuulasmaa, K., Puska, P., Pyörälä, K. and Tuomilehto, J. (2001) 'Relation of socioeconomic position to the case fatality, prognosis and treatment of myocardial infarction events; the FINMONICA MI Register Study', *J Epidemiol Community Health*, vol. 55, no. 7, pp. 475-82.

Salomaa, V., Niemelä, M., Miettinen, H., Ketonen, M., Immonen-Räihä, P., Koskinen, S., Mähönen, M., Lehto, S., Vuorenmaa, T., Palomäki, P., Mustaniemi, H., Kaarsalo, E., Arstila, M., Torppa, J., Kuulasmaa, K., Puska, P., Pyörälä, K. and Tuomilehto, J. (2000) 'Relationship of socioeconomic status to the incidence and prehospital, 28-day, and 1-year mortality rates of acute coronary events in the FINMONICA myocardial infarction register study.', *Circulation*, vol. 101, no. 16, pp. 1913-8.

Salonen, J. (1982) 'Socioeconomic status and risk of cancer, cerebral stroke, and death due to coronary heart disease and any disease: a longitudinal study in eastern Finland', *J Epidemiol Community Health*, vol. 36, no. 4, pp. 294-7.

Sarti , C., Rastenyte, D., Cepaitis, Z. and Tuomilehto, J. (2000) 'International trends in mortality from stroke, 1968 to 1994', *Stroke*, vol. 31, no. 7, pp. 1588-601.

Sarwar, N., Gao, P., Seshasai, S., Gobin, R., Kaptoge, S., Di Angelantonio, E., Ingelsson, E., Lawlor, D., Selvin, E., Stampfer, M., Stehouwer, C., Lewington, S., Pennells, L., Thompson, A., Sattar, N., White, I., Ray, K. and Danesh, J. (2010) 'Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies', *Lancet*, vol. 375, no. 9733, pp. 2215-22.

Sarwar, N., Sandhu, M., Ricketts, S., Butterworth, A., Di Angelantonio, E., Boekholdt, S., Ouwehand, W., Watkins, H., Samani, N., Saleheen, D., Lawlor, D., Reilly, M., Hingorani, A., Talmud, P. and Danesh, J. (2010) 'Triglyceride-mediated pathways and coronary disease: collaborative analysis of 101 studies', *Lancet*, vol. 375, no. 9726, pp. 1634-9.

Schmaltz, H., Southern, D., Ghali, W., Jelinski, S., Parsons, G., King, K. and Maxwell, C. (2007) 'Living alone, patient sex and mortality after acute myocardial infarction', *J Gen Intern Med*, vol. 22, no. 5, pp. 572-8.

Schunkert, H., Konig, I., Kathiresan, S., Reilly, M., Assimes, T., Holm, H., Preuss, M., Stewart, A., Barbalic, M., Gieger, C., Absher, D., Aberrahrou, Z., Allayee, H., Altshuler, D., Anand, S., Andersen, K., Anderson, J., Ardissino, D., Ball, S., Balmforth, A. et al. (2011) 'Large-scale association analysis identifies 13 new susceptibility loci for coronary artery disease', *Nat Genet*, vol. 43, no. 4, pp. 333-8.

Sharrett, A., Ballantyne, C., Coady, S., Heiss, G., Sorlie, P., Catellier, D., Patsch, W. and Group, A.R.i.C.S. (2001) 'Coronary heart disease prediction from lipoprotein cholesterol levels, triglycerides, lipoprotein(a), apolipoproteins A-I and B, and HDL density subfractions: The Atherosclerosis Risk in Communities (ARIC) Study', *Circulation*, vol. 104, no. 10, pp. 1108-13.

Sheth, T., Nair, C., Nargundkar, M., Ababd, S. and Yusuf, S. (1999) 'Cardiovascular and cancer mortality among Canadians of European, south Asian and Chinese origin from 1979 to 1993: an analysis of 1.2 million deaths', *CMAJ*, vol. 161, no. 2, pp. 132-8.

Shinton, R. and Beevers, G. (1989) 'Meta-analysis of relation between cigarette smoking and stroke', *BMJ*, vol. 298, no. 6676, pp. 789-94.

Silventoinen, K., Pankow, J., Jousilahti, P., Hu, G. and Tuomilehto, J. (2005) 'Educational inequalities in the metabolic syndrome and coronary heart disease among middle-aged men and women', *Int J Epidemiol*, vol. 34, no. 2, pp. 327-34.

Singh-Manoux, A., Adler, N. and Marmot, M. (2003) 'Subjective social status: its determinants and its association with measures of ill-health in the Whitehall II study', *Soc Sci Med*, vol. 56, no. 6, pp. 1321-33.

Singh-Manoux, S., Nabi, H., Shipley, M., Guégen, A., Sabia, S., Dugravot, A., Marmot, M. and Kivimaki, M. (2008) 'The role of conventional risk factors in explaining social inequalities in coronary heart disease: the relative and absolute approaches to risk.', *Epidemiology*, vol. 19, no. 4, pp. 599-605.

Sipilä, P. and Martikainen, P. (2009) 'Language-group mortality differentials in Finland in 1988-2004: assessment of the contribution of cause of death, sex and age.', *Eur J Public Health*, vol. 19, no. 5, pp. 492-8.

Siscovick, D., Weiss, N., Fletcher, R. and Lasky, T. (1984) 'The incidence of primary cardiac arrest during vigorous exercise', *N Engl J Med*, vol. 311, no. 14, pp. 874-7.

Sivenius, J., Tuomilehto, J., Immonen-Räihä, P., Kaarisalo, M., Sarti, C., Torppa, J., Kuulasmaa, K., Mähönen, M., Lehtonen, A., Salomaa, V. and Study, F. (2004) 'Continuous 15-year decrease in incidence and mortality of stroke in Finland: the FINSTROKE study.', *Stroke*, vol. 35, no. 2, pp. 420-5.

Smith, G., Hart, C., Blane, D. and Hole, D. (1998) 'Adverse socioeconomic conditions in childhood and cause specific adult mortality: prospective observational study', *BMJ*, vol. 316, no. 7145, pp. 1631-5.

Smith, A., Patterson, C., Yarnell, J., Rumley, A., Ben-Shlomo, Y. and Lowe, G. (2005) 'Which hemostatic markers add to the predictive value of conventional risk factors for coronary heart disease and ischemic stroke? The Caerphilly Study', *Circulation*, vol. 112, no. 20, pp. 3080-7.

Southerland, J., Moss, K., Taylor, G., Beck, J., PAnkow, J., Gangula, P. and Offenbacher, S. (2012) 'Periodontitis and diabetes associations with measures of atherosclerosis and CHD', *Atherosclerosis*, vol. 222, no. 1, pp. 196-201.

Stamler, J., Vaccaro, O., Neaton, J. and Wentworth, D. (1993) 'Diabetes, other risk factors, and 12-yr cardiovascular mortality for men screened in the Multiple Risk Factor Intervention Trial', *Diabetes Care*, vol. 16, no. 2, pp. 434-44.

Statistics Finland (2011) *Causes of death*, [Online], Available: http://tilastokeskus.fi/til/ksyyt/2009/01/ksyyt_2009_01_2011-02-22_kat_002_en.html [28 Oct 2011].

Strazzullo, P., D'Elia, L., Cairella, G., Garbagnati, F., Cappuccio, F. and Scalfi, L. (2010) 'Excess Body Weight and Incidence of Stroke. A Meta-Analysis of Prospective Studies With 2 Million Participants.', *Stroke*, vol. 41, no. 5, pp. 418-26.

Stringhini, S., Saba, S., Shipley, M., Brunner, E., Nabi, H., Kivimaki, M. and Singh-Manoux, A. (2010) 'Association of socioeconomic position with health behaviors and mortality', *JAMA*, vol. 303, no. 12, pp. 1159-66.

Sundell, L., Salomaa, V., Vartiainen, E., Poikolainen, K. and Laatikainen, T. (2008) 'Increased stroke risk is related to a binge-drinking habit', *Stroke*, vol. 39, no. 12, pp. 3179-84.

Tarkiainen, L., Martikainen, P. and Laaksonen, M. (2013) 'The changing relationship between income and mortality in Finland, 1988-2007', *J Epidemiol Community Health*, vol. 67, no. 1, pp. 21-7.

Tarkiainen, L., Martikainen, P., Laaksonen, M. and Valkonen, T. (2012) 'Trends in life expectancy by income from 1988 to 2007: decomposition by age and cause of death.', *J Epidemiol Community Health*, vol. 66, no. 7, pp. 573-8.

Teo, K., Ounpuu, S., Hawken, S., Pandey, M., Valentin, V., Hunt, D., Diaz, R., Rashed, W., Freeman, R., Jiang, L., Zhang, X., Yusuf, S. and Investigators, I.S. (2006) 'Tobacco use and risk of myocardial infarction in 52 countries in the INTERHEART study: a case-control study', *Lancet*, vol. 368, no. 9536, pp. 647-58.

Tilastokeskus (1989) *Sosioekonomisen aseman luokitus*, Tilastokeskus.

Tolonen, H., Kuulasmaa, K., Laatikainen, T. and Wolf, H. (2002) *European Health Risk Monitoring project. Recommendation for indicators, international collaboration, protocol and manual of operations for chronic disease risk factor surveys*, [Online], Available: http://www.ktl.fi/publications/ehrm/product2/title/htm [10 Nov 2009].

Townsend, I. and Davidson, N. (1982) *Inequalities in Health. The Black Report*, Harmondsworth: Penguin Books.

Truelsen, T., Mähönen, M., Tolonen, H., Asplund, K., Bonita, R., Vanuzzo, D. and Project, W.M. (2003) 'Trends in stroke and coronary heart disease in the WHO MONICA Project', *Stroke*, vol. 34, no. 6, pp. 1346-52.

Tunstall-Pedoe, H., Kuulasmaa, K., Amouyel, P., Arveiler, D., Rajakangas, A. and Pajak, A. (1994) 'Myocardial infarction and coronary deaths in the World Health Organization MONICA Project. Registration procedures, event rates, and case-fatality rates in 38 populations from 21 countries in four continents', *Circulation*, vol. 90, no. 1, pp. 583-612.

Tunstall-Pedoe, H., Kuulasmaa, K., Mähönen, M., Tolonen, H., Ruokokoski, E. and Amouvel, P. (1999) 'Contribution of trends in survival and coronary-event rates to changes in coronary heart disease mortality: 10-year results from 37 WHO MONICA Project populations', *Lancet*, vol. 353, pp. 1547-57.

Tuomilehto, J., Geboers, J., Joossens, J., Salonen, J. and Tanskanen, A. (1984) 'Trends in stomach cancer and stroke in Finland', *Stroke*, vol. 15, no. 5, pp. 823-8.

Tzoulaki, I., Murray, G., Lee, A., Rumley, A., Lowe, G. and Fowkes, F. (2007) 'Relative value of inflammatory, hemostatic, and rheological factors for incident myocardial infarction and stroke: the Edinburgh Artery Study', *Circulation*, vol. 115, no. 16, pp. 2119-27.

Udell, J., Steg, P., Scirica, B., Smith, S., Ohman, E., Eagle, K., Goto, S., Cho, J. and Bhatt, D. (2012) 'Living Alone and Cardiovascular Risk in Outpatients at Risk of or With Atherothrombosis.', *Arch Intern Med.*, vol. 172, pp. 1086-1095.

Valkonen, T. (1982) 'Psychosocial stress and sociodemographic differentials in mortality from ischaemic heart disease in Finland', *Acta Med Scand Suppl*, vol. 660, pp. 152-64.

Valkonen, T., Martikainen, P., Jalovaara, M., Koskinen, S., Martelin, T. and Mäkelä, P. (2000) 'changes in socioeconomic inequalities in mortality during an economic boom and recession among middle-aged men and women in Finland', *Eur J Public Health*, vol. 10, no. 4, pp. 274-80.

Valtioneuvoston periaatepäätös Terveys 2015 - kansanterveysohjelmasta (2001), Helsinki: Sosiaali- ja terveysministerön julkaisuja.

Van Oyen, H., Tafforeau, J. and Roelands, M. (1996) 'Regional inequities in health expectancy in Belgium', *Soc Sci Med*, vol. 43, no. 11, pp. 1673-8.

van Rossum, C., Shipley, M., van de Mheen, H., Grobbee, D. and Marmot, M. (2000) 'Employment grade differences in cause specific mortality. A 25 year follow up of civil servants from the first Whitehall study', *J Epidemiol Community Health*, vol. 54, no. 3, pp. 178-84.

Wannamethee, S. and Shaper, A. (1997) 'Socioeconomic status within social class and mortality: a prospective study in middle-aged British men', *Int J Epidemiol*, vol. 26, no. 3, pp. 532-41.

Vartiainen, E., Laatikainen, T., Peltonen, M., Juolevi, A., Mannisto, S., Sundvall, J., Jousilahti, P., Salomaa, V., Valsta, L. and Puska, P. (2010) 'Thirty-five-year trends in cardiovascular risk factors in Finland', *Int J Epidemiol*, vol. 39, no. 2, pp. 504-18.

Vartiainen, E., Pekkanen, J., Koskinen, S., Jousilahti, P., Salomaa, V. and Puska, P. (1998) 'Do changes in cardiovascular risk factors explain the increasing socioeconomic difference in mortality from ischaemic heart disease in Finland', *J Epidemiol Community Health*, vol. 52, no. 7, pp. 416-9.

Waterhouse, J., Muir, C. and Correa, P. (ed.) (1976) *Cancer Incidence in Five Continents: Vol III*, 15th edition, Lyon: International Agency for Research on Cancer.

Vemmos, K., Ntaios, G., Spengos, K., Savvari, P., Vemmou, A., Pappa, T., Manios, E., Georgiopoulos, G. and Alevizaki, M. (2011) 'Association between obesity and mortality after acute first-ever stroke: the obesity-stroke paradox.', *Stroke*, vol. 42, no. 1, pp. 30-6.

Wendel-Vos, G., Schuit, A., Feskens, E., Boshuizen, H., Verschuren, W., Saris, W. and Kromhout, D. (2004) 'Physical activity and stroke. A meta-analysis of observational data', *Int J Epidemiol*, vol. 33, no. 4, pp. 787-98.

Venters, M., Jacobs, D.J., Pirie, P., Luepker, R., Folsom, A. and Gillum, R. (1986) 'Marital status and cardiovascular risk: the Minnesota Heart Survey and the Minnesota Heart Health Program', *Prev Med*, vol. 15, no. 6, pp. 591-605.

Whincup, P., Gilg, J., Emberson, J., Jarvis, M., Feyerabend, C., Bryant, A., Walker, M. and Cook, D. (2004) 'Passive smoking and risk of coronary heart disease and stroke: prospective study with cotinine measurement', *BMJ*, vol. 329, no. 7459, pp. 200-5.

White, C., Van Galen, F. and Chow, Y. (2003) 'Trends in social class differences in mortality by cause, 1986 to 2000', *Health Stat Q*, no. 20, pp. 25-37.

WHO Monica Project Principal Investigators (1988) 'The World Health Organization MONICA Project (monitoring trends and determinants in cardiovascular disease): a major international collaboration', *J Clin Epidemiol*, vol. 41, pp. 105-14.

Wilson, P., D'Agostino, R., Levy, D., Belanger, A., Silbertshatz, H. and Kannel, W. (1998) 'Prediction of coronary heart disease using risk factor categories', *Circulation*, vol. 97, no. 18, pp. 1837-47.

Virtaranta-Knowles, K., Sistonen, P. and Nevanlinna, H. (1991) 'A population genetic study in Finland: comparison of the Finnish- and Swedish-speaking populations', *Hum Hered*, vol. 41, no. 4, pp. 248-64.

Volanen, S., Suominen, S., Lahelma, E., Koskenvuo, M. and Silventoinen, K. (2006) 'Sense of coherance and its determinants: A comparative study of the Finnish-speaking majority and the Swedish-speaking minority in Finland', *Scand J Public Health*, vol. 34, no. 5, pp. 515-25.

Wormser, D., Kaptoge, S., Di Angelantonio, E., Wood, A., Pennells, L., Thompson, A., Sarwar, N., Kizer, J., Lawlor, D., Nordestgaard, B., Ridker, P., Salomaa, V., Stevens, J., Woodward, M., Sattar, N., Collins, R., Thompson, S., Whitlock, G. and Danesh, J. (2011) 'Separate and combined associations of body-mass index and abdominal adiposity with cardiovascular disease: collaborative analysis of 58 prospective studies', *Lancet*, vol. 377, no. 9771, pp. 1085-95.

Yarnell, J., Yu, S., McCrum, E., Arveiler, D., Hass, B., Dallongeville, J., Montaye, M., Amouyel, P., Ferrières, J., Ruidavets, J., Evans, A., Bingham, A., Ducimetière, P. and group, P.s. (2005) 'Education, socioeconomic and lifestyle factors, and risk of coronary heart disease: the PRIME Study', *Int J Epidemiol*, vol. 34, no. 2, pp. 268-75.

Yusuf, S., Hawken, S., Ounpuu, S., Bautista, L., Franzosi, M., Commerford, P., Lang, C., Rumboldt, Z., Onen, C., Lisheng, L., Tanomsup, S., Wangai, P.J., Razak, F., Sharma, A., Anand, S. and Investigators, I.S. (2005) 'Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: a case-control study', *Lancet*, vol. 366, no. 9497, pp. 1640-9.

Yusuf, S., Hawken, S., Ounpuu, S., Dans, T., Avezum, A., Lanas, F., McQueen, M., Budaj, A., Pais, P., Varigos, J., Lisheng, L. and Investigators, I.S. (2004) 'Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study', *Lancet*, vol. 364, no. 9438, pp. 937-52.

Yusuf, S., Islam, S., Chow, C., Rangarajan, S., Dagenais, G., Diaz, R., Gupta, R., Kelishadi, R., Iqbal, R., Avezum, A., Kruger, A., Kutty, R., Lanas, F., Lisheng, L., Wei, L., Lopez-Jaramillo, P., Oquz, A., Rahman, O., Swidan, H., Yusoff, K. et al. (2011) 'Use of secondary prevention drugs for cardiovascular disease in the community in high-income, middle-income, and low-income countries (the PURE Study): a prospective epidemiological survey', *Lancet*, vol. 378, no. 9798, pp. 1231-43.