Socio-economic Status and Health in Women

Population-based studies with emphasis on lifestyle and cardiovascular disease

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ABSTRACT

The aim of this thesis was to investigate socio-economic status in relation to morbidity and mortality, in particular cardiovascular disease among women using data from two population based studies from Sweden. The secondary aim was to explore mechanisms potentially linking socio-economic status to health, assessing for example dental, dietary, and lifestyle factors.

Samples: The Population Study of Women in Gothenburg Sweden was begun in 1968-69. A representative random sample of 1,622 women was selected according to date of birth and within the strata 38, 46, 50, 54, and 60 years of age; the participation rate was 90 percent. The Gerontological and Geriatric Population Studies in Gothenburg (H-70) are based on representative samples of 70-year olds from Göteborg, Sweden who participated in a series of cross sectional and longitudinal studies between 1971 and 2000. Participation rates ranged from 86 percent for men and 83 percent for women in the 1901/2 birth cohort to 65 percent for men and 69 percent for women in the 1930 birth cohort.

Main results: High socio-economic status was associated with a decreased risk for cardiovascular disease [RR 0.49; CI 0.24 – 0.99] in middle aged women independently of risk factors such as smoking and obesity; moreover opposing monotonic trends were seen for mortality from cancer and cardiovascular disease in relation to socio-economic status. Tooth loss, a proxy for cumulative lifetime oral infection was also associated with an increased risk for cardiovascular disease in women independently of socio-economic factors such as the husband's occupational category, income, and educational level. Among 70-year old cohorts, later-born women were heavier and had higher body mass index than earlier-born women within the high education group only. However, secular increases in waist-hip ratio were seen in both educational groups. Compared to earlier-born cohorts of 70-year old men, later-born cohorts had higher body mass index and cholesterol levels across social strata, and heart disease and diabetes mellitus became more prevalent. Among the elderly, secular trends indicated greater improvements in cardiovascular risk factors among women than men, with exception to smoking and alcohol consumption. Diet quality and food selection were assessed in relation to socio-economic status in the youngest cohort of 70-year olds born in 1930. Socio-economic disparities in diet quality were detected in men but not in women.

Conclusions: From a public health perspective, it is suggested that risk factor patterns should be investigated in association with socio-economic status in order to expose health inequalities, and to develop more equitable interventions for cardiovascular disease prevention.

Key words: cardiovascular disease, dental health, diet, epidemiology, obesity, women, socio-economic status.

LIST OF ORIGINAL PUBLICATIONS

The thesis is based on the following four articles that are referred to throughout the thesis by their roman numerals.

I. Cabrera C, Helgesson Ö, Wedel H, Björkelund C, Bengtsson C, Lissner L. Socioeconomic Status and Mortality in Swedish Women: Opposing Trends for Cardiovascular Disease and Cancer. Epidemiology 2001; (12) 5:532-536.

II. Cabrera C, Hakeberg M, Ahlqwist M, Wedel H, Björkelund C, Bengtsson C, Lissner L. Can the relation between tooth loss and chronic disease be explained by socio-economic status? A 24-year follow-up from The Population Study of Women in Gothenburg, Sweden. Eur J Epidemiol 2005; 20:229-236.

III. Cabrera C, Wilhelmson K, Allebeck P, Wedel H, Steen B, Lissner L. Cohort differences in obesity related health indicators among 70-year olds with special reference to gender and education. Eur J Epidemiol 2003; 18: 883-890.

IV. Cabrera C, Rothenberg E, Eriksson BG, Wedel H, Eiben G, Steen B, Lissner L. Socio-economic gradient in food selection and diet quality among 70-year olds. Submitted to The Journal of Nutrition, Health, and Ageing November 2005.

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CONTENTS

INTRODUCTION

Social class differentials in morbidity and mortality persist in Europe even though health care allocation in general has become more equitable during the past century.[1] Such health differences may, in part, be due to demographic (age, sex, ethnicity, and marital status) and lifestyle (physical activity, smoking, diet, and psycho-social) aspects of socio-economic status rather than a lack of universal health coverage.[2, 3] This makes it of interest to examine whether inequity in health continues to exist in Sweden where health care has been made accessible to all, and where only small inequalities have been detected in health care usage.[4] The path between socio-economic factors and disease is not clear, and it may be argued that social factors are not directly related, in the biological sense, to disease development. On the other hand, research has continuously coupled health disparities with economic inequities suggesting that socio-economic status can not be excluded as a possible determinant of disease development.[5] Research in social epidemiology can provide public health authorities with further evidence concerning existing social inequalities in health, and facilitate the implementation of preventive health care measures.

This thesis begins with a brief historical, theoretical, and epidemiological background on social factors and health. The intent of this section is to differentiate important social concepts that are used throughout the thesis. A methodological section will follow describing the two populations studied in this thesis along with the statistical methods applied. It will conclude with an analysis of the results from articles I-IV, also attached as appendices. In the discussion the objectives will be reviewed in light of the major findings. The overall aim of this thesis was to elucidate the relation between socio-economic status and cardiovascular disease in women.

BACKGROUND

Socio-economic status: history and terms

In the twentieth century, terms such as *underdevelopment* began to emerge in the field of economics and by the mid 1950's economists such as T. W. Schultz and W. A. Lewis discussed the need for investment in "human capital". Their ideas led to numerous studies that stressed social development especially in the areas of education, agriculture, and health. It was discussed that human capital was a necessary prerequisite for growth and that industrialization could never be sustainable if it came at the cost of social development.[6] The economic reports mentioned here mainly addressed issues of poverty and health in countries that were economically far less well off than Sweden today. However, it should be noted that social disparity and inequality are problems that transgress political boundaries; there is a social gradient associated with health in all countries regardless of their level of development.[7] Assumptions regarding equitable health care allocation in western countries were widely accepted until the publication of the Black Report in 1988, stating that social inequalities in health had widened in the United Kingdom over the past 30 years; other studies from the United States, the Netherlands, and England have followed in support.[8-9] Therefore it is of interest to study disparities in health status across socio-economic groups, in an economically and socially well developed Nordic country. For many years, Sweden has enjoyed a high standard of living together with one of the longest life expectancies at birth in the world; 82 and 78 years for women and men respectively.[10]

The science of epidemiology developed rapidly during the first half of the twentieth century, but it was not until the latter half that the "contribution of the social environment to host resistance" related social vulnerability to disease.[11] Poverty, low education, and poor working conditions have been since then, documented to impair health in both industrialized and non-industrialized countries.[12] Moreover, terms such as inequality, inequity, relative deprivation, and gender equity became popular in the 1970's and 80's in association with socio-economic status and health. Inequality is the non-equal distribution of wealth or disease in a population. Inequity is a term used mainly in economics that expresses the disparity between social groups in terms of income and wealth; in public health it is more often associated with moral or ethical judgements (unfairness) related to avoidable health risks. Relative deprivation compares the material circumstances of an individual or group with that of others; it also relates an individual's perceived position in society with that of another.[13] Gender equity captures aspects of culture bound conventions, roles, and behaviours that differ between the sexes.[14] There are many biological differences between men and women but to adequately interpret social indicators in women, aspects of gender must be considered.

Categorization of socio-economic status

Socio-economic status has often been grouped into two major categories: social class and social categories of position. Social class refers to the economic inter-dependence between groups or individuals in a population and has most often been used in Great Britain;[15] this type of classification is based on the asymmetry of economic exploitation that suggests an imbalance between owners of resources and the non-owners who work for them. Social class is socially determined; it conceptualizes social inequalities in health and wealth. This thesis focuses more on social categories of position, which has been more commonly used in the United States.[16] Socio-economic position is the distribution of components of social class such as occupations, income, wealth, education, and social status. Social categories of position include resource based measures such as income, educational credentials, and wealth, while prestige based variables measure aspects of hierarchical rank and resources associated with access and consumption of goods, services, or knowledge, as demonstrated in Table 1.[17] The term socio-economic status includes both aspects of social position, and these terms can be used interchangeably.

Table 1. Socio-economic status - categorization of social indicators measured at the individual level for each study (Papers I-IV).

Social Indicators of Position	Papers I-IV
Resource Based	
Household Income	I, II
Composite of Income plus Education*	I
Social status of origin	II
Prestige Based	
Husband's Occupational Category	I, II, IV
Socio-economic Index (SEI)	IV
Educational Level	I, II, III, IV
Father’s occupational category	II

*weighted on household income

Table 1 presents the seven indicators of socio-economic status that were studied in papers I-IV: household income, a composite variable combining household income and education, social status of origin (did you grow up under impoverished circumstances, yes/no), occupation measured as the husband's occupational category, socio-economic index also a composite score based on information pertaining directly to occupation and indirectly to education, educational level, and father's occupational category. In a broad sense, it is possible to stratify these indicators based on whether they are resource or prestige based.

Epidemiological indicators of socio-economic position measure aspects of the social environment that in turn affect health status, but it must be noted that these variables only capture part of the social environment.[18] Unmeasured aspects can result in "residual confounding" in epidemiological associations. To assess causal pathways, socio-economic status and health must be analysed in conjunction with factors such as demographic, lifestyle, anthropometric, or biological measures. Furthermore, in an epidemiological context, socio-economic variables may also have a specific type of relation to a given health outcome; for example, an indicator of social position may at times be considered a confounder, a modifier of an association, or mediator of an exposure on an outcome. Papers I and IV assessed socio-economic status as the main independent variable of interest in order to describe the association between social status and health outcomes. In Paper II socio-economic status was assessed as a confounder between number of missing teeth and chronic disease while in Paper III socio-economic status was analysed as a potential modifier of a secular trend effect. The various ways that socio-economic indicators were used in the regression models will be further discussed later in the thesis.

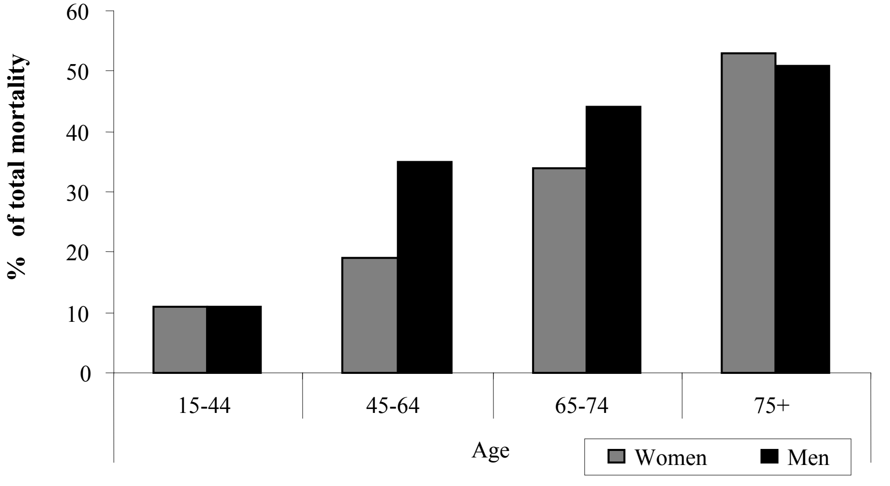
Socio-economic status and health in women

Cardiovascular disease

On a global scale, cardiovascular diseases accounted for 16 million or 29 percent of all global deaths in 2001. Women of all ages, but particularly post-menopausal women are at risk of cardiovascular morbidity and mortality and this has become the leading cause of death for all European women.[19] In Sweden, heart disease and stroke account for approximately 39% of all deaths for men and women between the ages of 65 to 75; and in the United States it accounts for 41% among those between the ages of 65 to 85.[20] Age is an important risk factor in relation to cardiovascular diseases where men and women differ; women appear to be at risk approximately ten years after their male counterparts as shown in Figure 1.[21-22] Mortality rates have declined over the past 15 years in both sexes, although cardiovascular mortality rates have decreased less in women (38%) than men (43%).[23]

Cardiovascular disease has not always been inversely associated with socio-economic status.[24] During the earlier part of the 20th century the reverse was true in men. It was not until more recently that both men and women from lower socio-economic groups were documented to be at greater risk of cardiovascular disease in western countries.[24-25] The prevalence of risk factors across socio-economic groups may explain this epidemiological transition. In Europe and North America, many studies have shown a persistent association between low socio-economic status and cardiovascular disease risk factors.[26-28]

Important risk factors associated with cardiovascular disease are smoking, high blood lipids, and high blood pressure levels, low physical activity, poor diet, and obesity, among others.[25, 29-30] A recently published study indicated that 1 in 10 cardiovascular deaths in the world was attributable to smoking, and a strong association was detected between smoking and ischaemic heart disease, cerebrovascular disease, and other cardiovascular diseases in both men and women.[31] This association also has been noted in Sweden; moreover, a social gradient in smoking was detected among women.[32] This same study also indicated that higher social position was associated with lower low-density lipoprotein cholesterol, serum levels of triglycerides, and blood pressure among women, while obesity was higher among men and women with low socio-economic index. Physical activity is associated with cardiovascular disease through cardiovascular risk factors that include hypertension and elevated blood lipids, among others. In Sweden, differences in type of physical activity were examined and leisure time physical activity was associated with a lower risk for myocardial infarction whereas labour-related physical activity such as heavy lifting had the opposite effect.[33]



Swedish National Board of Health and Welfare 2002

Figure 1. Percent (%) of total mortality due to cardiovascular disease among Swedish women and men by age group.

In Sweden the prevalence of obesity, based on self-reported height and weight (defined as body mass index weight(kl)/height(cm^2) $\geq$ 30) is approximately 10 percent in both men and women, although the "true" prevalence may be even higher. It is suggested that the total body mass index mean may have increased by 0.4 units between 1996/7 and 2000/1.[34] In the United States, 28 percent of the male and 34 percent of the female population was obese in 2000.[35] Recent studies conducted by Statistics Sweden indicate similar increasing trends among Swedish women and men as shown in Figure 2.[36] Furthermore, self reported indicators of obesity were found to be more prevalent among Swedish women with less education.[34, 37]

Recent studies have begun to show strong associations between poor oral health and cardiovascular disease.[38-41] It is not well understood whether low socio-economic status is the underlying explanatory factor. The mechanisms hypothesized as links between dental diseases and cardiovascular disease include the release of bacteria or bacterial products into the systemic circulation, while indirect effects could involve the release of inflammatory mediators into the systemic circulation causing destabilization of arterial plaque that may lead to blockage in a coronary artery.[40-41] A number of studies have demonstrated that individuals with poor oral health generally have a less favourable risk factor profile for cardiovascular disease but it is uncertain if this is due to oral health, low socio-economic status, or both.[42-43]

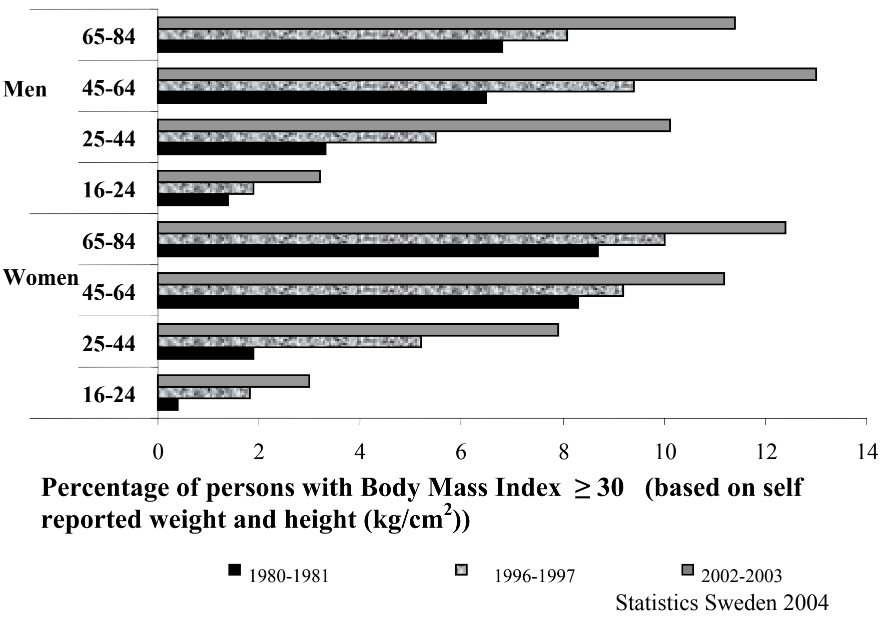
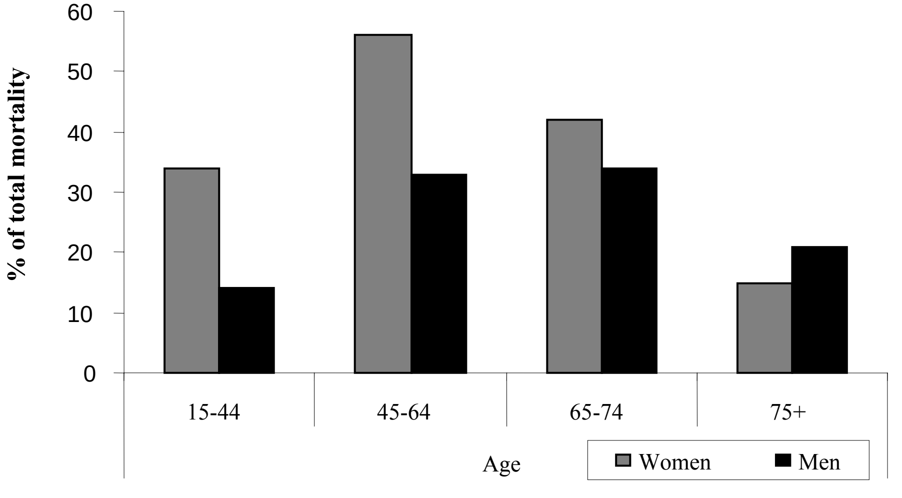


Figure 2. Obesity among Swedish women and men by age group.

Cancer

Globally, all site cancer accounted for 7 million or 12 percent of all global deaths in 2002. Although cancer has traditionally been associated with affluence, today more than 50 percent of all cancer cases occur in developing countries.[44] In European countries, cancer accounts for approximately 25 percent of all deaths and Sweden lies just below the European average at 23.5 percent for both women and men combined;[21,22] while in the United States, the percentage of total deaths due to malignant neoplasms was 22.9, in 2001.[20] As opposed to cardiovascular disease, cancer mortality in Sweden appears to affect women at a younger age, compared to men, as indicated in Figure 3. Moreover, cancer mortality rates have remained constant over the past almost 20 years in Sweden. However, lung cancer mortality has increased by 44 percent in women between the ages of 15 to 74; in contrast men in the same age group have decreased their risk by approximately 12 percent.[22]



National Board of Health and Welfare 2002

Figure 3. Percent (%) of total mortality due to all site cancer among Swedish women and men by age group.

In comparison to cardiovascular disease, general socio-economic trends related to malignant neoplasm have been, until recently, less documented.[45] Among women, low socio-economic status has been reported to be a risk factor for oesophagus, stomach, cervix, uteri, and liver cancer, while cancers most prevalent among higher social groups are colon, breast, ovary, and skin melanoma.[46] Recent studies indicate that Swedish women in manual occupations are at risk for stomach, cervical, and lung cancer while women in professional occupations experience higher rates of endometrial, breast, and melanoma cancer.[47] In Norway and Sweden a large longitudinal study indicated that women with more than 16 years of education had a greater risk of developing breast cancer but that this association could be explained by other risk factors for breast cancer such as parity and age at first birth, among others.[48] Another factor possibly affecting cancer (especially breast cancer) is the greater prevalence of hormone replacement therapy among women with higher social position.[49] The risk of other cancers, such as cervical and stomach cancers have proven to increase with low social status and viral or bacterial infections such as human papilloma virus and helicobacter pylori.[50-51] Among Swedish men lung, stomach, and oesophageal cancer are most prevalent among lower status occupations while white collar professionals are at risk for melanoma cancer.[47]

Lifestyle and environmental risk factors have been linked with cancer morbidity and mortality, and these factors are in turn also associated with socio-economic status. Smoking, physical inactivity, alcohol consumption, diet, and obesity are major lifestyle variables that have been reported to account for a large part of the global cancer incidence.[44-45] Smoking and tobacco products are reported to increase lung, larynx, mouth, pharynx, oesophagus, bladder and other cancers. Nevertheless, a large proportion of women especially in the lower social groups continue to smoke, while men have decreased their tobacco consumption across all social groups. In Sweden, the number of daily smokers in general, has decreased among women from 29 to 23 percent and from 32 to 19 percent among men between 1984 and 1997.[52] Gender difference in smoking may be increasing, for instance, smoking-attributable deaths among Swedish women have risen from 100 deaths in 1965 to 2,300 in 1995.[53] Moreover, younger women in lower socio-economic groups are smoking more today than a decade ago. Another important risk factor related to cancer incidence, and which has become a growing concern in Sweden is obesity. It has been indicated that obesity may increase cancers such as breast, endometrial, colorectal, oesophagus, and kidney among others. The lack of regular physical activity, food choices based on more high fat foods and low in vegetables and fruit, along with alcoholic beverages may be related to the increased cancer risk associated with obesity.[54-55]

Public health today is shaped by global changes that affect risk factor and disease patterns.[56] It is therefore important to study socially based health differences in Nordic countries, where basic health care is universal and mechanisms that continue to further affect our health may be more specifically identified. Population studies that investigate the relation between health behaviour and social position to cardiovascular disease and cancer in countries such as Sweden, contribute to public health knowledge that in turn may mitigate health inequities.

AIMS

Main aims

The aim of this thesis was to investigate socio-economic status in relation to morbidity and mortality, in particular cardiovascular disease among women using data from two population based studies from Sweden. The secondary aim was to explore mechanisms potentially linking socio-economic status to health, assessing for example dental, dietary, and lifestyle factors.

Specific objectives

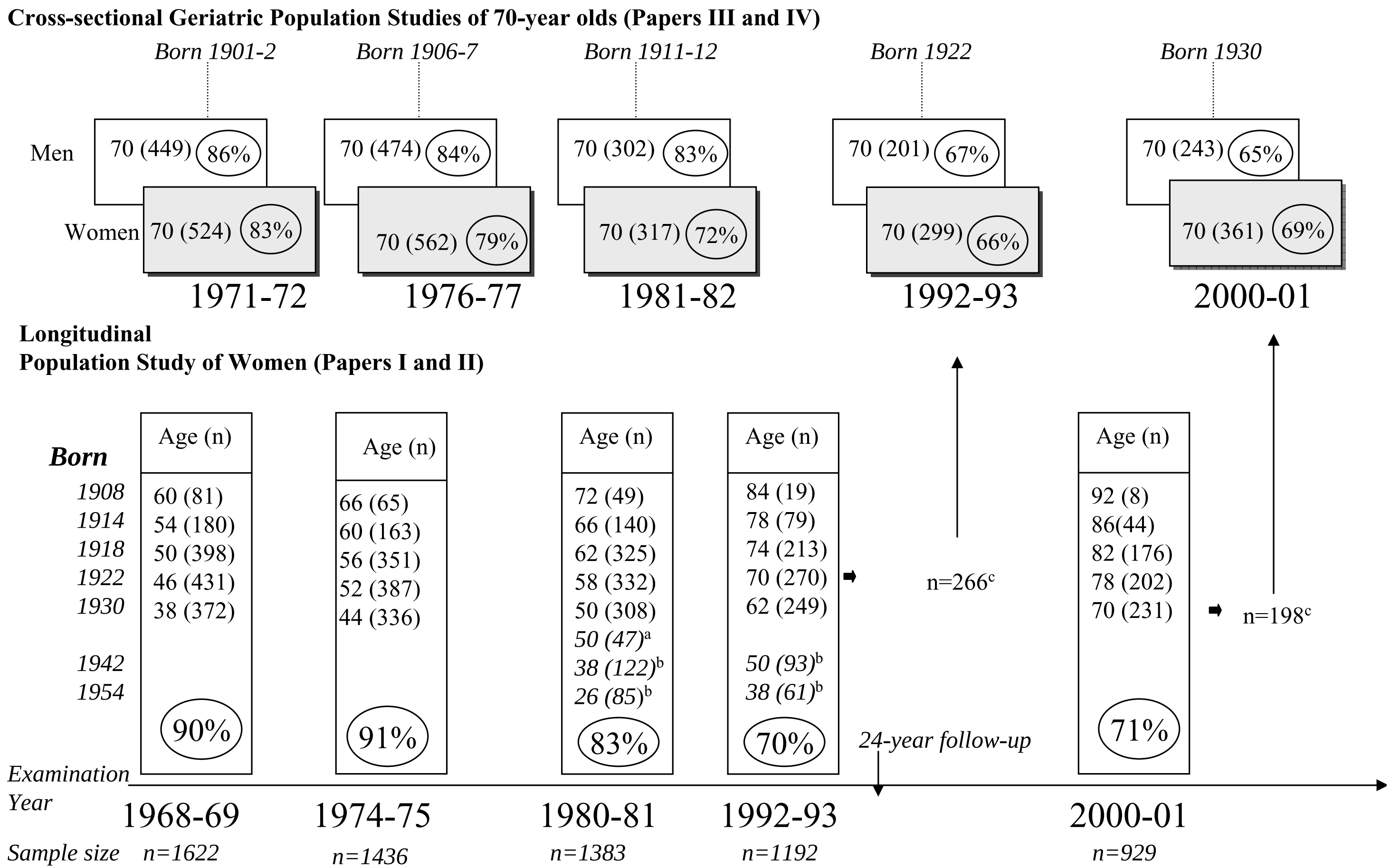
The specific objectives of this thesis were:

- to investigate associations between socio-economic status and subsequent cardiovascular disease and cancer in women (paper I);
- to assess the relative contributions of dental status and socio-economic status to cardiovascular disease and cancer in women (paper II);
- to analyse secular trends in cardiovascular disease risk factors and lifestyle indicators for 4 cohorts of 70 year-olds with attention to gender and education (paper III);
- to study food selection and diet quality in relation to socio-economic status among a contemporary sample of 70-year olds (paper IV).

MATERIAL AND METHODS

Göteborg, Sweden

Göteborg (Gothenburg in English) is an industrial city on the western coast of Sweden adjacent to the Skagerak, a part of the North Sea (see map below). It is the second largest city in the country with approximately 478 000 inhabitants in 2004 of which 29 percent are below the age of 24 and 15 percent are more than 65 years old.[57] Two population-based studies were begun in Göteborg between 1968 and 1971. The Population Study of Women in Gothenburg was initiated at Sahlgrenska Hospital and was one of the few epidemiological studies based solely on women, at the time. The Gerontological and Geriatric Population Studies in Gothenburg (H-70) are a series of cross-sectional and longitudinal studies on 70-year old men and women; the first cohort in this study was examined at the Department of Geriatrics in 1971.



Participation Rate: number that participated/number sampled and alive %; [a]50-year old women who moved to Göteborg and were born on originally selected dates; [b] not part of the original sample from 1968 and not followed up in 2000/1. [c]Participants in both studies.

Figure 4. Illustration depicting how the samples from Göteborg became integrated according to examination years from 1968-2000.

Samples

The Population Study of Women in Gothenburg

Papers I and II are based on the prospective Population Study of Women in Gothenburg. In 1968/69 a representative sample of 1,622 women was selected within the strata 38, 46, 50, 54, and 60 years of age. The sample was identified from the Revenue Office Register according to date of birth. Women born on the 6th, 12th, 18th, 24th, and 30th day (the 30th day was used only during the first half of the examination year, January through June) of each month were selected for 38, 46, and 50 year old women. Women who were 54 years old were selected on the 6th or 12th day and 60 year olds on the 6th day only. The survey was conducted approximately over a 12 month period and 1,462 women attended the first health examination, constituting a participation rate of 90.1 percent.[58] Four follow-up examinations have been subsequently carried out using the same procedure The participation rate for the 1974/75 follow-up was 91%, in 1980/81 it was 83%, in 1992/93 it was 70%, and in 2000/01 it was 71%. The participation rates include the number of participants at each follow-up divided by the number of participants from the original cohort in 1968/69 who were alive and available to participate in the follow-up examinations. For example, the response rate for the 1992/93 examination was 70% for the group of women who had participated in the 1968/69 examination, had not been lost to follow-up (n=4), and were still alive at the time of the 1992/93 examination (n = 1192) as depicted in Figure 4. In the prospective studies (papers I and II) 24 years of follow-up time from 1968 to 1992 was used, during which time 266 (18 percent) of the original participants died.[59]

The investigations were carried out as follows: an invitation was initially sent out offering a complete health examination to the selected population. Those who responded and agreed to participate were sent a general questionnaire that included questions regarding medical and social history. The participants arrived after having fasted during the night (they were allowed to drink water). Detailed physical examinations along with their respective questionnaires were administered at different work stations following a set schedule. Inevitably, the examination staffs changed from 1968 to 1992, although one doctor from the original staff has remained throughout all four follow-ups.

The physical examinations included anthropometric measurements, blood pressure, an electrocardiogram (ECG), urine specimens, and blood samples. Women in this study who were considered to be in need of further care were referred to a general practitioner or specialist.[60-61]

The dental surveys included an initial examination in 1968/69 and three follow-up examinations in 1980/81 and 1992/93, and 2000/01. Each examination consisted of a panoramic radiographic survey, a dental questionnaire, and a coloured photograph of dentition. Dental information measured at baseline was used in paper II only, and the variable number of missing teeth was calculated from a possible total of 32 teeth.[62] The participation rate in the 1968/69 dental examination was 97% of those who participated in the main examination.

The Gerontological and Geriatric Population Studies in Gothenburg (H-70)

Papers III and IV are based on samples of 70-year old women and men living in Göteborg, Sweden. These surveys are collectively referred to as The Geriatric Population Studies in Gothenburg (H-70). These studies consist of five cross sectional studies of 70-year olds measured between 1971/2 and 2000/01. At each survey, approximately 30% of all 70-year olds listed in the Revenue Office Register were systematically selected to participate in the Geriatric Population Studies in Gothenburg (H-70).[63] The cohorts included participants who were either community dwelling, living in a nursing home, or receiving help at home, in order to reflect a true elderly population. The average proportion of non-community dwelling elderly was approximately 2% among female cohorts and 2.5% in male cohorts. The population was selected based on birthdates that ended with 2, 5, or 8. The sampling itself was performed in four intervals in order to select the participants as close as possible to their 70th birthday. Subjects sampled on August 9, 1971 were born July 1 to September 30th 1901; those selected on September 28th were born October 1st to December 31st 1901; subjects sampled on December 6th were born January 1st to March 31st 1902; and on March 10th 1972 subjects born April 1st to June 30th 1902, were sampled. This selection method was used for cohorts born in 1901/2, 1906/7, and 1911/2. Some of the subjects from The Population Study of Women in Gothenburg, who were 46 and 38 years old in 1968, formed part of the fourth and fifth 70-year old cohorts examined in 1992/3 (n=266) and 2000/01 (n=198) respectively, as shown in Figure 4. Women from the Population study of Women who did not reside within the Göteborg region were excluded; in order to acquire a representative sample from Göteborg, additional women and 70-year old men were selected based on birth dates ending in 2, 5, or 8 (as described above).

After the selection of a participant had been completed, a letter of invitation was posted in the mail and telephone contact was made one week later. The participants were offered a medical examination that included blood and urine sampling and an ECG and X-ray of the heart, lungs, and breast along with a questionnaire that included social, behavioural, diet, and medical questions, among others, previously described in detail.[64-65] Information on morbidity was ascertained during the health examinations conducted at the Outpatient Department along with laboratory analyses. When necessary, a home visit was conducted.

Paper III is based on cohorts born in 1901/2, 1906/7, 1911/12, and 1922. The first cohort consisted of 524 women and 449 men born in 1901/2 and examined in 1971/2 (participation rate was 83% and 86% respectively). The second cohort consisted of 562 women and 474 men born in 1906/7 and examined in 1976/7 (participation rate was 79% and 84% respectively). The third cohort consisted of 317 women and 302 men born in 1911/12 and examined in 1981/2 (participation rate was 72% and 83% respectively). The cohort born in 1911/12 also became part of an intervention study IVEG (InterVention of Elderly people in Göteborg) which began after the baseline study at age 70 and was studied prospectively until the participants were 86 years old. The fourth cohort consisted of 299 women and 201 men born in 1922 and examined in 1992/3 (participation rate was 66% and 67% respectively). Paper IV is based on the fifth cohort which consisted of 361 women and 243 men born in 1930 and examined in 2000/01 (participation rates were 69% and 65% respectively).

The dietary examination in 2000/01 was conducted on n=321 women and n=233 men (as described in paper IV) and consisted of a structured interview which lasted approximately one to one and a half hours. The interview was administered by a dietician and began with a 24-hour recall that was followed by an in-depth dietary history interview that aimed at probing information on habitual intakes of food, energy, and nutrients. This method has been utilised and validated previously and the same diet history method has been used in previous studies with only minor adjustments (more detailed descriptions have been published previously).[65]

Measures and analyses

Prospective analyses (papers I and II) using data from The Population Study of Women in Gothenburg

Papers I and II
Measures of socio-economic status

Socio-economic status was characterised in papers I and II by four methods: husband's occupational category, household income, women's own education, and a composite variable reflecting household income and women's education (the composite variable was used in paper I only). Women's own occupational category could not be used as a socio-economic indicator because 35% described themselves as housewives and of those that worked outside the home, many worked part-time. The husband's occupational category is a conventional socio-economic indicator reflecting community status and financial earnings of the husband in each household, for married women. This variable comprised three levels of socio-economic status: high (large scale employers and officials of high or intermediate rank, including 14% of the 1,156 married women); medium (small scale employers, officials of lower rank, foremen, 43% of the sample); and low (skilled and unskilled workers, 43%).[66-67] 78% of the women were married and could be characterised in this way. In addition, the variables household income and education were examined in order to include all women in the analyses. Self reported household income at the time of the baseline study was calculated from women's own income plus that of her husband, if married; a cut point of 35,800 Swedish Crowns (SEK) per year (median) was used to discriminate lower versus higher income groups. Educational group also included two categories that were based on a natural cut off level: the majority of women had attended primary school grades 1 through 6 or 7 (70%), while only 30% had gone beyond this level, and fewer than 2% had attended university or college in 1968. Combining information on household income and education in paper I, a three level composite indicator was created. High socio-economic status consisted of high income with high education and included 20% of all 1,462 participants. Medium referred to high income with low education comprising 29% of the sample. The remaining 51% were classified as low (low income with either high or low education). This type of composite approach combines information concerning resources available to the household with individual information on social position as reflected by educational level for each woman.[68] The categorisation scheme used here gives greater importance to income than education in the assessment of health risk in women in accordance with previous research suggesting that income has a stronger relation to morbidity than education in women.[69]

Mortality and morbidity endpoints

For each socio-economic variable, Cox proportional hazards models were used to estimate time to total mortality, cause specific mortality, and selected morbidity endpoints. Endpoints were identified through individual case assessments in 1992/3 and were classified according to the International Classification of Diseases, Ninth Revision (ICD 9).[70] Previous endpoints coded after 12 years of follow-up in 1980/1, used the 7th edition of the ICD codes. Differences between ICD 7 and ICD 9 coding in this data were minimal. 266 deaths occurred after 24 years of follow-up. Cause specific mortality included cardiovascular disease (96 deaths) and all site cancer (90 deaths). Specifically, mortality due to cardiovascular disease consisted of all deaths from myocardial infarction (40%) ICD codes 410 and 411, other heart diseases (34%) ICD codes 414 and 428, or stroke (26%) ICD codes 430-438. Death due to all site cancer, ICD codes 140-208, included breast cancer (20%) ICD codes 174-175, uterine cancer (5%) ICD code 179, ovarian cancer (12%) ICD code 183, lung cancer (9%) ICD codes 162-165, blood/lymph cancer (14%) ICD codes 155-159, gastro-intestinal cancer (22%) ICD codes 140-154, skin cancer (1%) ICD code 172-173, multiple site cancer (1%), or other cancers (15%). Two general types of cancer morbidity were studied separately, out of a total of 221 cases: breast cancer (22%), and non-breast cancer cases (78%) (non-breast cancer morbidity was used in paper I only). Morbidity from myocardial infarction (92), stroke (83), and diabetes mellitus (82) was also evaluated.

Non-fatal myocardial infarction was diagnosed from hospital records when two of the following three criteria were fulfilled: central chest pain of more than 15 minutes duration with onset during the previous 48 hours; an electrocardiogram (ECG) indicating pathological status; and a transient rise above the normal laboratory limit of serum glutamic-oxaloacetic transaminase (SGOT). Non-fatal stroke was diagnosed from hospital records and fatal stroke cases were ascertained if signs of cerebrovascular accident were noted during an autopsy or when stroke was indicated as the major cause of death on the death certificate. Diabetes mellitus was diagnosed by a doctor after inquiring about diabetes medication and having taken two fasting blood samples that showed concentrations of serum glucose levels greater than or equal to 7 mmol/l (126 mg/100 ml).[121] Information on mortality was obtained from the Hospital Discharge Registry (managed by the Centre for Epidemiology at the National Board of Health and Welfare), death certificates, the local Revenue Office, and the Swedish Central Bureau of Statistics. Morbidity was ascertained from self-reported history, medical examinations, the Hospital Discharge Registry, and the National Board of Health and Welfare (the Swedish Cancer Registry).

Statistical methods

Assessing longitudinal data is a good way to gather evidence that may support potential causal relations in health. In papers I and II, the data were analysed using Cox´s Proportional Hazards model to estimate time to morbidity or mortality.[71] Each socio-economic factor in paper I was studied in outcome-specific regression models to evaluate socio-economic status as the main independent variable of interest. The covariates included in the regression models (papers I and II) when cardiovascular disease was analysed as the dependent variable were age, waist hip ratio, body mass index, and smoking; while for cancer endpoints the covariates included were age, smoking, age at first birth, and parity. Reduced models were used when number of events was low, and the distribution of covariates was assessed individually. In paper II, descriptive statistics summarized dental status in relation to three socio-economic variables (the husband's occupational category, education, and combined income) and logistic regression models assessed the association between number of missing teeth and each (independent) socio-economic variable in age adjusted models. The role of socio-economic status as a potential mediator between number of missing teeth and cardiovascular disease or cancer also was assessed in proportional hazards models. This was of import given that previous studies had demonstrated an association between low social status and oral health as well as to cardiovascular disease.[13] Results from the proportional hazards models in paper I were presented with trend estimates, standard errors, hazard ratios [relative risks (RR)], and 95 percent confidence intervals (95% CIs). The trend estimates (in Table 2 Paper I) represent the increased risk per unit change in the husband's occupational category (low, medium, and high); these estimates are given with standard errors. In paper II, results from the proportional hazards models were presented with hazard ratios [relative risks (RR)], 95 percent confidence intervals (95% CIs), and p-values. P-values less than 0.05 were considered statistically significant. The unit of risk presented for the hazard models in paper II corresponds to 10 missing teeth, although number of missing teeth was analysed as a semi-continuous factor (0 to 32 teeth) in the statistical models. Proportional hazards assumptions were assessed by dividing the follow-up time in half and comparing the hazards ratios in each time period for each health endpoint, and also for covariates that could have potentially varied over time.

Cross sectional studies (papers III and IV) using data from The Gerontological and Geriatric Population Studies in Gothenburg (H-70)

Paper III
Measure of socio-economic status

Paper III evaluates cardiovascular disease trends, gender, and education in 70-year olds born in 1901/2, 1906/7, 1911/12 and 1922. A dichotomous variable for education was used as a proxy for socio-economic status where primary education less than or equal to 7 years indicated lower educational level and more than primary education was considered higher educational level. At least 75 percent of the participants in cohorts born in 1901/2, 1906/7, and 1911/12 acquired a primary school education (≤ 6 years), which was mandatory during their childhood. In the last cohort born in 1922, obtaining more than primary school education was more common in both men (49%) and women (37%) compared to earlier-born cohorts.

Measures of lifestyle and metabolism

Continuous health indicators included systolic and diastolic blood pressures (mm/Hg), triglycerides (mmol/L), cholesterol (mmol/L), height (cm), weight (kg), body mass index (kg/m^2), and waist hip circumference ratio (cm/cm). Information on "lifestyle" variables was collected during the interview process and included: current smoking of cigarettes (yes/no), alcohol consumption all types (yes/no), and physical inactivity. In this study physical inactivity was created from a series of activity variables in each cohort and compiled into a dichotomous variable.[72] Smoking was also converted into a dichotomous variable from more complex scales, as has been previously described. Each study included all of the indicators mentioned above except waist hip ratio and alcohol consumption. Waist hip ratio was measured in sub-samples of birth cohorts from 1901/2, 1906/7, and 1922. Alcohol consumption was measured in all subjects for birth cohorts 1901/2, 1911/12, and 1922, but not in the 1906/7 cohort.

Prevalent morbidity

Information on morbidity was initially acquired through a self-assessment question that indicated number of past or current diseases along with the age at which diagnosis occurred. The main question was asked in the following manner: "Have you been told by a physician that you have or have had: diabetes/ angina pectoris/ myocardial infarction/ other heart disease/ stroke/ hypertension/ goitre/ chronic bronchitis/ asthma/ lung tuberculosis/ rheumatic fever/ icterus/ gall stones/ gastric ulcer/ appendicitis/ kidney stones/ urinary tract infections/ diseases of the prostate/ disorders of the female reproductive organs/ chronic rheumatic arthritis/ lumbago/slipped disc/sciatica/ cancer/ anaemia/ TIA (transitorial ischaemic attack)/ or surgery for inguinal hernia?" Self reported morbidity was further confirmed by official register data such as the Swedish Hospital Discharge Register (HDR). In paper III, morbidity from angina pectoris, myocardial infarction, stroke, other heart diseases, and diabetes mellitus were evaluated across cohorts of 70-year old women and men

Statistical methods

Anthropometric, metabolic, and lifestyle variables, as well as morbidity endpoints were compared in a cross-sequential manner among four birth cohorts of 70-year olds. The term "Cross-sequential" refers to serial cross-sectional studies that assess subjects of specific ages at different points in time. To analyse secular health trends, linear and logistic regression models were used. Statistical interactions between gender and cohort effects were tested. Dependent variables included in the linear regression models were systolic and diastolic blood pressure, triglycerides, cholesterol, height, weight, body mass index, and waist-hip ratio. Logistic regression models included physical inactivity, smoking, alcohol consumption, angina pectoris, myocardial infarction, stroke, other heart disease, and diabetes mellitus as dependent variables. A two way interaction tested the effect of gender over time (unit change for time was 1 year) for each dependent variable. Further effect modification of secular trends by education was tested in men and women separately for similar dependent variables. Results were presented with beta coefficients from linear regression models where the dependent variables were non 0, 1 health indicators such as blood pressure. Odds ratio estimates were given for dependent lifestyle indicators, such as smoking which were measured in a dichotomous manner, and presented with corresponding 95% confidence intervals. P-values less than 0.05 were considered statistically significant.

Paper IV
Measures of socio-economic status

Paper IV analyses socio-economic status and nutrition among 70-year olds born in 1930. Socio-economic status was estimated by two separate indicators at one point in time: educational attainment and the Swedish socio-economic index. Education was converted into an ordinal variable consisting of three levels: low, medium, and high educational attainment. The category low education (*folkskola*) included all participants with a primary school education or less (≤ 7 years); 63% of the women and 57% of the men that responded were in this category. Medium educational level was comprised of all participants who had completed more than a primary school education and up to 10 years of education (*läroverk, folkhögskola, or realskola*); 24% of the women and 17% of the men were in this category. High educational attainment was defined as having acquired more than 10 years of education (*gymnasium, högskola*); 13% of the women and 26% of the men were in this category. This may be contrasted with the education definitions used in studies including earlier born cohorts.

The Swedish socio-economic index (SEI) was first developed by the Swedish Central Bureau of Statistics in 1984.[73] SEI is a widely accepted socio-occupational classification method that includes the number of years a person has worked in an occupation in conjunction with educational level. This socio-economic variable ranks occupations in an ordinal scale ranging from 10 to 89 where the categories begin with blue collar professions consisting of manual labour occupations that do not require specific training, and range to academically trained professions or higher ranked self-employed categories such as owning your own business. The participants in this study were all retired at the time of the examination, and therefore the socio-economic index reflects main occupation previous to retirement. Socio-economic index was studied as a semi-continuous variable and also as a dichotomous variable that separated the participants into blue collar or white collar employment. Blue collar workers included 49% of the women and 38% of the men in this study.

Further analysis was conducted in a sub-sample of married women who were also part of The Population Study of Women in Gothenburg. The relation between the husband's occupational category, as measured in 1968 and combined household income (both variables have been described in paper I) were analysed in order to determine whether the husband's occupational category is a more discriminating indicator in women, compared to education or occupation.

Measures of diet

Standardised diet history interviews were conducted in this cohort of 70-year olds. The food variables analyzed included 35 different reported food items. The amounts consumed per day were converted from varying measurements such as "decilitre" and "slice" into grams consumed per day.[74]

The Diet Quality Index-Revised is a tool that attempts to assess total diet quality by incorporating calculations of dietary intake of nutrients along with dietary moderation, variety, and proportionality.[75-76] The diet history interviews provided data that was classified into ten components comprising the diet quality index-revised instrument; component scores were summed for a highest possible score of 100. Criteria for the food categories were followed whenever possible although Swedish recommendations varied slightly from recommendations given by the Food and Drug Administration in the United States.[77] Minor changes were made to the food subgroups in order to accommodate traditional Swedish foods such as rye crisp breads and a grain based drink among others. The standard recommendation for alcohol intake among middle aged persons in Sweden is ≤30 grams per day and there are no adjusted alcohol levels for the elderly. Alcohol (all types), a category in the dietary moderation component, gave the maximum number of points to subjects drinking ≤24 grams per day while participants drinking ≥48 grams per day received the least amount of points.

Statistical methods

Exploratory analyses were initially conducted on this data where multiple variable regression models tested mean differences in food choices across educational and socio-economic index categories while controlling for total energy intake (kcal), smoking (never/ex-smoker/current smoker), body mass index ($kg/m^{2)}$, and physical activity (inactive, moderately active, regularly active, very active), and after stratifying by sex. Due to noted differences in food selections across socio-economic categories, it became important to assess the overall quality of a subject's diet by social group. The Diet Quality Index-Revised scores were calculated and stratified by sex. The regression models assessing diet quality included the following covariates: smoking, body mass index, and physical activity. Results from the multiple variable models where education is assessed in relation to lifestyle factors were presented with mean levels or proportions per social level along with p-values for trend. Mean levels of 35 different foods or food groups were analyzed as dependent variables in multiple variable regressions and were presented with mean levels plus their standard deviations and their corresponding p-values for trend. P-values less than 0.05 were considered statistically significant although the multiple hypotheses problem was assessed and a conservative p-value less than 0.002 may be more appropriate for the food based analyses. Diet quality index was also analyzed in a multiple variable regression where results are presented with β beta coefficients and their corresponding p-values. Diet Quality Index was further analysed in a sub-sample of married women using similar regression models; the husband's occupational category and combined household income (as measured in 1968) were studied as the main variables of interest along with covariates.

All data were analysed using the statistical package for SAS versions 6.0 and 8.2.

RESULTS

Specific results and conclusion

Paper I

Socio-economic Status and Mortality in Swedish Women: Opposing Trends for Cardiovascular Disease and Cancer

For married women, the husband's occupational category was analysed in relation to morbidity and mortality. Trend estimates indicated no association between the husband's occupational group and total mortality, in age adjusted and fully adjusted Cox proportional hazards models [beta coefficient (β) = -0.09; 95% confidence interval (95% CI) = -0.31 - 0.13)]. However, occupational category was associated with excess cardiovascular disease mortality [β = 0.46; 95% CI = 0.28 – 0.83]. In contrast, occupational category of the husband was associated with a decreased risk in all site cancer mortality [β = -0.36; 95% CI = -0.69 – -0.3]. These associations were independent of all covariates included in the respective regression models. Considering the morbidity endpoints, occupational category was positively associated with elevated breast cancer morbidity while inverse trends were seen for stroke and diabetes morbidity. These findings of excess stroke and diabetes risk in the lowest socio-economic group persisted even after covariate adjustment. Compared to stroke and diabetes, the relation between spouse's occupational category and myocardial infarction was less clear.

In order to include all women in the analysis, regardless of marital status, analyses were conducted using a composite socio-economic indicator derived from income plus educational level. Consistent with results seen using husband's occupation, total mortality in the lower composite socio-economic group did not differ from that in any of the other groups. Again, high socio-economic status was associated with a decreased risk for cardiovascular disease [RR 0.49; CI 0.24 – 0.99]. While the composite variable was not significantly related to mortality from cancer [RR 1.45; CI 0.83 – 2.51], it did present a positive trend similar to that seen using the husband's occupational category. The composite measure of socio-economic status was also related to morbidity from breast cancer which increased in a strong dose response manner as socio-economic status increased, and marked differences were seen when high socio-economic status was compared to low [RR 3.31; CI 1.74 – 6.31]. Finally, using this composite measure of socio-economic status, stroke and diabetes incidence were both lower in the medium compared to low socio-economic level. Stroke also showed an inverse trend with socio-economic level which became attenuated in the fully adjusted regression model. Consistent with the results in married women, only a weak and uncertain association was seen between socio-economic status and incidence of myocardial infarction using the composite index. These results could be summarized in Figure 5 below, where cumulative incidence for mortality was plotted for each socio-economic category and p-values for trend were given.

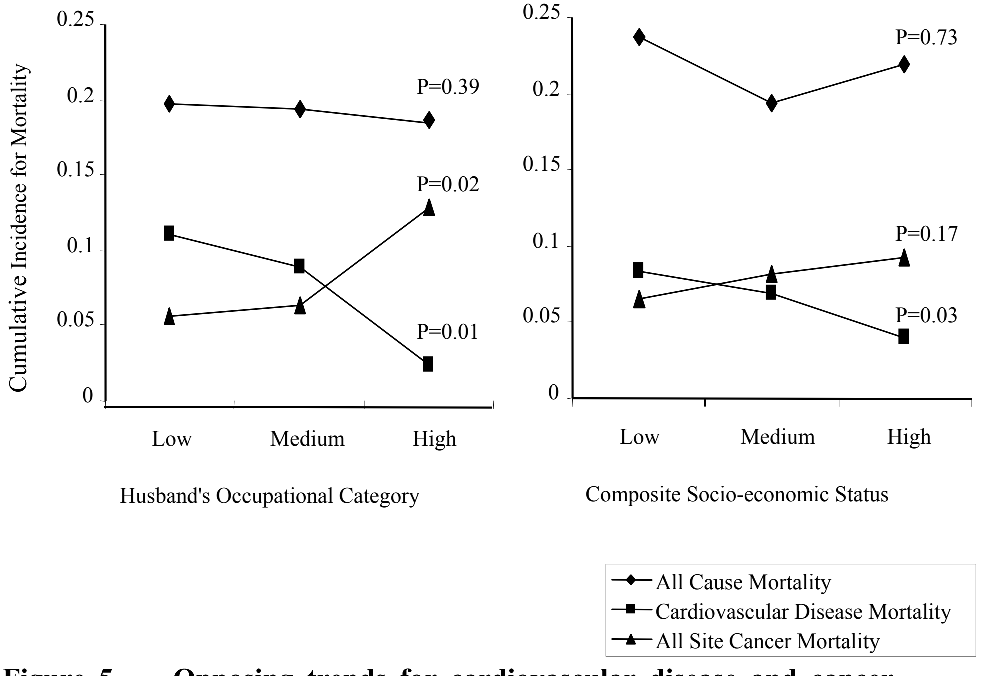


Figure 5. Opposing trends for cardiovascular disease and cancer mortality in women along with levels of significance (p-values).

The results presented in paper I support an association between social status and health that could not be explained by selected confounding factors. The covariates included in the models were analysed as shown in Table 2 below. Socio-economic variables such as education and marital status were not as strongly associated with mortality endpoints compared to the husband's occupational category and the composite variable. The lack of association between women's own socio-economic position and health in Western countries has been noted previously.[68, 78] Anthropometric and lifestyle variables such as waist hip ratio and smoking demonstrated a continued association with mortality in middle aged women. Even though body mass index was highly correlated with waist hip ratio it was not strongly associated with mortality; this is in contrast to other studies.[79] This indicates that obesity associations may be confounded with the socio-economic indicators included in the models, or with other covariates and endpoints as indicated previously.[80] Smoking was associated with all cause and cardiovascular mortality but not cancer mortality. The lack of association between smoking and cancer mortality may be explained by the variety of cancers included as endpoints; for example only 9% of the cancer deaths were due to lung cancer. Although these confounders did not always demonstrate strong relations to the dependent variables tested, they were included in the models due to previously noted associations in earlier studies.

Proportional hazards assumptions were assessed for the socio-economic indicators, as well as for waist hip ratio, body mass index, and smoking in relation to all-cause, cardiovascular, and all-site cancer mortality (for time constancy tables see Appendix 2). The hazard ratios indicated similar relations between socio-economic and cardiovascular disease in each time period, and the confidence intervals over-lapped one another. Similar relations were noted for other covariates that may vary over time such as smoking and waist hip ratio.

TABLE 2. Adjusted Relative Risks[b] (RR) for Mortality in relation to selected covariates at baseline.

Mortality		Waist/Hip Ratio RR AND 95% CI	Body Mass Index RR AND 95% CI	Smoking RR AND 95% CI	Parity RR AND 95% CI	Education RR AND 95% CI	Marital Status RR AND 95% CI
All cause Mortality	Adj age only	1.37	1.01	1.27	0.99	0.92	1.11
	n=266	(1.23 - 1.53)	(0.98 - 1.05)	(1.12 - 1.44)	(0.91 - 1.09)	(0.60 - 1.39)	(0.92 - 1.33)
	Multiple variable[a]	1.44	0.98	1.25	0.98	0.95	1.08
	n=254	(1.26 - 1.66)	(0.94 - 1.02)	(1.09 - 1.43)	(0.89 - 1.09)	(0.62 - 1.47)	(0.88 - 1.33)
Cardiovascular Disease	Adjage only	1.66	1.05	1.58	1.12	0.59	0.90
Mortality	n=96	(1.39 - 1.89)	(1.00 - 1.11)	(1.28 - 1.96)	(0.97 - 1.29)	(0.26 - 1.36)	(0.64 - 1.27)
	Multiple variable	1.66	0.99	1.53	1.06	0.67	0.92
	n=93	(1.33 - 2.10)	(0.93 - 1.06)	(1.23 - 1.91)	(0.91 - 1.24)	(0.29 - 1.55)	(0.65 - 1.31)
Cancer Mortality	Adjage only	1.11	0.97	1.12	0.91	0.93	1.04
	n=90	(0.88 - 1.32)	(0.92 - 1.03)	(0.91 - 1.38)	(0.78 - 1.06)	(0.47 - 1.85)	(0.75 - 1.45)
	Multiple variable	1.18	0.96	1.12	0.91	0.84	0.88
	n=87	(0.93 - 1.49)	(0.89 - 1.02)	(0.89 - 1.39)	(0.77 - 1.09)	(0.41 - 1.75)	(0.61 - 1.27)

[a]Multiple variable model includes: waist hip ratio (continuous variable), body mass index (continuous variable), smoking (never, ex-smoker, current smoker), parity (minimum 0 - maximum 8 live births), education(<=primary or >primary), and marital status (single, previously married, married). [b]Relative risks are for one unit change in the risk factor.

Paper II

Can the relation between tooth loss and chronic disease be explained by socio-economic status? A 24-year follow-up from The Population Study of Women in Gothenburg Sweden

Risk estimates for morbidity and mortality were calculated in relation to number of missing teeth in married women while controlling for the husband's occupational category. The covariates included were the same as in paper I. Mortality from cardiovascular disease was elevated in the women with more missing teeth, independently of age, socioeconomic status, smoking, and body mass index. In contrast, all site cancer morbidity and mortality were not statistically associated with number of missing teeth. Morbidity from stroke and myocardial infarction significantly increased with tooth loss independent of socio-economic status and other covariates. Incidence of diabetes mellitus was also significantly associated with tooth loss after adjustment for age and socio-economic status. However, the association was attenuated once waist hip ratio and body mass index were entered into the model. Finally, stratification of the data by the husband's occupational category (low and high/medium) was conducted to further investigate whether the associations between tooth loss and disease were modified by socio-economic status. The stratified results involving all cause mortality, cardiovascular disease mortality, and myocardial infarction morbidity were consistent with previous results in both socio-economic strata. This provides further evidence that the associations presented here can not be fully explained by available indicators of socio-economic status as illustrated for cardiovascular mortality and non-fatal myocardial infarction in Table 3.

In order to document socio-economic effects on dental health in the whole sample, alternative socio-economic variables (household income and educational level) were used that described both single and married women. In this series of analyses, number of missing teeth was significantly associated with total mortality, cardiovascular mortality, and morbidity from myocardial infarction, independently of combined income and education. Weaker associations were observed for stroke and diabetes, and no associations were observed between number of missing teeth and cancer mortality or morbidity.

Table 3. Relative risks (RR) and 95% confidence intervals for number of missing teeth after stratifying by the husband's occupational category.

	Husband's Occupational Category	
	Low	*High plus Medium*
	Missing teeth RR and 95% CI	Missing teeth RR and 95% CI
All-cause Mortality	n=81 1.50 (0.86 - 2.62)	n=104 1.65 (1.11 - 2.46)
Cardiovascular Disease Mortality	n=38 4.89 (1.47 - 16.23)	n=31 2.78 (1.28 - 6.05)
Non-fatal Myocardial Infarction	n=37 2.88 (1.09 - 7.61)	n=33 2.24 (1.09 - 4.62)

Missing teeth is a dichotomous variable: <12 versus ≥12 missing teeth.
Multiple variable models were adjusted for age only.

A final series of analyses was conducted assessing indicators measured at baseline in a subset of this population (approximately half of the participants). Two variables measuring socio-economic status of origin were studied: the father’s occupational category, classified in a similar manner as the husband’s occupational category and growing up under impoverished conditions (yes/no/unknown). Both of these variables were correlated with number of missing teeth at baseline but did not attenuate the association between number of missing teeth and mortality or morbidity, in the same subset of women. In addition, two indicators of inflammation or infection were assessed, serum C-reactive protein and white blood cell count. These measures of infectious burden were not correlated with number of missing teeth at baseline and did not significantly change the association between tooth loss and mortality or morbidity.

In paper II, socio-economic status was analysed mainly as a possible mediator in the relation between number of missing teeth and cardiovascular disease or cancer endpoints. Effect modification of number of missing teeth by socio-economic status was described when the data were stratified by social level (low or high/medium); differences in the association between oral health and cardiovascular disease were not detected across social levels. Furthermore, proportional hazards assumptions were assessed for number of missing teeth in relation to cardiovascular mortality, and the hazard ratios continued to be positively related to cardiovascular disease in each time period (in Appendix 2).

Paper III

Cohort differences in obesity-related health indicators among 70-year olds with special reference to gender and education

In paper III we report on secular trends in selected cardiovascular and lifestyle risk factors (see Table 1 and Figure 1 in paper III) between 1971 and 1992. Among women, secular trends for mean weight and height varied significantly although no significant difference was noted for body mass index across cohorts. Despite the stability of body mass index in women, later-born cohorts had significantly higher waist hip ratio estimates increasing from 0.81 cm/cm in the 1901/2 birth cohort to 0.83 cm/cm in the birth cohort from 1922. In addition, a greater proportion of women in the latest born cohort versus the 1901/2 birth cohort were smokers (18 versus 12%) and alcohol consumers (47 versus 12%). Among elderly men cohort differences were seen for weight and body mass index, where mean body mass index in the 1901/2 birth cohort was approximately 25 compared to 27 in the 1922 birth cohort. In addition, the latest born men were less likely to smoke than the earliest born cohort (21 versus 50% current smokers) but consumed more alcohol.

For some indicators, later-born cohorts of men seemed to improve less than women. The difference in blood pressure levels between earlier and later-born cohorts of men was not as great as that noted among cohorts of women and secular increases in weight and body mass index were much greater across male than female cohorts. Later-born female cohorts did not display a markedly greater prevalence of selected morbidity, unlike their male counter parts as shown in Figure 6 below.

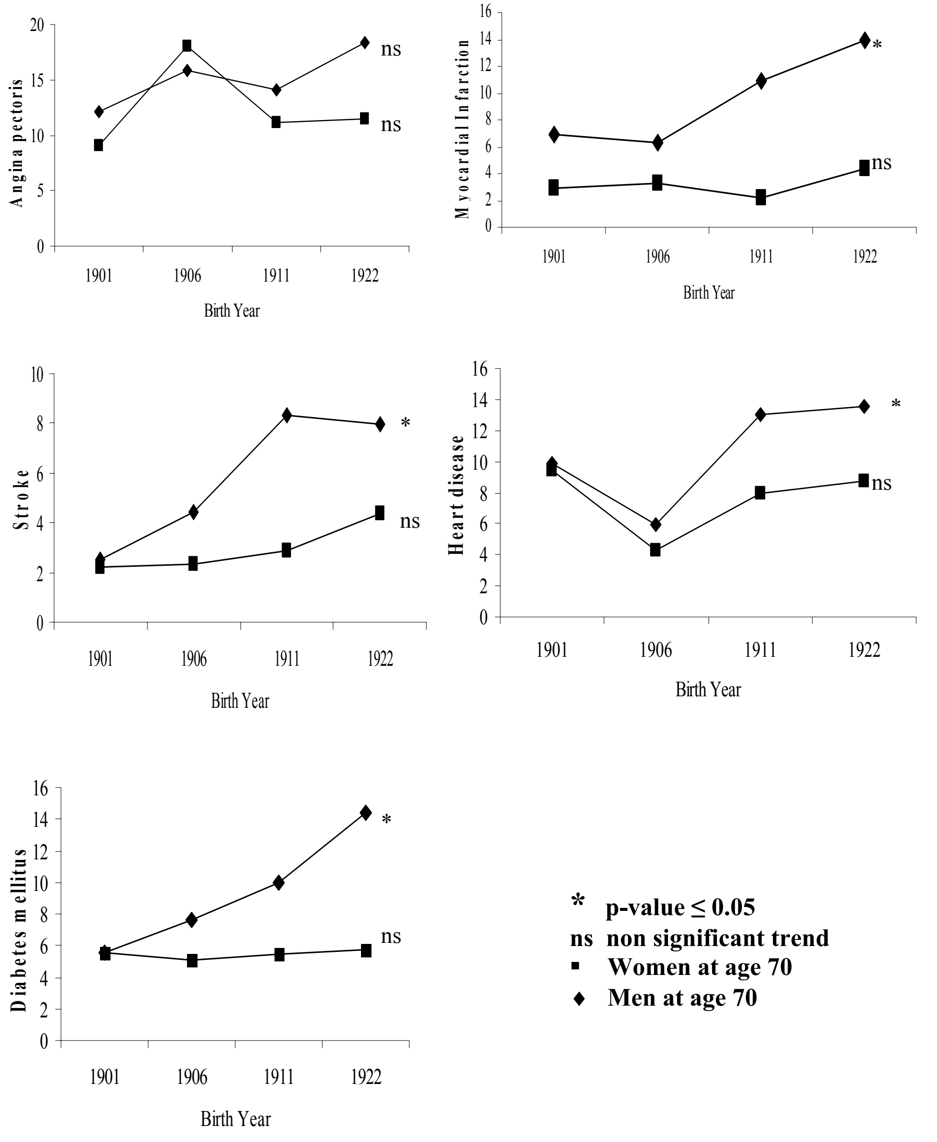


Figure 6. Prevalent conditions (%) in four cohorts of 70-year old men and women examined between 1970 and 1992 (paper III).

Significant differences between men and women were found for health indicators such as systolic and diastolic blood pressures, weight, body mass index, waist hip ratio, and smoking. Blood pressures, for instance, "decreased" in both women and men but more markedly among women. Other significant differences by sex include secular "increases" in weight and body mass index, noted mainly in men and much less so in women. Finally, prevalent morbidity significantly differed by sex for diabetes mellitus only. The significance of these gender interactions confirms that secular trends in health are not occurring in a parallel manner across female and male cohorts.

Cohort differences in several health indicators were further dependent on socio-economic status, although differences could be seen for women and men. For example, height displayed significant secular increases only among women with a lower educational level while weight and body mass index displayed secular increases in women with more than primary school education. Alcohol consumption, on the other hand became more prevalent in both educational groups of females. The proportion of current smokers increased in the later-born, compared to earlier-born, female cohorts with less education but decreased among the more educated. In contrast, smoking prevalence among men decreased in both educational categories. Obesity indicators such as weight and body mass index were higher among later-born male cohorts but mainly in the less educated group. As in women, alcohol consumption became more common among later-born men irrespective of education. Marginal slope differences by education were significant for alcohol consumption; moreover, a higher prevalence of alcohol consumption was noted among later-born cohorts of men and women with greater education. Socio-economic differentials were not found for prevalent morbidity trends in women. Among less educated men, myocardial infarction, stroke, and diabetes mellitus displayed significant secular increases while none were found in the more educated group. Finally, no significant interaction was found between birth-year and educational groups for morbidity trends in either men or women.

An additional consideration, not directly assessed in this paper, relates to the relation between lifestyle and anthropometric factors. In order to understand the effects of socio-economic status on health, these relations must also be understood. Figure 7 shows pair-wise secular trends in body mass index and smoking in relation to education. Secular increases in body mass index were largest among current smokers. Moreover, secular trends in smoking increased among women with less education and decreased among more educated women. Finally, secular increases in body mass index were significant among women with more education and men with less education. To better understand the association between body mass index and smoking, it would be interesting to investigate how education could modify these secular trends. More specifically, three way interactions may contribute to our understanding of the complex associations between lifestyle, social position, and health.

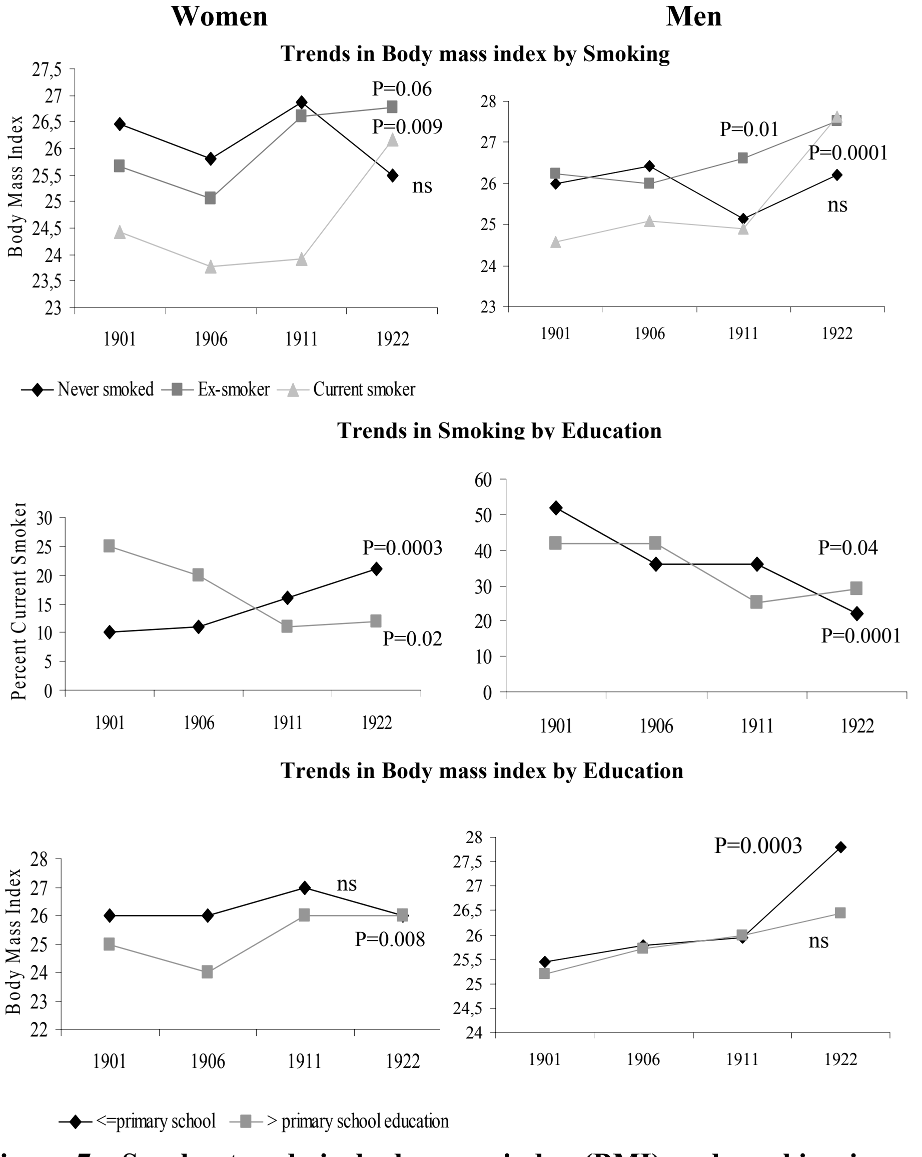


Figure 7. Secular trends in body mass index (BMI) and smoking in relation to education among 70-year olds born in 1901/2, 1906/7, 1911/12, and 1922.

Paper IV

Socio-economic gradients in food selection and diet quality among 70-year olds

In paper IV, socio-economic status was studied in relation to food selection among elderly men and women. An exploratory analysis was undertaken to study specific foods. Based on these results a general indicator of overall diet quality was constructed and analysed.

The exploratory analyses indicated that women with less education consumed less low fat cheese, pasta, vegetables, poultry, tea, and wine while consuming more red meat than the more educated women. Moreover, different patterns were noted across socio-economic index categories in women, for example women in the lower socio-economic index group significantly consumed more soft drinks, sugar, and candy while consuming less low fat cheese and wine. Men with less education had a significantly lower intake of whole meal bread, light beer, juice, tea, and wine while consuming more low fat spread, soft drinks, sweet rye bread, potatoes, and red meat compared to more educated men. Similar food patterns were noted across socio-economic index categories; for example men in the lower socio-occupational category consumed less high fat cheese, light beer, juice, tea, fish, and wine while consuming more low fat spread, soft drinks, canned fruit, sugar, and coffee compared to men with a higher socio-economic index level.

Mean total diet quality scores were 55 for women and 51 for men out of a possible 100 points. No social differences were noted in women whereas among elderly men, total diet quality scores increased with greater socio-economic position. In the sub-sample analysis restricted to married women, social inequalities were also not detected when the husband's occupational category or combined income were assessed. In contrast, men with more education and higher occupational status scored higher than those with less, as shown in Figure 8. It also must be noted that when total energy intake was included in the multiple regression model the association between diet quality and socio-economic status remained stable, even though the association with socio-economic index was slightly weakened ($p=0.11$). Men's education, on the other hand remained significantly associated with diet quality indicating that the diet quality index captures aspects of a healthy diet that are independent of energy intake.

In general, the mean scores for each of the index components were similar for both women and men, and very few of the individual component scores varied by socio-economic status. Among women, the grain component score was higher and iron intake lower among women with higher social status. In elderly men, fruits, vegetables, and iron components were associated with higher social status.

Differential dietary reporting errors across socio-economic categories are a possible source of bias. In order to assess energy underreporting, energy intake divided by an estimate of basal metabolic rate EI/BMR[81] was analysed in relation to the socio-economic variables. Energy intake divided by basal metabolic rate did not differ across educational or socio-economic index. In addition, physical activity did not differ across educational categories but significantly differed across socio-economic index levels. Compared to white collar workers, female blue collar workers were significantly more active and should therefore have consumed more energy. This indicates a possibility of differential reporting bias when the data is stratified across socio-economic index among women.

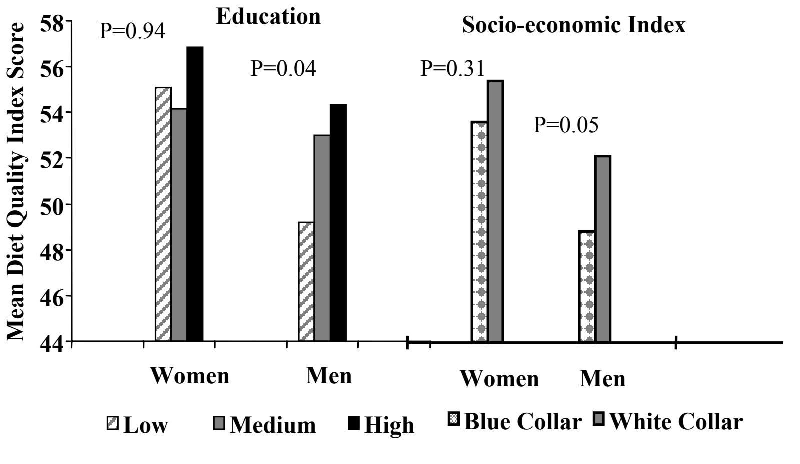


Figure 8. Diet quality index score in relation to education and the Swedish socio-economic index.

Supplementary analyses on secular health trends in women

Secular trends in women at age 38, 50, and 70 in relation to social position.

Cross sectional measurements taken at three points in time among 38, 50, and 70-year old women from the Göteborg region were assessed in order to further explore secular health trends across social groups. The aim of this analysis was to investigate metabolic and lifestyle differences in cohorts of middle aged and elderly women across socio-economic status, and provide an epidemiological background that was compared to earlier results in papers I-IV.

These additional analyses used data from the Population Study of Women in Gothenburg and the Gerontological and Geriatric Population Studies in Gothenburg (H-70) as shown in Table 4. The participants studied in this section were born between 1901 and 1954; many of them experienced a changing socio-political climate along with demographic changes. Legal improvements include universal suffrage passed in 1918, along with advances in civil rights related to income, education, and working conditions. Urbanisation increased in Sweden during the 1930's, due in part to the depressed economy, today 83% of the population lives in an urban setting.[82] After the Second World War women began to enter the work force in greater numbers and today approximately 1.9 million women between the ages of 16 and 64 work outside of the home and 18 percent of them have children under the age of 7.[83]

Compulsory education successively increased during the past century therefore the data was stratified across educational level where low education (≤compulsory education, included were 6, 7, or 9 years) and high educational attainment (>compulsory education) were compared across cohorts and age groups. Variables studied included: systolic blood pressure (mm/Hg), diastolic blood pressure (mm/Hg), cholesterol (mmol/l), triglycerides (mmol/l), weight (kg), height (cm), body mass index (kg/m^2), waist hip ratio (circumference cm/cm), number of missing teeth (32 teeth dentition), parity (number live births), physical inactivity (yes/no), current smoker (yes/no), wine consumer (≥ once per week), beer consumer (≥ once per week), spirits consumer (≥ once per week). P-values for secular trends assess 'increases' or 'decreases' in mean values or prevalences across cohorts as shown in Appendix 3.

Table 4. Description of three cohorts of 38, 50 and 70-year old women from Göteborg analysed in a cross-sectional manner.

	Examination Year		
	1968-71	1981-82	1992-93
Cohorts			
38-year olds			
N	372*	122¤	61
Birth year	1930	1942	1954
Population study	PSWG	PSWG	PSWG
50-year olds			
N	398	308*	93¤
Birth year	1918-19	1930	1942
Population study	PSWG	PSWG	PSWG
70-year olds			
N	524	317	299
Birth year	1901	1911	1922
Population study	H-70	H-70	H-70 and PSWG

The Population Study of Women in Gothenburg (PSWG)
The Gerontological and Geriatric Population Studies (H-70)
* Same population analysed cross-sectionally at age 38 (1968/9) and 50 (1981/2).
¤ Same population analysed cross-sectionally at age 38 (1981/2) and 50 (1992/3).

Social differences and secular health trends were noted across all age strata. Metabolic factors such as blood pressure and cholesterol levels were lower in later-born cohorts independently of educational level. Cholesterol also was lower in the later-born cohorts of middle aged women whereas blood pressure was lower across all age strata and cohorts with the exception of systolic blood pressure which improved mainly among 70-year old cohorts. Results from the additional analyses did not demonstrate anthropometric differences in weight and height across the 38-year old cohorts, while among 50 and 70-year olds secular increases in weight were noted in the more educated groups only. Body mass index on the other hand, remained stable across cohorts of all ages. In contrast, waist hip ratio 'increased' among later-born cohorts in all age strata and in both high and low educated groups. Among 38-year old cohorts, significant secular decreases in smoking were only seen in the more educated subgroup; while among

70-year old cohorts, secular increases in smoking were detected in the less educated group. Among later-born cohorts of all ages, wine consumption was more prevalent among the less educated while beer consumption was lower in later-born cohorts of 38 and 50-year olds in both educational groups. These results are described in Table 5. Another lifestyle factor that improved was dental status. Dental status appears to have improved across cohorts and social groups for instance, the socio-economic differential in number of missing teeth successively decreased over time.

Table 5. Summary of significant secular health trends by education for three cohorts of Göteborg women (based on information in Appendix 3).

Cohorts	≤Compulsory Education	>Compulsory Education
38-year old cohorts were born in 1930, 1942, and 1954	***Secular decreases***: diastolic blood pressure, cholesterol, number missing teeth, and beer consumption. ***Secular increases***: waist hip ratio, and wine consumption.	***Secular decreases***: diastolic blood pressure, cholesterol, number missing teeth, smoking, and beer consumption. ***Secular increases***: waist hip ratio.
50-year old cohorts were born in 1918, 1930, and 1942	***Secular decreases***: diastolic blood pressure, cholesterol, triglycerides, number missing teeth, and beer consumption. ***Secular increases***: waist hip ratio, physical inactivity, and wine consumption.	***Secular decreases***: diastolic blood pressure, cholesterol, number missing teeth, and beer consumption. ***Secular increases***: weight, height, and waist hip ratio.
70-year old cohorts* were born in 1901, 1911, and 1922	***Secular decreases***: systolic and diastolic blood pressure. ***Secular increases***: height, parity, smoking, and wine consumption.	***Secular decreases***: systolic and diastolic blood pressure. ***Secular increases***: weight.

Secular increases and decreases refer to trends across birth cohorts.
*Trends in missing teeth not available.

GENERAL DISCUSSION

Socio-economic status and cardiovascular disease

Epidemiological methods were used to further our understanding of potentially causal relations between socio-economic status and lifestyle factors in association to cardiovascular disease development. The prospective studies indicated that low socio-economic status was associated with cardiovascular disease independently of classic cardiovascular disease risk factors such as smoking and obesity (papers I) but this association was not independent of poor oral health (papers II) among middle-aged women. This result supports a growing body of evidence indicating that the relation between dental disease and cardiovascular disease in women may be independent of conventionally accepted mediators such as socioeconomic status and smoking.[38] The extent to which statistically persistent associations indicate a direct causal link between dental status and cardiovascular disease remains uncertain. Causal associations, in a strict sense, are difficult to establish using epidemiological methods. The most appropriate way to demonstrate causal relations is through randomised clinical trials. The studies in this thesis are all observational studies, and therefore can only achieve a weaker degree of causality which can be assessed by the fulfilment of requirements such as Hill's Criteria; an example of one such criterion, relevant for paper II is consistency of results.[84]

Current epidemiological evidence indicates that not all cardiovascular health indicators have improved over the past decades among women. Social inequalities in health have been noted here and elsewhere for indicators such as smoking (paper I and III), oral health (paper II), obesity (paper III), and physical activity.[85-87] More specifically, among middle aged women, waist-hip ratio and smoking significantly increased the risk of cardiovascular disease mortality (paper I). Among the elderly, later-born women with less education smoked more than earlier-born women, and later-born men with less education were more obese than earlier-born cohorts. Secular increases in weight and body mass index from 1970-1992 also were detected among more educated 70-year old women whereas waist hip ratio was greater in later-born cohorts of 38, 50 and 70-year old women irrespective of educational level (paper III and additional analyses) this is in agreement with a recent study.[88]

Past social pressures may have influenced lifestyle choices made by each generation at various points in their lives. When secular trends for smoking and body mass index were analysed together, (as shown earlier in Figure 7) later-born cohorts of women with less education smoked more than earlier-born cohorts, and later-born women who smoked or were ex-smokers had greater body mass index levels than earlier-born smokers. These secular lifestyle choices may in part reflect transitions in social acceptability of certain behaviours such as smoking among women. In addition to period and cohort effects, obesity and diet were further affected by social position and gender. It was therefore important to assess how socio-economic indicators contributed to dietary selections and whether the less well off groups in society had poorer dietary quality (paper IV).

Previous studies have indicated that nutrition related health choices are affected by educational level and that diet appears to be improving more in women than in men.[89] Educational attainment has been linked with health related decisions and the incorporation of dietary guidelines into the daily Swedish diet especially among women.[90] Socio-economic index measures economic potential along with occupational position within the labour market and also purchasing power which has been previously associated with food selection.[91] It is speculated that persons with more purchasing power have greater selection capacity, choosing to consume more organically grown foods, fruits, and vegetables while those with less purchasing power may select high fat foods or processed foods containing more sugar or preservatives, due to lower costs.[92-94] Social differences in food selection and diet quality were noted among 70-year old men born in 1930, while women had more similar diet quality scores. When additional analyses were conducted among married women, no association was found between the husband's occupational category (described in paper I) and diet quality scores. Thus irrespective of whether social position was a measurement of prestige or resources women appear to have stable diets across socio-economic groups.

Equality, Equity, and Socio-economic Status

Socio-economic status and equality

In countries that are less well off, aspects of inequality are more directly related to the design of equitable health care systems or socio-political infrastructures.[95] In Europe, current research on social aspects of inequality in health has emphasized understanding the aetiology of a disease.[96] Therefore various theories have been developed relating social position to disease development. Some explanations are based on ideas related to individual income or susceptibility,[97] while others are associated with health behaviour,[98-99] the psycho-social environment,[100] social effects throughout the life course,[101-102] and socio-political frameworks.[103-104]

Health inequalities were found across social categories. Heart disease, for example, appeared to be more prevalent among groups with lower occupational grade (paper I) or less education (paper III). In 1968, middle-aged women with less resources and prestige were at greater risk of developing heart disease twenty-four years later but not cancer (papers I and II). Among the elderly, social gradients in prevalent cardiovascular disease, some risk factors, and diet were more apparent in men than in women (papers III and IV).

Socio-economic status and equity

Socio-economic status also reflects issues of inequity that include underlying gender aspects.[105-106] For example, the strongest socio-economic correlate of health outcome among middle-aged women was the husband's occupational category, which reflected women's dependencies on their husband's income, even if they were employed in 1968 (paper I), also noted elsewhere.[78, 107-108] In contrast, a current study from Finland indicated that men and women have participated almost equally in the work force in recent years and it was noted that the social gradient in health for women was not related to the spouse's social level more than their own.[109] Alternatives that may capture aspects of women's social prestige and available resources include a woman's own education, occupation, or income. However, statistical reports suggest that indicators of social position continue to be distributed inequitably between men and women in Sweden. [110]

In past research, occupation has been the socio-economic factor most often studied in relation to men's health.[111] Later research has focused on comparing different indicators of socio-economic status, such as education and wealth, between women and men in order to understand if the process was the same for both sexes.[112-113] At present, researchers attempt to acknowledge the multiple roles within paid and unpaid work that women do in order to assign social group.[114] Traditional indicators of social position are being replaced by alternatives such as consumption measures (car ownership or housing tenure).[112, 115] Paper I utilised both traditional and non-traditional methods in assessing social position. In hindsight, classifying women by their husband's occupational category may have captured a dimension of social status which reflected middle-aged women's social position in the late sixties in Sweden but it did not capture women's abilities to use these resources. At present, most Western women still have less autonomy than men and earn lower salaries.[110, 116]

Occupation, in general, has not been the preferred socio-economic variable for women because women's work pattern has historically fluctuated more than men's patterns. For example although most women in Western countries work, they continue to have a major role in family and child care responsibilities.[111, 112, 117] A more stable indicator of social position in women, advocated by some, has been education,[69] while others prefer household income.[68] Thus, to further study the effects of socio-economic status on women's health, a composite indicator was formed combining household income and education (paper I). Although composite indicators capture more varied social aspects, it must be noted that they are less precise and flaws in one of the components or in the construction of the index may occur.

The elderly constitute a group in society that is potentially exposed to social inequities due to changes in their social position after retirement. Among the elderly, the burden of disease appeared to be occurring disproportionately across different generations of 70-year olds and particularly among men of lower socio-economic status, as noted elsewhere.[118] This social gradient may be related to an increasing but modifiable education differential whereby the less educated are becoming a smaller but more marginalised group (paper III) thus increasing the level of inequity. Among elderly women, the lack of social gradient in health (paper III and IV) can be argued to have been related to women's level of dependency on their husbands' occupation for social and financial position or the possible inaccuracy of traditional social variables.

Strengths and limitations of this research

Some of the limitations of studies I-IV include aspects of competing risks, time latency in relation to endpoints, time constancy in relation to prospectively measured risk factors in a proportional hazards regression model, confounding, low response rates, measuring lifestyle factors, and inaccuracy of nutritional data. Before proceeding, it is important to note the high quality of the two population based data sets used. Long follow-up time, high participation rates, and low number of subjects lost to follow-up, make the Population Study of Women in Gothenburg a unique data set. The Gerontological and Geriatric Population Studies in Gothenburg (H-70) had satisfactory response rates for elderly populations and thorough methods were used to obtain data aimed for cross-sequential comparisons. Moreover, both of these studies are small in number but wide in their scope of measurements.

In general, longitudinal studies may be limited by the number and type of endpoints analysed. Cancer morbidity and mortality endpoints for example, could not be studied in a site specific manner because there were too few individual cases per site (papers I and II). The low number of morbidity endpoints of other causes also limited the number of simultaneously controlled covariates (papers I and II). Another limitation related to disease endpoints could have been risk of competing causes of death. In the longitudinal studies (papers I and II), approximately 18 percent of the women had died after 24 years of follow-up and of those who were deceased, almost equal numbers were found in the two major disease endpoints: all-site cancer and cardiovascular mortality. The general distribution of mortality during the whole 24-year study period also was considered; while more cancer cases were noted in the 12-year follow up,[60] most of the cardiovascular deaths occurred after the first 12 years of follow-up and only 15 occurred during the first twelve year period.

In papers I and II, Cox's Proportional Hazards regression was utilised where the assumption of proportional hazards was analysed. The proportional hazards model assumes that the effect of each covariate is the same at all points in time during the study period.[71] In order to analyse the proportional hazards assumption models for each endpoint were stratified over time. The first 0-12 years of follow-up were compared with the second half of the 24-year follow up period and proportionality assumptions were adequately met for the main variables (the husband's occupational category, number of missing teeth, education, and household income) included in the models even though these variables most probably varied to some degree during the study period as a whole. Covariates thought to vary over time were also assessed: waist-hip ratio, body mass index, and smoking. Although the proportional hazards assumption is very difficult to meet, the hazard ratios produced at every twelve year measurement indicated that the relations noted may be relatively stable.

Controlling for risk factors may explain part of the exposure-outcome relation but residual confounding remains a concern in the interpretation of epidemiological results. One such example is hormone replacement therapy; since the publication of paper I it has become a recognised risk factor regarding breast cancer.[49] Therefore, extra analysis was conducted to assess the relation between hormone replacement therapy (ever/never), the husband's occupational category, and cardiovascular or cancer mortality and morbidity (not in paper I). In general, hormone replacement therapy was taken more by women with higher social position: 21 percent in the high, 15 percent in the medium, and 9 percent in the low husband's occupational category. The association between socio-economic status and cardiovascular disease was unchanged by hormone replacement therapy; in contrast, the association between the husband's occupational category and cancer mortality was attenuated by 2 percent.

Limitations specific to paper II, relate to the use of baseline dental data; although number of missing teeth was re-measured later in the study, it was not possible to assess exactly when a subject lost a tooth. Presently, we have limited knowledge of the true progression of periodontal disease for each woman, which limits the causal inferences that can be drawn. To further study this latency problem, measures of infectious burden were analysed. Neither serum C-reactive protein nor white blood cell count was associated with number of missing teeth at baseline, although both significantly estimated cardiovascular disease events.

Both the Population Study of Women in Gothenburg and the Gerontological and Geriatric Population Studies experienced lower response rates in later examinations. In the Geriatric Population studies non-response rates have increased throughout the years from 1971 to 2000. Reasons for decreases in participation include fear of personal information entering computer data bases or possible violations of personal integrity. The participation rates were especially low in the last two cohorts examined in 1992/3 and 2000/1, compared to earlier examinations, which indicates an increasingly self-selected sample (paper III and IV). The later-born cohorts for instance, may be a healthier group of elderly men and women compared to those that did not respond. However, these decreases were similar in men and women and analysis of non participation has not revealed major differences in gender and socio-economic status.[119] Other methodological issues related to population-based samples among the elderly, consist of healthier survivors compared to their deceased counterparts (papers III and IV).

Lifestyle and social factors are difficult to measure in a precise and standardized way. For instance physical activity was not identically measured over the years and the only categories that were comparable were active versus inactive, resulting in a loss of information. Another variable that may have incurred loss of information is alcohol consumption. In paper III, alcohol was treated as a dichotomous variable measuring whether a person consumed alcohol or not and did not capture type or quantity of alcohol consumed.

Education is considered a stable and precise indicator of social position; however, in paper III secular effects may have altered the impact of education on health. More specifically, compression of a scale (not in the strict statistical sense) such as educational level affects the interpretability of associations between education and other health factors. It is important to note that educational attainment increased during the years of observation in both sexes, and the fixed cut point of six years was not strictly analogous for all cohorts (paper III). In contrast, the additional cross-sectional analyses, conducted among 38, 50, and 70 year old women, measured education as above compulsory education or not, and could then be used over time in a manner which gave more comparable estimates of education. Further limitations in paper III included the creation of subgroups which compromised our power to detect effect modification by education in the gender stratified analyses; an example of such a case was smoking in women.

The interpretation of results from nutritional studies is often limited by under- or over-reporting bias. Ratio of EI/energy requirements was stable, suggesting constant under-reporting. However, there was some indication of differential reporting of physical activity across occupational categories in women (paper IV). This could indicate, albeit in an indirect way, a possible under-reporting of energy intake in blue collar versus white collar occupations.

The findings in papers I-IV emphasise various aspects of socio-economic status in relation to disease outcome, behavioural attitudes, gender, and changes in these relations over time. Studying such qualities of socio-economic status highlighted areas that may need further attention in future public health interventions as described below.

Implications for Public health

Public Health efforts are often concentrated on identifying the determinants of disease in order to prevent morbidity and mortality in a population. Much research has demonstrated that those with low social position usually experience poor health.[1] Currently there is a widening gap in death rates between upper and lower socio-economic groups in Europe;[4] this indicates that social disparities persist even in highly equitable societies with well developed infrastructures. In welfare states such as Sweden, compression of income along with compulsory education laws since 1842 make it less likely that disparities in health are mainly due to social status per se. Understanding the relation between social position and lifestyle[120] may lead to the reduction of chronic diseases in Westernized countries and also in countries that currently are under economic transition.

It is hypothesised here that behavioural attitudes assist in the selection of lifestyle factors such as smoking, diet, and physical activity[120] which in turn shape health trends that vary across social groups as illustrated in Figure 9.[121] Important lifestyle factors that have a long term and sustainable impact on cardiovascular disease reduction and prevention are for example, physical activity and diet. Lifestyle intervention studies have successfully reduced cardiovascular risk factors in women when combining lifestyle and diet modification programs.[122-123] In this thesis, susceptible subgroups with specific risk profiles were identified, and risk factors for cardiovascular disease such as smoking, body mass index, and diet were found to vary by social position. This indicates that risk factors are not distributed equally across social strata and therefore specific subgroups should be targeted.

Targeting social groups in an unequal manner can be described as intervening with a vertical approach. On the other hand, health related associations are not always unique to one social group. Poor dental health was associated with increased cardiovascular risk independently of social position. In this case social position did not confound the epidemiological relation, and therefore a social target group is not essential; instead, an intervention can be implemented across social groups in a horizontal manner. Previous research has referred to these forms of interventions as "high risk" versus "population" strategies.[124] High risk methods attempt to protect susceptible individuals, and population strategies seek to mitigate causes of incidence in the whole population. For public health this suggests analysing epidemiological transitions within social strata in order to better understand the disease aetiology in a population. Although many studies have assessed social inequalities in health, few have studied the structural "causes" of social inequality. Further research in socio-economic status may contribute towards an improved understanding of the health risks taken within and across social groups and therefore towards more precise and relevant policies for equitable health care and disease prevention.

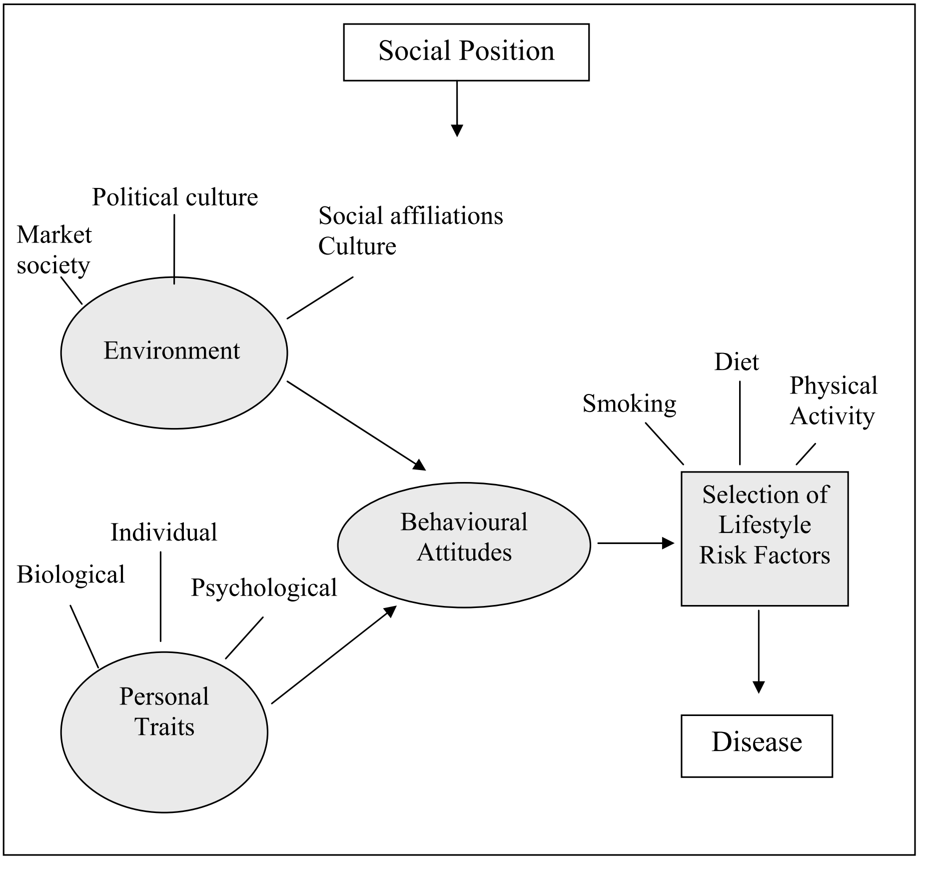


Figure 9. Illustration depicting the relation between behaviour, lifestyle, and health which is further dependent on disease and social context (extension of Kenrick's behavioural model).[121]

CONCLUSIONS

This thesis may contribute to improvements in health care, public health policy, and interventions especially for less advantaged groups, by further explaining the associations between socio-economic status and not only morbidity and mortality but also to mediating health factors that can be modified such as oral health, obesity, and diet. In summary:

- Low socio-economic status remains a significant risk factor for heart disease in Swedish women despite universal health coverage and one of the highest living standards in the world (paper I).
- Social gradients in health vary by disease outcome studied (paper I).
- The association between tooth loss and cardiovascular disease could not be explained by socio-economic status in women (paper II).
- Social gradients in secular health trends observed in male populations cannot necessarily be generalized to women (paper III).
- Social differences in diet quality appear less pronounced among elderly women compared to elderly men (paper IV).

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APPENDIX 1

Abbreviations

BMI	Body Mass Index
CI	Confidence Interval
ECG	Electrocardiogram
HR	Hazard Ratio
HSES	Husband's Occupational Category
H-70	Gerontological and Geriatric Population
ICD	International Classification of Diseases
PSWG	Population Study of Women in Göteborg Studies
RR	Relative Risk
SD	Standard Deviation
SE	Standard Error
SEI	Socio-economic Index
SGOT	Serum glutamic-oxaloacetic transaminase
TIA	Transitorial ischaemic attack

Glossary of terms

Cox's proportional hazards regression – is a statistical technique which analyses the relation of the independent variable to the incidence rate of disease by taking time into consideration under the assumption of proportional hazards.

Cross-sectional study – is a descriptive study that assesses both exposures (risk factors) and disease status at the same point in calendar time.

Cross-sequential studies – are serial cross-sectional studies that assess subjects of a specific age at different points in time.

Confounding – occurs when the exposure and the desired effect are both associated with a third factor that can lead to a positive or negative statistical association between the exposure and effect which does not truly exist.

Effect modifier – assesses interactions between two covariates in a regression model.

Health care – is a broad term that directly refers to different activities and means used to prevent or cure different processes of morbidity.

Inequality in health – refers to a broad range of differences in both health experience and health status between countries, regions, and socio-economic groups. Most inequalities are not biologically inevitable but reflect population differences in circumstances and behaviour that are in the broadest sense socially determined. However, in industrial countries "inequalities in health" has tended to refer to differences in health status between regions and population subgroups that are regarded as inequitable. (*David A. Leon*)

Inequity in health – systematic and potentially remediable differences in one or more aspects of health across populations or population groups defined socially, economically, demographically, or geographically (*International Society for Equity in Health*)

Linear regression – used when the dependent outcome is continuous, it estimates the coefficient of each independent variable which can be interpreted as an increase or decrease in the mean value of the dependent variable for every unit increase in the predictor variable, while taking into account the effect of other covariates in the model.

Logistic regression – is a statistical technique which analyses the magnitude of the association between an exposure and a binary outcome over the same period of time for all the participants.

Mortality rate – is the incidence of death in a selected population during a set period of time.

Prevalent morbidity – is the proportion of the sample that are diseased at a specific instant, it estimates the probability that a person will be ill at that specific time.

Prospective study – longitudinal cohort study measures various risk factors at baseline and follows the subjects over time until disease status is ascertained.

APPENDIX 2

Table 6. **Hazard ratios (HR) and 95% confidence intervals for socio-economic indicators stratified after 12 years of follow-up and compared with 24 years of follow-up were calculated to assess the proportional hazard's assumption.**

	Husband's Occupational Category			Number of Missing Teeth			Education			Household Income		
	1968-1980	1980-1992	1968-1992	1968-1980	1980-1992	1968-1992	1968-1980	1980-1992	1968-1992	1968-1980	1980-1992	1968-1992
Mortality												
All-cause	n=52	n=133	n=185	n=73	n=179	n=252	n=72	n=179	n=251	n=71	n=173	n=244
	1.19	1.06	1.00	1.08	1.19	1.180	1.03	1.01	1.01	0.83	0.68	0.75
	(0.80 - 1.76)	(0.84 - 1.35)	(0.82 - 1.22)	(0.85 - 1.36)	(1.04 - 1.36)	(1.05 - 1.32)	(0.85 - 1.24)	(0.92 - 1.11)	(0.93 - 1.09)	(0.49 - 1.39)	(0.50 - 0.93)	(0.58 - 0.98)
Cardiovascular Disease	n=12	n=59	n=69	n=15	n=73	n=88	n=15	n=73	n=88	n=15	n=71	n=86
	4.78	1.46	1.65	1.45	1.28	1.32	0.24	0.94	0.89	0.46	0.66	0.62
	(1.13 - 20.22)	(0.98 - 2.15)	(1.14 - 2.37)	(0.82 - 2.56)	(1.05 - 1.58)	(1.09 - 1.59)	(0.04 - 1.34)	(0.79 - 1.11)	(0.76 - 1.05)	(0.13 - 1.61)	(0.04 - 1.08)	(0.39 - 0.98)
All-site Cancer	n=22	n=46	n=68	n=26	n=60	n=86	n=25	n=60	n=85	n=24	n=59	n=83
	0.74	0.94	0.79	0.97	1.07	1.06	1.03	1.04	1.03	1.64	0.82	1.04
	(0.40 - 1.37)	(0.63 - 1.40)	(0.57 - 1.08)	(0.65 - 1.44)	(0.84 - 1.36)	(0.86 - 1.29)	(0.74 - 1.43)	(0.89 - 1.21)	(0.91 - 1.17)	(0.64 - 4.19)	(0.49 - 1.38)	(0.67 - 1.61)

All models were age-adjusted.

Table 7. **Hazard ratios (HR) and 95% confidence intervals for covariates stratified after 12 years of follow-up and compared with 24 years of follow-up were calculated to assess the proportional hazard's assumption.**

	Waist hip ratio			Body mass index			Smoking		
	1968-1980	1980-1992	1968-1992	1968-1980	1980-1992	1968-1992	1968-1980	1980-1992	1968-1992
Mortality									
All-cause	n=71	n=173	n=244	n=73	n=179	n=252	n=73	n=179	n=252
	0.99	1.28	1.26	0.98	1.01	1.01	1.09	1.29	1.23
	(0.81 - 1.20)	(1.11 - 1.47)	(1.12 - 1.41)	(0.93 - 1.03)	(0.97 - 1.05)	(0.96 - 1.04)	(0.85 - 1.40)	(1.11 - 1.51)	(1.08 - 1.39)
Cardiovascular Disease	n=15	n=71	n=86	n=15	n=73	n=88	n=15	n=73	n=88
	1.37	1.48	1.51	1.04	1.04	1.05	1.26	1.52	1.48
	(0.90 - 2.09)	(1.21 - 1.81)	(1.26 - 1.79)	(0.96 - 1.14)	(0.98 - 1.09)	(0.99 - 1.09)	(0.70 - 2.28)	(1.19 - 1.94)	(1.18 - 1.85)
All-site Cancer	n=24	n=59	n=83	n=26	n=60	n=86	n=26	n=60	n=86
	0.74	1.04	0.99	0.95	0.99	0.99	1.12	1.09	1.07
	(0.51 - 1.08)	(0.80 - 1.35)	(0.79 - 1.23)	(0.87 - 1.04)	(0.93 - 1.07)	(0.94 - 1.05)	(0.74 - 1.71)	(0.84 - 1.43)	(0.86 - 1.34)

All models were age-adjusted.

APPENDIX 3

Table 8. **Risk factor profile from 1968 to 1992 for women aged 38, 50, or 70 and living in the Göteborg region.**

	Age 38			Trend	Age 50			Trend	Age 70		
Cohort	1968-69	1981-82	1992	P-value	1968-69	1981-82	1992	P-value	1971-72	1981-82	1992
Mean (SD)											
Systolic Blood Pressure (mm/Hg)											
≤ Compulsory Education	124 (14.88)	122 (15.63)	119 (14.84)		139 (22.23)	136 (21.06)	136 (20.98)		171 (24.02)	162 (22.87)	158 (24.21)
> Compulsory Education	121 (13.81)	123 (13.65)	117 (13.55)		135 (20.45)	133 (17.74)	133 (21.08)		164 (20.93)	160 (17.02)	154 (23.58)
Diastolic Blood Pressure (mm/Hg)											
≤ Compulsory Education	79 (9.55)	81 (9.63)	73 (10.08)	**	86 (10.63)	85 (10.09)	79 (11.68)	**	94 (13.05)	83 (11.64)	81 (12.12)
> Compulsory Education	79 (8.74)	81 (8.97)	70 (9.32)	**	84 (10.58)	83 (9.30)	79 (11.14)	**	93 (11.63)	84 (11.58)	80 (12.08)
Cholesterol (mmol/l)											
≤ Compulsory Education	6.3 (0.91)	5.7 (0.96)	5.1 (0.64)	***	7.26 (1.07)	6.52 (1.14)	5.82 (0.85)	***	6.3 (1.48)	6.5 (1.26)	6.5 (1.08)
> Compulsory Education	6.3 (0.92)	5.7 (0.96)	4.8 (1.04)	***	7.01 (1.12)	6.39 (1.06)	5.76 (1.04)	***	6.1 (1.43)	6.4 (1.16)	6.3 (1.00)
Triglycerides (mmol/l)											
≤ Compulsory Education	1.11 (0.46)	1.11 (1.21))	0.94 (0.39)		1.32 (0.62)	1.21 (0.62)	1.14 (0.64)	*	1.52 (0.65)	1.47 (0.73)	1.58 (0.71)
> Compulsory Education	1.05 (0.39)	0.96 (0.30)	0.96 (0.53)		1.12 (0.43)	1.05 (0.41)	1.21 (0.58)		1.38 (0.68)	1.48 (0.72)	1.49 (0.73)
Weight (kg)											
≤ Compulsory Education	64 (12.24)	66 (14.71)	65 (11.67)		67 (11.05)	66 (11.77)	68 (13.70)		67 (11.59)	69 (12.03)	68 (12.15)
> Compulsory Education	63 (8.73)	62 (9.98)	65 (9.85)		65 (11.24)	67 (10.94)	69 (11.93)	**	64 (9.84)	67 (11.83)	68 (11.76)
Height (cm)											
≤ Compulsory Education	164 (5.63)	164 (5.99)	164 (5.57)		163 (5.40)	163 (5.70)	165 (6.49)		160 (5.61)	161 (5.53)	161 (6.02)
> Compulsory Education	166 (5.57)	168 (5.78)	167 (5.90)		165 (5.66)	165 (5.67)	168 (5.93)	**	161 (5.66)	161 (6.58)	163 (5.65)
Body Mass Index (kg/m2)											
≤ Compulsory Education	24 (4.16)	25 (5.52)	24 (3.77)		25 (3.87)	25 (4.05)	25 (4.73)		26 (4.18)	27 (4.59)	26 (4.19)
> Compulsory Education	23 (3.10)	22 (3.03)	24 (3.17)		24 (3.49)	25 (3.87)	25 (3.49)		25 (3.88)	26 (3.93)	26 (4.47)
Waist-Hip Ratio (circumference cm/cm)											
≤ Compulsory Education	0.73 (0.05)	0.79 (0.06)	0.83 (0.06)	***	0.75 (0.05)	0.81 (0.07)	0.8 (0.07)	***	0.81 (0.05)	n/a	0.83 (0.06)

> Compulsory Education	0.72 (0.05)	0.78 (0.06)	0.79 (0.04)	***	0.74 (0.05)	0.79 (0.07)	0.81 (0.07)	***	0.8 (0.05)	n/a	0.82 (0.06)
Number of missing teeth (32 teeth dentition)											
≤ Compulsory Education	11 (7.65)	10 (7.90)	4 (2.15)	***	20 (9.18)	12 (7.70)	11 (7.86)	***	n/a	n/a	20 (8.81)
> Compulsory Education	7 (4.78)	6 (3.68)	4 (2.29)	***	12 (8.37)	9 (5.39)	6 (3.96)	***	n/a	n/a	13 (8.11)
Parity											
≤ Compulsory Education	1.95 (1.37)	2 (0.95)	2.2 (1.08)		1.9 (1.35)	n/a	2.14 (0.71)		1.56 (1.63)	1.63 (1.25)	1.93 (1.38)
> Compulsory Education	1.86 (1.26)	1.9 (1.11)	1.96 (1.13)		1.66 (1.15)	n/a	2.25 (1.18)		1.67 (1.49)	1.42 (1.35)	1.89 (1.09)
Number (%)											
Physical inactivity (yes/no)											
≤ Compulsory Education	43 (17)	16 (37)	3 (11)		50 (18)	65 (32)	6 (21)	**	100 (23)	78 (34)	36 (21)
> Compulsory Education	20 (16)	26 (33)	4 (12)		21 (18)	29 (28)	13 (21)		16 (22)	21 (32)	25 (26)
Current Smoker (yes/no)											
≤ Compulsory Education	119 (48)	20 (47)	13 (46)		106 (38)	91 (44)	10 (35)		45 (10)	39 (16)	36 (21)
> Compulsory Education	53 (43)	26 (33)	8 (24)	*	41 (35)	33 (32)	20 (32)		18 (25)	7 (11)	13 (13)
Wine Consumer (≥ once per week)											
≤ Compulsory Education	29 (12)	7 (16)	7 (25)	*	40 (14)	40 (20)	11 (38)	**	14 (9)	19 (19)	39 (23)
> Compulsory Education	31 (25)	33 (42)	11 (33)		44 (37)	27 (27)	30 (48)		10 (35)	6 (21)	37 (38)
Beer Consumer % (≥ once per week)											
≤ Compulsory Education	122 (49)	12 (28)	11 (39)	*	112 (40)	47 (23)	11 (38)	**	49 (31)	33 (32)	59 (35)
> Compulsory Education	75 (61)	30 (38)	11 (33)	***	73 (62)	27 (27)	24 (38)	***	9 (31)	8 (29)	45 (46)
Spirits Consumer % (≥ once per week)											
≤ Compulsory Education	5 (2)	3 (7)	1 (4)		11 (4)	21 (10)	1 (4)		14 (9)	7 (7)	13 (8)
> Compulsory Education	7 (6)	9 (11)	1 (3)		14 (12)	10 (10)	7 (11)		3 (10)	2 (7)	12 (12)

* = p-value ≤ 0.05; ** = p-value ≤ 0.01;*** = p-value ≤ 0.001; n/a not available.

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