ESKO POPPIUS

The Sense of Coherence and Health

The Effects of the Sense of Coherence on
Risk of Coronary Heart Disease, Cancer, Injuries
and All-cause Mortality

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UNIVERSITY OF TAMPERE

CONTENTS

ABSTRACT

Esko Poppius: The sense of coherence and health – the effects of the sense of coherence on risk of coronary heart disease, cancer, injuries and all-cause mortality.

The hypotheses were tested that people with a strong sense of coherence (SOC) have decreased all-cause mortality and incidence of coronary heart disease, cancer and injuries. The SOC was measured with the original 29-item questionnaire among participants of the Helsinki Heart Study. Clinical findings such as total cholesterol, systolic and diastolic blood pressure and body-mass index had been measured earlier. Lifestyle factors like smoking, alcohol consumption and leisure time physical activity were also recorded. Occupation was obtained from Statistics Finland according to the code for occupation in the 1980 Finnish version of the Nordic Classification of Occupations. The SOC score was categorised into tertiles for evaluation of the association between the SOC and CHD, cancer, injuries and all-cause mortality. The follow-up time was eight years. Relative risk was estimated using Cox proportional hazards models. These models were also used to assess the importance of covariates, i.e. age, smoking, alcohol consumption, smoking and occupation.

In white-collar work environment the low SOC tertile had a high CHD incidence of 20.1 per 1000 person-years as the incidences in the moderate and high SOC tertiles were respectively 10.9 and 12.3. No similar effect was seen in blue-collar work environment. For all cancers combined, those with a strong SOC had the fewest cancers (4.0 per 1000 person years) and those with a weak SOC had the most cancers (5.6 per 1000 person years). Among blue-collar workers the difference was statistically significant, but there was no trend among white-collar workers. The SOC was inversely associated with risk of injuries, with a significant 25% lower incidence in the highest tertile of the SOC (7.6 per 1000 person years) compared with the lowest tertile (10.2 per 1000 person years). Alcohol drinkers with a weak SOC emerged as a high risk group. There was an effect of the SOC on the incidence of injury especially among blue-collar workers. A substantial part of the effect was mediated by alcohol consumption. The effect of the SOC on all-cause mortality was not great. The classic risk factors showed higher relative risks of all-cause mortality than the SOC, smoking very significantly (p<0.001) and alcohol significantly (p<0.01).

To summarise the effects of the SOC it can be concluded that they vary depending on age, illness and occupation. A strong SOC protects from CHD, but in a white-collar environment only. Among blue-collar workers those with a strong SOC had the fewest cancers. A strong SOC protects against injuries across occupations. All-cause mortality is shaped by lifestyle factors which are partly dependent on the SOC. The sense of coherence is an instrument to measure an individual's ability to cope with stressors. A person's poor coping undermines health. Salutogenically expressed, good coping improves health.

TIIVISTELMÄ

Esko Poppius: Koherenssin tunne ja terveys – koherenssin tunteen vaikutukset sepelvaltimotautiin, syöpään, tapaturmiin ja kokonaiskuolleisuuteen.

Testattiin hypoteesi, että vahvan koherenssin (SOC) omaavilla miehillä on sepelvaltimotaudin, syövän ja tapaturmien ilmaantuvuus sekä kokonaiskuolleisuus pienempi kuin niillä, joilla koherenssin tunne on heikko. Koherenssin tunne mitattiin alkuperäisellä 29-osioisella kyselyllä Helsinki Heart Studyyn osallistuneilta miehiltä. Lisäksi heiltä mitattiin kliiniset tiedot, kuten kokonaiskolesteroli, systolinen ja diastolinen verenpaine ja painoindeksi sekä kysyttiin tupakointi, alkoholin käyttö ja vapaa-ajan liikunta. Ammattinimike saatiin Tilastokeskuksesta vuoden 1980 väestölaskennan perusteella. Koherenssipistemäärä luokiteltiin tertiileihin terveysriskien arviointia varten. Miehiä seurattiin kahdeksan vuotta. Sepelvaltimotaudin, syövän, tapaturmien ja kuoleman ilmaantuvuus laskettiin. Yhteisvaikutusten ja sekoittuneisuuden arvioimiseksi ilmaantuvuus vakioitiin iän, alkoholinkäytön, ammatin ja tupakoinnin mukaan Coxin mallin avulla.

Huonon koherenssin omaavilla toimihenkilöillä oli korkea sepelvaltimotaudin ilmaantuvuus, 20.1 tuhatta henkilövuotta kohti, kun taas keskinkertaisen tai hyvän koherenssin omaavilla ilmaantuvuus oli vastaavasti 10.9 ja 12.3. Vastaavaa koherenssin vaikutusta ei ollut työntekijöillä. Vahvimman koherenssin omaavat sairastuivat vähiten syöpään (4.0 tuhatta henkilövuotta kohti) ja huonon koherenssin omaavat (5.6 tuhatta henkilövuotta kohti) eniten. Työntekijöillä erot olivat tilastollisesti merkitseviä, mutta toimihenkilöillä ne eivät olleet. Tapaturmien vaarasuhde oli tilastollisesti merkitsevästi alhaisempi hyvän (7.6 tuhatta henkilövuotta kohti) ja keskinkertaisen (7.5 tuhatta henkilövuotta kohti) koherenssin omaavilla verrattuna huonon (10.2 tuhatta henkilövuotta kohti) koherenssin omaaviin. Työntekijöillä hyvän ja huonon koherenssin omaavien ero oli tilastollisesti merkitsevä, mutta toimihenkilöillä se ei ollut. Alkoholin ja huonon koherenssin yhteisvaikutus lisäsi tapaturmavaaraa. Koherenssin vaikutus kokonaiskuolleisuuteen oli vähäinen ja klassisilla riskitekijöillä, alkoholilla ($p<0.01$) ja tupakalla ($p<0.001$), oli koherenssia suurempi vaikutus kuolemanvaaraan.

Koherenssin vaikutuksesta voidaan todeta yhteenvetona, että se vaihteli iän, ammatin ja sairauden mukaan. Vahva koherenssi näyttäisi suojaavan tapaturmilta, toimihenkilöitä sepelvaltimotaudilta ja työntekijöitä syövältä. Kokonaiskuolleisuuteen vaikuttavat klassiset elämäntapariskitekijät, joilla on kuitenkin yhteyttä koherenssin tunteeseen. Koherenssin tunne on siis stressinhallintaan liittyvä tekijä, minkä puute näkyy terveydelle vahingollisina huonoina elämänhallinnan keinoina.

LIST OF ORIGINAL PUBLICATIONS

I. Poppius E, Tenkanen L, Kalimo R and Heinsalmi P (1999): The sense of coherence, occupation and the risk of coronary heart disease in the Helsinki Heart Study. Soc Sci Med 49:109–120.

II. Poppius E, Virkkunen H, Hakama M and Tenkanen L (2006): The sense of coherence and incidence of cancer – role of follow-up time and age at baseline. J Psychosom Res 61:205–211.

III. Poppius E, Virkkunen H, Hakama M and Tenkanen L. The sense of coherence and risk of injuries: role of alcohol consumption and occupation. (accepted by J Epidemiol Community Health)

IV. Poppius E, Tenkanen L, Hakama M, Kalimo R and Pitkänen T (2003): The sense of coherence, occupation and all-cause mortality in the Helsinki Heart Study. Eur J Epidemiol 18:389–393.

ABBREVIATIONS

BASOC   Brief Assessment of Sense of Coherence
BMI   body mass index
BPRS   Brief Psychiatric Rating Scale
CHD   coronary heart disease
CVDR   Finnish Cardiovascular Diseases Registers Project
EPIC   European Prospective Investigation into Cancer
GRR   Generalized Resistance Resource
HHS   Helsinki Heart Study
ICD   International Classification of Diseases
PTSD   posttraumatic stress disorder
QOL   quality of life
RR   relative risk
SOC   the sense of coherence

1. INTRODUCTION

The Helsinki Heart Study was launched by the pharmaceutical company Warner-Lambert in collaboration with the University of Helsinki and the National Public Health Institute throughout Finland in 1980. The role of cholesterol had been earlier recognised as an important risk factor for coronary heart disease and the pharmaceutical industry needed a large prospective study to prove that their lipid-lowering drug was useful in combatting heart disease. The Helsinki Heart Study was carried out in a setting favourable to a salutogenic approach, namely the occupational health services of government institutions and companies. The nature of occupational health is health enhancing, the idea being that work should not cause any damage to health, and also, how working life can support one's health.

The sense of coherence (SOC) was one of the psychosocial factors that caught the attention of medical, psychological and nursing communities all over the world in the 1980's. The fresh outlook was stimulating for research. How great is the influence of a strong SOC in keeping a person healthy? What diseases can a strong SOC prevent?

As both the topics, heart disease and psychosocial factors, were on the agenda in medical circles in Finland at the time, why not combine them? It was a good opportunity to conduct a prospective study on the SOC, because most classical health risk factors in the Helsinki Heart Study could be controlled for because blood pressure, smoking, lipid levels, body mass index, etc. were measured and recorded.

This summary concentrates on the sense of coherence. The goal was to study the predictive power of the SOC in forecasting the health of middle aged men in working life while controlling for confounding factors like the most relevant clinical risk factors and occupation. Besides all-cause mortality, the occurrence of the most common diseases posing a risk to a working man's health was chosen: coronary heart disease, cancer and injuries. The intention was not to engage in evaluating the psychometric properties of the SOC scale. Articles had been already been published on that topic.

"We are aware of only one prospective study that examined whether a strong SOC had a salutogenic effect in terms of being associated with a reduced risk of chronic disease incidence" Surtees and co-workers stated in their article published in 2003, referring to Article **I** in this summary (Surtees et al. 2003). Until 2007, at the time of writing, prospective studies with the SOC as a predictor of health are still rare. The only other major

study on all-cause mortality (including cardiovascular and cancer mortality) has been the EPIC-Norfolk Study by the above-mentioned authors from the UK with a follow-up time of up to six years.

2. REVIEW OF THE LITERATURE

The number of studies on the sense of coherence (SOC) has increased rapidly. A Medline search 1992–1996 with the keyword "sense of coherence" yielded 63 articles in 1996. Out of those 63 articles 25 had appeared in nursing journals. In the field of sociology the Sociofile2 search 1/1972–10/1996 yielded 34 articles. A Medline search in 2003 yielded more than two hundred articles with the sense of coherence as a keyword. In November 2006 the number of articles had risen to 523. A systematic review of all SOC research available in 8 databases and fulfilling a defined criterion found 458 scientific publications and 13 doctoral theses published 1992–2003 (Eriksson and Lindström 2006).

A pathogenic orientation in the framework of the traditional Western medical model has been dominant for decades. It was strengthened by the discovery of external causes of disease such as bacteria, radiation and lack of vitamins at the end of the 19th century. The idea of promoting health took an upturn at the same time as the reinstatement of the Olympic Games, while countless sports societies mushroomed all over the Western hemisphere. Healthy lifestyles were promoted while poverty and, for example, tuberculosis were still being combatted. Health promotion and health education were considered important, so they were introduced as subjects in the school system, too. The earlier health was promoted, the better. Following this principle, the paediatrician Arvo Ylppö founded a network of prenatal and infant counselling units in Finland as early as 1920. It was only much later that the idea of health promoting factors would be involved in the definition of disease – or actually a new perspective to health and disease would emerge.

2.1   The books by Aaron Antonovsky

After moving from his birthplace in Brooklyn, NY, to Israel in 1960, Aaron Antonovsky in his sociological studies had come across, among others, holocaust survivors. Some of those people seemed to have no obvious mental handicap. This phenomenon caused Antonovsky to contemplate how this was possible. What had preserved these individuals' sanity despite all the horror of the concentration camps? His fundamental question was – in contrast to the usual approach – what creates health, what is the origin of health? He called this approach

"salutogenic". In his world health is relative on a continuum and the key research question is what causes health (salutogenesis) rather than what are the reasons for disease (pathogenesis). The salutogenic perspective focuses on three aspects. Firstly, the focus is on problem solving/finding solutions. Secondly, it identifies generalised resistance resources help people to move in the direction of positive health. Thirdly, it identifies a global and pervasive sense in individuals, groups, populations, or systems that serves as the overall mechanism or capacity for this process, the sense of coherence (Lindström and Eriksson 2005).

2.1.1 Health, stress and coping

Antonovsky formulated his ideas in a book called "Health, stress and coping" published in 1979. There he introduces the concept of "generalized resistance resources" (GRR). He admits that he started his idea of GRRs intuitively, but came to define them as follows:
 "A GRR is a
        1. physical/
        2. biochemical/
        3. artifactual-material/
        4. cognitive/
        5. emotional/
        6. valuative-attitudinal/
        7. interpersonal-relational/
        8. macrosociocultural
characteristic of an
        1. individual/
        2. primary group/
        3. subculture/
        4. society
that is effective in
        1. avoiding/
        2. combating
a wide variety of stressors and thus preventing tension from being transformed into stress" (Antonovsky 1979, p. 103)

According to the above-mentioned definition, a GRR may be part of the immune system, may be money, may be knowledge and intelligence, and may be ego identity, rationality, flexibility and farsightedness. It may also be social support, culture and religion. A person can make the best use of these GRRs when he or she is planning a strategy for coping with a stressor. Lacking GRRs is directly and immediately a stressor. "The extent to

which our lives provide us with GRRs is a major determinant of the extent to which we come to have a generalized, pervasive orientation that I call a strong sense of coherence." (Antonovsky 1979, p. 122) Antonovsky further explains that early childhood experiences, social class, the complexity of one's work, social conditions in society providing lawfulness and predictability all together build up the GRRs necessary for a strong SOC. One important aspect of this definition is that a GRR can be a characteristic of a group instead of only pertaining to a single individual.

In the last chapter of his first book Antonovsky summarises the salutogenic model in a rarely referred-to figure with boxes and arrows. He repeats that childhood experiences are crucial in shaping one's SOC. GRRs provide one with sets of meaningful, coherent life experiences. The sources of GRRs are in one's social class and material resources. GRRs also function as a potential. Someone with a strong SOC, whatever its sources, confronted with tension, can call on the GRRs to manage the tension successfully. The final issue of health and the SOC has three aspects. Firstly, health can affect the extent to which one is exposed to stressors. Secondly, good health in itself is a GRR. Thirdly, in the same way that the other GRRs are interrelated, being on the healthy end of the health continuum can facilitate the acquisition of other GRRs.

2.1.2   Unravelling the mystery of health

Antonovsky discussed GRRs further in his second book "Unraveling the mystery of health" (Antonovsky 1987). He redefined the term as "phenomena that provide one with sets of life experiences characterised by consistency, participation in shaping outcome, and an underload-overload balance".

Antonovsky (1987, p. 19) defined the concept of the sense of coherence as a "global orientation that expresses the extent to which one has a pervasive, enduring though dynamic feeling of confidence that

(1)   the stimuli, deriving from one's internal and external environments in the course of living are structured, predictable, and explicable;

(2)   the resources are available to one to meet the demands posed by these stimuli; and

(3)   these demands are challenges, worthy of investment and engagement."

These are the three components in the SOC construct, namely comprehensibility, manageability and meaningfulness. Theoretically the dimensions are well founded, but in practice they present a rather one-dimensional variable. Antonovsky (1987, pp. 87–88)

wrote: "The reader is duly warned, then, that the present version of the SOC scale is not wisely used to study component interrelations". Later, Antonovsky (1993) still repeated his plea not to separate the components by writing "as the evidence indicates, this is impermissible on technical grounds".

Introducing salutogenesis as a new concept Antonovsky did not abandon the concept of pathogenesis, but saw the two as complementary orientations. After going through similar concepts he explained the four-facet design of the SOC questionnaire. The first psychometric data were available from studies in the early 80's. Some occupational groups were tested, among them students, health workers and officer trainees.

A long chapter in the book is devoted to the issue how the SOC develops over the lifespan and to its stability. In the first book the SOC was hypothesised to remain stable, but in the second book Antonovsky explained, that he had earlier the strong-SOC person in mind. He suggested that "adulthood will show an increasing disparity in the strength of the SOC between those who embark on this period of life with a strong SOC and those with a moderate SOC, and even greater disparity between those with a weak SOC" (Antonovsky 1987, p. 123).

A strong SOC is not a particular coping style. What the person with a strong SOC does is to select the particular coping strategy that seems most appropriate to deal with the stressor confronted. In other words, he or she chooses from the repertoire of generalised and specific resistance resources at his or her disposal what seems to be the most appropriate combination.

The issue of coping has two sides: the instrumental side and the regulation of emotion. Tension, the response to a stressor, is an emotional phenomenon. Resolution of the instrumental problem posed by the stressor does not mean that the problem of emotion is automatically solved. The person with a strong SOC takes the stressor emotionally as challenge rather than a burden. The person with a strong SOC mobilises emotional and cognitive intra- and interpersonal and material resources to cope with problems. He or she mobilises, through the central nervous system, neuroimmunological and neuro-endocrinological resources to prevent damage to organism.

The last chapter of the book is about the SOC as a group property. A good example is family, small local community, work or friendship group or the like – that is, some primary group. It is questionable whether the concept is applicable to a very large scale group like the working class or Spanish society. There must be a sense of group consciousness of a subjectively identifiable collectivity before it is possible to talk about of a group SOC. This issue was raised, because group SOC could be a factor in shaping and modifying the individual SOC, particularly in childhood and adolescence.

Antonovsky closes the book with thoughts about the association of the SOC and health and well-being. "In sum, I think it reasonable to expect positive, though not directly causal, correlations between the SOC and well-being, on two grounds. First, if the SOC is indeed generative of good health, and health has a positive influence on global estimates of one's well-being, then the two will be related, though indirectly. Second, many of the GRRs that promote a strong SOC are also directly related to well-being." He closes the book by saying in the last paragraph "how closely the SOC predicts concrete behaviors is a matter for empirical investigation".

2.2   Studies in peer reviewed journals

2.2.1 Critics of the concept of the sense of coherence

Some authors have been critical of the SOC. For example, Siegrist (1993) initially felt that Antonovsky had not incorporated emotional experience into the SOC concept. Antonovsky mentioned emotions in his commentary on the three components in his book, but did not include this in the definition of the SOC.

> "Formally, the meaningfulness component of the SOC refers to the extent to which one feels that life makes sense emotionally, that at least some of the problems and demands posed by living are worth investing energy in, are worthy of commitment and engagement, are challenges that are 'welcome' rather than burdens that one would much rather do without" (Antonovsky 1987, p. 18).

Secondly, Siegrist stated that there were no sociological and psychological variables relevant to the SOC within a theoretical model. Another missing feature of the SOC, according to Siegrist, is the lack of explicit statements on the way social factors may initiate or modulate the experience of coherence.

Geyer (1997) points out that "little empirical evidence concerning the stability of the SOC is available, well-educated and privileged people have anyway more opportunities for decision-making and that high negative correlations between the SOC and depression/ anxiety suggest that the instruments used may assess the same phenomenon, but with inverse signs". He also pointed out that there are other concepts which explain salutogenesis, namely sociological aspects; the SOC being optimally developed by individuals in the highest social class while in the lowest social class the situation is exactly the opposite. According to Geyer SOC research has also suffered from inappropriate study

designs. He thus calls for a more systematic approach with prospective study designs and repeated measurements. Smith and Egger (1997) simply state that the SOC does not work. Another critic of the construct found evidence that the sense of coherence (short-form) measure is plagued with emotionality (Korotkov 1993).

2.2.2 The Orientation to Life Questionnaire

The first articles on the psychometric qualities of the SOC questionnaire were published soon after the wide-spread use of the Orientation to Life Questionnaire (Frenz et al. 1993, Antonovsky 1993, Flannery et al. 1994). The original Orientation to Life Questionnaire is a 29-item questionnaire with a seven-point semantic differential scale to respond between a definitive yes, don't know or definitive no. The SOC questionnaire has been used in 32 countries in 33 languages. Cronbach's alpha describing the internal consistency of the questionnaire ranged in 124 studies using the original 29-question version from 0.70 to 0.95. The mean score ranged from 100.5 to 164.5 (Eriksson and Lindström 2006). The review article by Eriksson and Lindström (2006) is an important addition to the articles on validity, reliability and internal consistency data. The authors concluded that the SOC scale seems to be a reliable, valid, and cross-culturally applicable instrument measuring how people manage stressful situations and stay well. Critical views have also been expressed about the materialisation of the SOC-29 scale (Flensborg-Madsen et al. 2005).

For large scale population studies the 29-item questionnaire is quite lengthy, so shorter versions have been developed. Antonovsky presented a shorter version of the original questionnaire by selecting the 13 most important items. He evaluated the SOC-13 questionnaire and published psychometric data (Antonovsky 1993). Others have validated the short 13-item SOC questionnaire, too (Korotkov 1993). Articles on SOC-13 validity are published continuously; the most recent study being by Feldt et al. (2007). These new data suggest relatively high structural validity and high stability for the 13-item SOC measure and support the notion that the SOC becomes more stable following maturation. The 13-item SOC measure seems to provide a psychometrically sound survey instrument for testing Antonovsky's theory of life orientation and health.

A 3-item version was also used by Lundberg and Nyström Peck (1995). Schumann et al. assessed the reliability and validity of the SOC-3 by comparing it to the SOC-29 (Schumann et al. 2003). They found Cronbach alpha to be .45 for the SOC-3 while it was .91 for the SOC-29. The authors came to the conclusion that reliability and validity of the

SOC-3 are so poor that they developed a new 3-item questionnaire they call Brief Assessment of Sense of Coherence (BASOC).

2.2.3 The stability of the sense of coherence

Lundberg (1997) questions the widespread belief that Antonovsky himself claimed said that the SOC is stable – on the contrary. In his study the SOC becomes weaker with age, contrary to another Swedish study (Larsson and Kjellberg 1996).

There is a study on the short term stability of the SOC measuring it prior to, during and after a stressful situation (McSherry and Holm 1994). The study supports Antonovsky's concept. Low SOC persons reported significantly more stress, anxiety and anger throughout the experiment than did either moderate or high SOC persons. Low SOC persons were also significantly less likely than high SOC persons to believe they possessed the personal resources necessary to cope with the situation. Furthermore, low SOC persons showed no physiological changes within the anticipation phase, whereas high SOC persons showed decreases in pulse rate during the last minute of anticipation. Antonovsky's (1987) hypothesis to explain to this phenomenon is that before taking action the strong SOC individual will have mobilized resources to confront the stressor, whereas the weak SOC individual will have been more likely to have simply given up at the outset.

A very large study in Canada examined the stability of the SOC over a four-year period. A total of 6,790 participants active in working life and aged 16–64 had two SOC scores for evaluation. Change was reported by 34.4% of the participants. The threshold criterion for the change was (+10%). The probability of change in the SOC increased towards the unskilled end of the occupational dimension, also towards the low end of the household income and even the low end of job decision latitude and job security (Smith et al. 2003).

In a Swedish 5-year follow-up study (Nilsson et al. 2003) in a cohort of 1,254 men and women, those with the initially lowest SOC scores showed the greatest decrease during the study period. Importantly, the oldest age group (45–74 years) had the greatest decrease in SOC score.

One study tested the stability of the SOC in a 5-year follow-up comparing those under 30 years of age with those over 30. The stability coefficient in the longitudinal factor analysis was 0.67 for both age groups. The participants were mainly men, technical employees and engineers (Feldt et al. 2003). These results confirm Antonovsky's view that a strong SOC is easily maintained, but a weak SOC is prone to deteriorate.

2.2.4 The sense of coherence and occupation

According to a Swedish study (Larsson and Kjellberg 1996) men had a significantly higher average SOC score than women. Occupation was significantly related to the SOC as well as income and number of friends. The only non-significant socioeconomic variable was education. The correlation between self-reported health status and the SOC was very high, as expected. In a regression analysis the SOC had the highest relative importance of the independent variables measuring physical health and general well-being. Age was a consolidating factor; participants aged 50 and over reported stronger SOC than those between 30 and 49 years of age. The authors recommend further studies with a prospective design including chronic illnesses, biological markers and other assessments of health-related behaviours.

Antonovsky (1987) stressed the important role of high social class promoting a strong SOC. Other studies support the suggestion (Lundberg 1997). "In the highest social positions optimum conditions for the development of SOC and for putting it into action are present. In the lowest social classes the situation is the exact opposite, as neither the preconditions for developing a higher SOC nor many options for making choices will be found. A high SOC may be an appropriate pattern of attitudes for professionals, executives and for the upper middle class, who comprise only a small proportion of the entire population". Geyer (1997) continues by saying that "the situation is unfavourable for those with semi-skilled and unskilled jobs as flexible thinking, independent judgments and responsibility are neither primary nor secondary goals. Instead, these jobs entail restrictiveness, high division of labour, fixed sequences of events, time pressure, narrow opportunities for individual variations (e.g. working on an assembly line) and external control. Thus, experiences of success and opportunities for developing and maintaining a high sense of control are rare".

There are not many studies on the difference of the SOC between occupations, since most published studies have been made on uniform groups, such as students (Smith and Meyers 1997), social workers (Gilbar 1998), health care personnel (Lewis et al. 1994), patients (Santavirta et al. 1996) and the deprived (Nyamathi 1991). In an early review article of published SOC studies (Antonovsky 1993), however, some occupational groups can be found, such as supervisors, production workers and faculty members and their SOC scores are compared. In three studies on Israeli army officer trainees (Antonovsky 1987) the average SOC was high (SOC = 159, 160 and 159 respectively). Other studies have shown low average values, like those reported by Fiorentino (1986), average SOC was

133.0 among U.S. production workers (78% female). The SOC was found to be very high among mountain guides (average 157.9 +-18.4, n= 1347) (Sommer and Ehlert 2004).

2.2.5 The sense of coherence and quality of life

The SOC construct has enjoyed relatively lively attention by medical sociologists, psychologists as well as medical and nursing researchers. In the 1990's several studies on the SOC were conducted in the caring sciences concentrating on nursing (Forsberg and Bjorvell 1996, Jakobsson et al. 1997) or prediction of quality of life (Klevsgard et al. 2000). Other studies focused, for example, on recovery from a disease (Drory et al. 1999), threat of disease (Gilbar and Borovik 1998), success of rehabilitation (Kamwendo et al. 1998), prediction of post-operative pain (Hall-Lord et al. 1999), absenteeism in working life (Kivimäki et al. 2000) and return to work (Newton 1999). The authors of a study on post-operative chest pain (Karlsson et al. 1999) called the SOC "a quality-of-life indicator". A study on hip fractures (Johansson et al. 1998) concluded that after a hip fracture, people with a stronger SOC seem to cope more successfully with their situation.

In a study on patients with CHD who survived cardiac arrest, the SOC was measured to predict quality of life (Motzer and Stewart 1996). The hypothesis was that the physical and emotional consequences of a chronic illness, such as CHD, coupled with an acute event, like surviving a cardiac arrest, would influence quality of life negatively through the degree of instability of the chronic illness trajectory and also through the amount of work required to manage and shape the trajectory. Furthermore the cardiac arrest survivors with a strong SOC would be more satisfied with their quality of life than those survivors with a moderate or weak SOC. The SOC scale used was the 13-item version. The authors had a 6-step regression model adding first data on social status, then social support, self-esteem, symptoms, etc. In the last step the SOC score was added. In the findings the explained variance in quality of life measured by the Flanagan Quality of Life Scale (QOL) (Flanagan 1982) prior to the entry of SOC into the model was 50% and the independent contribution of SOC improved the variance 15%. There was a high correlation ($r = .73$) between the QOL and SOC. The authors concluded that the SOC indeed predicts QOL and the high correlation is not a result of a measurement artefact. In summary, there seems to an overlapping of the concepts of QOL and the SOC.

2.2.6 The sense of coherence and psychiatric illness

The association of the SOC with several diseases has been studied. Many of those diseases are somatic, for example, musculoskeletal symptoms (Viikari-Juntura et al. 1991, Tuomi et al. 1999), diabetes (Cohen and Kanter 2004), rheumatoid arthritis (Hawley et al. 1992, Buchi et al. 1998) and trauma (Schnyder et al. 2000). Some diseases with a psychosomatic component like blood pressure (Kalimo and Vuori 1993), fibromyalgia (Jamison 1999), irritable bowel syndrome (Sperber et al. 1999) and chronic stomach trouble (Nilsson et al. 2000) have also been studied in conjunction with the SOC. Moreover, psychiatric illnesses like post-traumatic stress disorder (PTSD) have been studied (Frommberger et al. 1999, Schnyder et al. 2001). A Swiss study on mountain guides (Sommer and Ehlert 2004) concluded that the SOC was not a good protective factor against PTSD, but rather a marker of psychological health.

One study on the SOC concentrated on the prediction of psychiatric treatment outcome. Sack and co-workers (1997) found that the SOC score increased significantly during inpatient treatment, but outcome of treatment could not be predicted by the initial SOC. However, a highly significant association was observed between an increase in SOC and a decrease in complaints. The authors point out that the SOC has a high overlap with psychiatric complaints (i.e. anxiety and depression). Carstens and Spangenberg (1997) found not only a significant negative correlation between Beck depression scores and the SOC, but also a significant positive correlation between the SOC and age.

Depressive and suicidal persons were studied and the SOC seemed to better predict suicidal ideation and reattempt of suicide than scales for depression, hopelessness and self-esteem. Subscales of the SOC were also used in this six-month follow-up study (Petrie and Brook 1992) of hospitalised parasuicide patients. At hospitalisation the SOC subscale meaningfulness seemed to be most closely related to suicidal thoughts. After six months the other subscales, manageability and comprehensibility, replaced meaningfulness as the closest association with suicidal thoughts. Salutogenic variables were included in order to identify psychological factors that could be targets for intervention. Suicidal individuals have deficits in active problem-solving and are more susceptible to developing dysfunctional attitudes, particularly regarding their ability to influence stressful events. Intervention that can successfully modify these beliefs and misattributions may have some potential to reduce suicidal behaviour in the long term. This result was further confirmed in a study on Norwegian conscripts during their first week of basic training. The lifetime prevalence of suicidal ideation was 21.7% and attempted suicide 2.6%. Suicide ideators and

attempters had on average significantly weaker SOC scores compared to respondents with no suicidal ideation or behaviour (Mehlum 1998).

In a German study (Hannöver et al. 2004) the average SOC scores for the SOC-29 among males 41–60 years of age were for those with no psychiatric diagnosis 163.7 and for those with a psychiatric diagnosis sometime in their lives 151.6, and finally for those with a psychiatric diagnosis within the last four weeks 146.2. The differences were significant. In a Swedish study on patients with schizophrenia (Bengtsson-Tops et al. 2005) the total SOC mean value was much lower than in the German study, namely 129 (SD: 26.6). The female patients had a weaker SOC than their male counterparts (123.5 vs. 134.1, p = 0.036). Patients with a higher level of psychopathology (BPRS median value 35 used as cut-off point) had a weaker SOC than those with a lower level of psychopathology (119 vs. 138; p = 0.001).

The SOC is an instrument to measure an individual's ability to cope with stressors and has been found to be positively related to social support (de Boer et al. 1999). Those with a strong SOC have more social support and manage the effects of stressors better than those with a weak SOC (Heiman 2004).

It seems that the SOC has an overlap with anxiety, depression and suicidal ideation and psychiatric diseases in general, but it is not clear if this has clinical relevance in treating the disease.

2.2.7 The sense of coherence and coronary heart disease

The number of studies on coronary heart disease (CHD) and the SOC is limited to four, although in Western affluent societies coronary heart disease is the leading cause of death and morbidity among middle-aged males. In Finland the proportion of deaths among middle-aged men (45–59) due to CHD was 35.6% in the years 1980–1989 (Kunst et al. 1998). If high and moderate SOC scores really have a general salutogenic effect, a lower incidence of CHD could be anticipated among those with a strong SOC compared to those with a weak SOC.

A Swedish cross-sectional study focused on the four-fold difference in CHD mortality among 50-year old men in Sweden and Lithuania (Kristenson et al. 1998). The classic risk factors could not explain the difference. The reason turned out to be psychosocial risk factors like higher job strain, lower self-esteem, lower social support, lower sense of coherence, higher vital exhaustion and more depression in Lithuanian men.

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One explanation for the protective effects of the SOC against CHD is the study by Zhang et al. (2001), where blood glucose level and the SOC were found to be negatively correlated.

Cardiovascular mortality was also analysed in addition to cancer by Surtees et al. (2003) in the EPIC-Norfolk Study when they reported all-cause mortality. The results for cardiovascular mortality in men expressed as rate ratio when comparing a strong SOC with a weak SOC (reference) were 0.75 (95% CI 0.58–0.97) after adjustment for age and prevalent disease, 0.85 (95% CI 0.65–1.12) and after adjustment for age, prevalent disease, and social class and 0.87 (95% CI 0.66–1.15) after adjustment for age, prevalent disease, social class, and cigarette smoking history. This is the most conclusive study indicating that the SOC was a statistically significant risk factor for CHD after adjusting for the known confounders.

2.2.8 The sense of coherence and cancer

In Finland the proportion of deaths among middle-aged men (45–59) due to cancer was 20.7% in the years 1980–1989 (Kunst et al. 1998). This represents the second largest cause of death. There is a multitude of studies on associations between other psychosocial factors and cancers. For example, there are two recent studies on psychosocial factors and female breast cancer. The first concluded that the evidence for the association of breast cancer and psychosocial factors is weak (Butow et al. 2000) and the second study found that job stress was not related to an increase in the incidence of breast cancer (Achat et al. 2000). A meta-analysis of breast cancer and psychosocial factors (McKenna et al. 1999) supported only a modest association between specific psychosocial factors and breast cancer, contrary to the conventional wisdom that personality and stress influence the development of breast cancer. When the association of all cancers and psychosocial work environment was studied among men and women (van Loon et al. 2000) no differences in the prevalence of lifestyle risk factors were found among the psychosocial work characteristics. Denollet (1998) studied personality features among men with coronary heart disease, but no cancer. Development of cancer during subsequent follow-up was unrelated to cardiac pathology, but was associated with age, poor exercise tolerance, pessimism and anxiety. Depression has been associated with elevated lung cancer risk in a Finnish study (Knekt et al. 1996). In a Danish study (Dalton et al. 2002) depression was shown not to increase the risk of cancer independently, but depression can have a deleterious effect on lifestyle factors.

There are several possible pathways for the effect of psychological factors on risk of cancer. As reviewed by Garssen (2004), firstly, there may be a direct SOC-modified effect

of chronic stress on the immune system. Suppression of immunity could result in the initiation and progression of some cancers, especially immunologically or hormonally dependent cancers. Secondly, poor strategies for coping in chronic stress and lack of social support, i.e. a weak SOC, may cause adverse lifestyle factors like smoking, alcohol consumption as ultimate efforts to cope. A weak SOC may thus have an effect on cancer risk via behavioural factors (Dalton et al. 2002). Blue-collar workers have a greater probability of exposure to occupational carcinogens (Pukkala 1995).

A recent meta-analysis of studies on psychological stress and the human immune system (Segerstrom and Miller 2004) concludes that little is known about the psychological pathways linking stressors with the immune system. It is tempting to speculate that a strong SOC, the tool for dealing with stress, operates via a neuroimmunological pathway, especially as the SOC has been shown to correlate with natural killer cell activity in healthy adults (Lutgendorf et al. 1999, Nakamura et al. 2003) and with cyclic adenosine monophosphate levels in peripheral blood mononuclear cells in healthy male volunteers (Cohen et al. 2004). If the effect of the SOC works at least partly through immunological pathways, then its effect is obviously heavily dependent on the other prevailing risk factors. In the younger age groups cancers are more genetically dependent and develop despite a favourable immunological state, but in later age inherited genetic factors make a minor contribution to susceptibility to most types of neoplasms (Lichtenstein et al. 2000). At a later age the occurrence of cancer depends more on an accumulation of environmental carcinogens (Anisimov 2003). It is possible that this process could be delayed by a favourable immunological state leading to a later onset of cancer among those with a strong SOC. In contrast, those with a weak SOC seem to have a heavier cumulative burden of environmental exposures and probably less immunological capacity, both leading to earlier onset of cancer.

A study on the SOC from the caring sciences found when evaluating two models of care for breast cancer that the strongest predictor of the patients' well-being postoperatively was their perceived well-being before surgery. Furthermore, the stronger the SOC the more positive were the patients' emotional perceptions, perceived general health and mental well-being after surgery (Boman et al. 1999).

Cancer mortality was directly analysed in the EPIC-Norfolk Study follow-up (Surtees et al. 2003). The results among men for the association of cancer mortality and the SOC between a strong vs. a weak SOC (reference) rate ratio were 0.61 (95% CI 0.47–0.79) after adjustment for age and prevalent disease, 0.66 (95% CI 0.50–0.89) and after adjustment for age, prevalent disease, and social class and 0.66 (95% CI 0.49–0.88) after adjustment for age, prevalent disease, social class, and cigarette smoking history. The SOC played a more

important role as a risk factor for cardiovascular mortality than for cancer mortality. Even after adjusting for social class and smoking, the rate ratio was significant.

2.2.9 The sense of coherence and injury

The third largest cause of death in Finland among middle-aged men (45–59) is injuries due to external causes, representing 18.1% of all deaths in the years 1980–1989 (Kunst et al. 1998).

There are several studies on the SOC and injury, but concentrating on the SOC after injury such as on the development of the SOC after orthopaedic injury (Ristner et al. 2000), on the stability of the SOC after trauma (Snekkevik et al. 2003) and coping strategies after trauma (Hepp et al. 2005).

According to coping theory, those people who can give meaning to a traumatic event, who can comprehend what has happened and have a sense of the manageability of the sequelae, are better able to cope with a traumatic event. This hypothesis was confirmed in a study on 51 road traffic accident victims subsequently admitted to hospital. The SOC was measured after a few days after admission and then after six months. The SOC total score correlated negatively with measurement of PTSD symptoms at first assessment and follow-up. The results showed that cognitive and affective reactions to the accident correlated with the SOC. The reactions were independent of the severity of the injury (Frommberger et al. 1999).

The association of the SOC and injury has not earlier been studied prospectively. The SOC is known to be related to some well-known risk factors for injury like occupational category (Baarts et al. 2000), pattern of alcohol consumption (Paljärvi et al. 2005), and smoking (Chau et al. 2004). One study on injured emergency-room patients investigated the association of the SOC and alcohol consumption (Neuner et al. 2006). The conclusion was that the SOC and hazardous alcohol consumption were significantly associated. The data supported Antonovsky's original concept of increased alcohol consumption as a result of failed coping strategies.

2.2.10 The sense of coherence and all-cause mortality

It was only in 2003 that a large prospective study on the SOC and all-cause mortality was published (Surtees et al. 2003) coinciding with Article **II** published in the same year. In

20,579 participants aged 41–80 years the authors analysed the association of the SOC and all-cause mortality. They found that the dichotomised strong SOC variable was associated with a 30% reduction in mortality (RR 0.69, p<0.0001) independent of age, sex, and prevalent chronic disease. The association for all-cause mortality remained after adjustment for smoking, social class, body mass index, systolic blood pressure, cholesterol, hostility and neuroticism. The results suggested that a strong SOC may confer some resilience to the risk of chronic disease.

Surtees and co-workers found further in the EPIC-Norfolk Study that the SOC is a potential marker of an individual's social stress adaptive capacity, which is predictive of mortality (Surtees et al. 2006a) The joint association between mastery and sense of coherence revealed both personal coping dispositions to be independently associated with lower rates of all-cause mortality. In addition, these data suggested that the association for mastery was specific to cardiovascular mortality, whereas the association for sense of coherence was specific to cancer mortality (Surtees et al. 2006b). These results may aid the future study of coping resources as determinants of sustained well-being.

3. PURPOSE OF THE STUDY

The purpose of this summary was to assess the effect of the sense of coherence on health. The specific hypotheses were tested that

1. people with a strong SOC have decreased incidence of coronary heart disease.
2. people with a strong SOC have decreased incidence of cancer.
3. people with a strong SOC have decreased incidence of injuries.
4. people with a strong SOC have decreased all-cause mortality.

4.   MATERIALS AND METHODS

4.1   The Helsinki Heart Study

The HHS was a five-year randomized, double-blind, placebo-controlled primary prevention trial of gemfibrozil, a lipid-lowering drug (Frick et al. 1987, Manninen et al. 1988). The participants were selected via two successive screenings from among those employed at two state agencies and five industrial companies. All male employees aged 40–55 were invited to the first screening. To be eligible for the trial as well as for the second screening the subjects' non-HDL cholesterol level had to be 5.2 mmol/l or higher, and for the primary prevention trial participants also had to be without evidence of coronary heart disease (CHD) or any other major illness. Those with evidence of CHD were included in a secondary prevention trial. Altogether 4,744 participants (4,081 in the primary prevention trial and 663 in the secondary prevention trial) took part in the double-blind drug trials. After the double-blind trial the participants were offered free gemfibrozil from 1987 until the end of 1995. About 2/3 in both treatment groups chose to take gemfibrozil.

4.2   Participants of this study

The participants of this study are a subgroup ($n = 5,866$) of those who attended the first screening visit ($n=18,939$) within the HHS as described in Figure 1. At the first screening a low cholesterol (non-HDL cholesterol <5.2 mmol/l) control group (C1) was selected using systematic sampling ($n = 2,432$). A second control group (C2) was formed of those participants who met the selection criterion in the first screening, but not in the second screening (see Figure 1). After the five-year double-blind trial a psychosocial questionnaire was distributed among the trial groups (response rate 79%) and among those in the control groups (response rate 65%). Those who responded formed our study group ($n = 5,866$). Of these, 2,250 came from the control groups (with low or moderate cholesterol levels) and 3,616 came from the dyslipidemic trial groups. Of these, 2,416 were treated with gemfibrozil during our follow-up.

FIRST SCREENING

| 18 939 | 1981-82 |

SECOND SCREENING

| 6 897 |

DOUBLE BLIND TRIAL

Gemfibrozil	Placebo	Control 2	Control 1
2 046 +328	2 035 +335	1 164	2 432

| PSYCHOSOCIAL QUESTIONNAIRE N=5885 | 1986-88 |

FREE GEMFIBROZIL

GN	PG	GG	PN	Control 2	Control 1
648	2 422		554	714	1 547

REGISTER FOLLOW-UP   1995
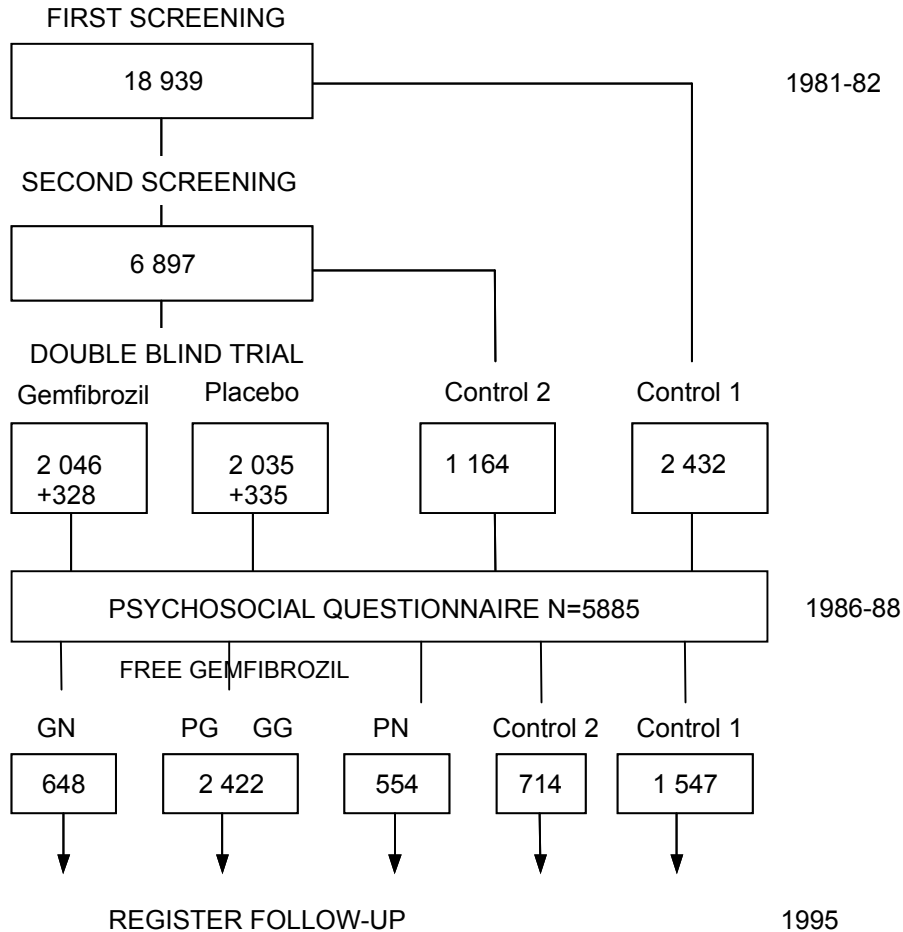
Figure 1. Schematic presentation of the different phases of the follow-up in a subgroup of Helsinki Heart Study screenees. GN = gemfibrozil during trial, not after, PG = placebo during trial, gemfibrozil after trial, GG = gemfibrozil during and after trial, PN = placebo during trial, no medication after trial, C1 = control group with non-HDL cholesterol <5.2 mmol/l, C2 = control group, qualified for the first screening, but did not meet the criterion of non-HDL cholesterol >5.2 mmol/l for the second screening.

Out of 5,885 participants, 5,866 with completed questionnaires were included in the follow-up study. After excluding those who had retired from work during the drug trial, a total of 4,405 participants remained for analysis. All those 4,405 were active in working life at the time of the measurement of the psychosocial factors.

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┌─────────────────────────────────────────────────────┐
│  PSYCHOSOCIAL QUESTIONNAIRE N=5866                   │
└─────────────────────────────────────────────────────┘

┌──────────────────────────┐   ┌──────────────────────────┐
│  EMPLOYED N=4405         │   │  RETIRED N=1461          │
└──────────────────────────┘   └──────────────────────────┘

┌──────────────────────────┐
│  FOLLOW-UP 8 YRS         │
└──────────────────────────┘

┌──────────────────────────┐
│  DEATHS      N=231       │
│  CVD         N=499       │
│  INJURIES    N=292       │
│  CANCERS     N=166       │
└──────────────────────────┘
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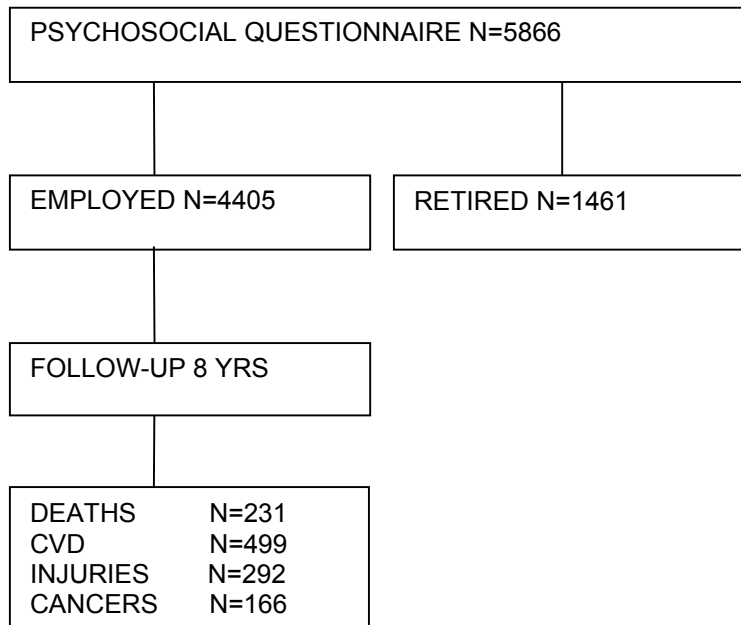
Figure 2. Schematic presentation of the follow-up study. Only men active in working life when responding to the psychosocial questionnaire were included for analysis.

4.3 Risk factors

The sense of coherence was measured at baseline in the years 1986–1988. The 29-item version of the "Orientation to Life" questionnaire was used (see Appendix). This was the original version designed and validated by Antonovsky (1993). The original questionnaire was used in order on the one hand to ensure maximum reliability and on the other hand to achieve maximum comparability with other studies.

The *occupation*al code was matched to the participants by record linkage using their social security identification number as a key. The code for occupation is the 1980 Finnish version of the Nordic Classification of Occupations. The occupational status dates from the year 1980, when Statistics Finland took the census. The white-collar and blue-collar workers were defined according to the ten major classes of the occupational classification. Classes 0–2, consisting of academic, administrative, office and sales work, are considered white collar. Classes 3–9 consist of manual labour (transport, industrial and service work) and are considered blue collar.

Alcohol consumption was measured with a modified version of the questionnaire used in the Scandinavian Drinking Survey (Simpura 1981). The questionnaire included items to determine the quantity and the type of alcohol consumed. The result was expressed in grams per year of absolute alcohol per person. In this analysis the participants were usually classified as non-drinkers and drinkers (0–200g/year vs. >200g/year), but in some studies a categorisation into four classes (0–150g/year, 151–250g/year, 251–450g/year and >451g/year) was applied.

Smoking was measured using a scale relating to the daily consumption of cigarettes irrespective of whether participants were inhalers or not. In this analysis a dichotomised category smokers/non-smokers (including ex-smokers) or a three-stage categorisation was used.

Leisure-time physical activity was recorded with the 4-point Gothenburg scale (Wilhelmsen et al. 1971) but in this study the subjects were divided into three categories. The first group was the inactive individuals, the second the moderately active and we combined the Gothenburg categories three (very active) and four (professional) activities into a "very active" category, because there were very few subjects left in the professional category.

Body mass index was calculated as weight in kilograms per square metre of height. *Blood pressure* was recorded from the right arm at the first screening visit with calibrated mercury sphygmanometers with cuffs measuring 12 x 40 cm. The measurement was carried out in sitting position before the blood sample was taken.

The *lipid* measurements have been described in detail elsewhere (Frick et al. 1987). Briefly, at the first screening visit serum samples from the local clinics were mailed daily to the central laboratory at the National Public Health Institute in Helsinki. Total cholesterol concentration was determined directly from serum and HDL-cholesterol was measured after precipitation of VLDL and LDL with dextran sulphate magnesium chloride by an enzymatic method.

4.4   Linkage to register data and follow-up

The CHD events were obtained by linking the hospital discharge diagnosis from the National Hospital Registry and the diagnosis from the cause of death register kept by Statistics Finland to the material. The first event was considered as end point in the follow-

up. The diagnosis used was in non-fatal cases ICD9 410 and in fatal cases ICD9 410–414. These registers and linking them have been shown to be reliable (Mähönen et al. 2000).

The cancer data were obtained from the Finnish Cancer Registry, which is population-based and uses personal identification numbers for all patients diagnosed with cancer. It is compulsory for all hospital pathology laboratories and medical practitioners to report all cases of cancer coming to their attention to the Cancer Registry. Various studies have indicated that cancer registration in Finland is almost complete (Teppo et al. 1994). The follow-up data from the Finnish Cancer Registry was linked to the HHS material in 1998 for cancers from the years 1986–1995. Each subject was followed up from completion of the questionnaire until occurrence of his first cancer, or death or closure date in 1995. The mean follow-up time was 8.0 years.

The diagnoses of injury were obtained from the hospital discharge diagnosis register of the National Hospital Registry and the official cause of death diagnosis from Statistics Finland. All external causes of injuries according to ICD9 categories E 807–999 were included (cut/pierce, drowning, fall, fire/burns, firearm, machinery, traffic accidents, poisoning, suffocation and other reasons), but in the final analysis self-inflicted injuries were excluded. The number of suicides and attempted suicides was only 11, so a more detailed analysis of these was not possible.

The data for all-cause mortality was obtained from Statistics Finland from their cause of death register. This information was essential in order to calculate the follow-up times.

4.5 Statistical methods

Data were entered and analysed using SPSS software. The SOC score was categorised into tertiles for evaluation of the shape of the association between the SOC and the relative risk (RR) of the health hazard in question. The significance of differences in percentage levels was assessed using the Chi square test. The factor analysis was performed using the SAS program. Cronbach's alpha was calculated, also using the SAS statistical program. To show the absolute levels of the risks crude incidences were presented by levels of the SOC, alcohol consumption and occupational category. Cox proportional hazards models were used to calculate the relative risks both when the variables were assessed separately, when studied jointly and when testing the importance of different covariates such as age, alcohol, occupation and smoking. These models were also used to test for trend across the

categories. The proportionality assumption was checked by visual inspection of the log cumulative hazard functions.

4.6   Ethical approval

The Helsinki Heart Study was approved by the ethics committee of the Helsinki University Central Hospital in 1980.

5. RESULTS

5.1 Psychometric properties of the SOC-29 scale

In order to study the interrelations of the three components – comprehensibility, manageability and meaningfulness – a factor analysis was performed. In the analysis of the 29 items of the questionnaire the Eigenvalues of the first factors were 8.8, 1.7, 1.4, 1.1 and 1.0 respectively. The first factor was thus fairly dominant, explaining 30% of the total variance, while all five together explained only 48%.

When reliability was calculated from 29 questions, Cronbach's alpha was 0.91 (N = 5,823). The alpha remained the same when the retired persons were excluded (alpha = 0.91, N = 4,405). To explain the difference between the blue and white-collar workers the alphas were checked to see if these two groups had answered any differently, but the alphas were identical (white-collar alpha = 0.9129 N = 918 and blue-collar alpha = 0.9123 N = 3,487). The distribution of the values of the SOC score (average 143.5, N = 4,405) was close to normal.

5.2 The sense of coherence and general risk factors

The average SOC was highest in administrative and managerial work and lowest in manufacturing work. Service work had the second highest average SOC. The differences between the occupational classes were highly significant. For a general view of the average SOC in major occupational classes see Table 2 in Article **I**.

The average SOC among white-collar workers was 146.0 (SD 19.5) while blue-collar workers had an average SOC of 142.6 (SD 20.8). The difference was statistically significant ($p<0.001$). The proportion of white-collar workers increased with increasing SOC tertiles and accordingly the proportion of blue-collar workers decreased ($p<0.001$). See Table 1.

Smokers' average SOC score was 143.0 while non-smokers' SOC score was slightly higher, 143.7. The difference is non-significant. There were differences, however, when prevalences of smoking were compared among those with a strong SOC and those with a weak SOC. For example, those with a weak SOC were more often heavy smokers with a statistically significant margin than those with a strong SOC, see Table 1. Smoking did not depend on the SOC among blue-collar workers, but among white-collar workers the portion of smokers was the greatest among those who had a weak SOC.

Those who were *alcohol* drinkers had an average SOC of 142.7 (SD 20.3), lower than those who were non-drinkers (144.3, SD 20.9). Those who did not respond to the alcohol enquiry had the same average SOC as non-drinkers (SD 21.1). One is may not infer that their alcohol consumption was similar to that of non-drinkers, because those who did not answer had the highest all-cause mortality. Those with a weak SOC were more often heavy drinkers than those with a strong or moderate SOC. See Table 1.

There was no correlation between the SOC and *BMI*. Nor did the SOC correlate with the *lipid* level. The diastolic and systolic *blood pressure*s were not dependent on the SOC. See Table 2.

The Helsinki Heart Study was conducted as a double blind clinical trial and therefore there were 41% of participants on *gemfibrozil* in some phase of the follow-up. As gemfibrozil was found to decrease the incidence of CHD by 34% in the HHS (Frick et al. 1987) it was considered necessary to adjust for it, especially in case of CHD. When those on gemfibrozil were excluded, the RR for CHD increased among white-collar workers, but among blue-collar workers the RR for CHD decreased. See Table 3 in Article **I**.

Table 1. Prevalence of occupation, smoking and alcohol consumption by baseline SOC tertiles in a subgroup of Helsinki Heart Study screenees.

Risk factor	SOC		
	Weak	Moderate	Strong
Occupation			
N	1976	1920	1927
Blue-collar (%)	85.4	80.3	78.4
White-collar (%)	14.6	19.7	21.6
Pearson Chi-Square	$\chi^2(2)= 34.53$	$p < 0.001$	
Smoking			
N	1993	1929	1940
Non (%)	66.1	66.1	68.4
Light/Medium (%)	13.9	16.5	15.4
Heavy (%)	20.0	17.3	16.2
Pearson Chi-Square	$\chi^2(4)= 13.64$	$p = 0.01$	
Alcohol consumption			
N	1887	1821	1827
None (%)	8.2	7.1	9.4
Light (%)	39.5	41.5	42.0
Medium (%)	37.0	40.7	38.2
Heavy (%)	15.3	10.8	10.3
Pearson Chi-Square	$\chi^2(6) = 33.79$	$p < 0.01$	
Age			
N	1993	1929	1944
45–50 years (%)	31.9	29.8	32.2
51–55 years (%)	33.5	32.7	29.8
56– years (%)	34.6	37.6	38.0
Pearson Chi-Square	$\chi^2(4) = 10.47$	$p = 0.03$	

Table 2. Mean values of clinical variables by occupation and the SOC

Occupation	SOC	BMI (kg/m^2)	Tot Chol (mmol/l)	HDL Chol (mmol/l)	Diast BP (mmHg)	Syst BP (mmHg)
White-collar						
	Strong	25.8	6.81	1.24	90.2	138.8
	Moderate	26.1	6.71	1.24	90.2	138.5
	Weak	25.8	6.85	1.24	88.5	136.5
Blue-collar						
	Strong	26.3	6.90	1.24	90.6	140.7
	Moderate	26.3	6.90	1.25	89.9	139.2
	Weak	26.4	6.91	1.25	90.9	140.9

5.3 The sense of coherence and health hazards

In Table 3 the risks of CHD, cancer, injury, and all-cause mortality by SOC tertiles can be compared. The follow-up time was the same, 8 years for all risk estimates. By all outcome variables the risk was higher for those with a weak SOC than for those with a strong SOC, although not necessarily with significance. Only minor non-significant differences in CHD risk were seen between the SOC tertiles, while in the case of cancer there was a decreasing trend with increasing SOC (p = 0.06). The RR of cancer among those with a strong SOC was 30% lower than among those with weak a SOC (p = 0.06). In the case of injuries those with a moderate or a strong SOC had about 25% lower risk than those with a weak SOC (p for trend 0.04). A decreasing trend with increasing SOC was seen for all cause mortality, although this did not reach significance. Adjustment for age, alcohol, occupation or smoking did not materially change the pattern of risk for the outcome variables except in the case of injuries.

Table 3. Incidences per 1000 person-years and adjusted relative risks (RR) of coronary heart disease (CHD), all cancers, injuries and all-cause mortality with 95% confidence intervals (CI) by tertiles of the sense of coherence (SOC).

SOC	Incidence		Adjusted for age		P for trend	Adjusted for age, alcohol occupation and smoking	
	N	Rate	RR	95% CI		RR	95% CI
CHD							
Weak	159	14.4	1.00			1.00	
Moderate	170	15.7	1.09	(0.88–1.36)		1.10	(0.88–1.36)
Strong	170	14.0	0.97	(0.78–1.20)	0.73	0.97	(0.78–1.21)
Cancer							
Weak	64	5.6	1.00			1.00	
Moderate	51	4.5	0.80	(0.55–1.16)		0.81	(0.56–1.17)
Strong	51	4.0	0.70	(0.48–1.01)	0.06	0.70	(0.48–1.01)
Injury							
Weak	114	10.2	1.00			1.00	
Moderate	83	7.5	0.74	(0.56–0.98)*		0.75	(0.57–1.00)*
Strong	95	7.6	0.75	(0.57–0.99)*	0.04	0.77	(0.59–1.02)
All-cause mortality							
Weak	85	7.3	1.00			1.00	
Moderate	69	6.1	0.82	(0.60–1.13)		0.83	(0.60–1.14)
Strong	77	6.0	0.80	(0.59–1.09)	0.16	0.81	(0.59–1.11)

* P < 0.05

5.4   Joint effects of the sense of coherence and occupation on health risks

Considering the SOC jointly with occupational category as risk factors for different outcomes (CHD, cancer, injury, and all-cause mortality) revealed great differences in the effect of the SOC among white-collar workers compared with the blue-collar workers (see Table 4).

According to the hypothesis, blue-collar workers with a weak SOC should have had the poorest health and one would have anticipated that they would also have the highest incidence of CHD. However, this was not the case as can be seen in Table 4. White-collar workers with a weak SOC had a 56% higher RR of CHD than the reference group of blue-collar workers with a weak SOC, and there was no decreasing trend of CHD risk with increasing SOC among blue-collar workers (p for trend 0.52). In contrast, among white-collar workers those with a moderate and a strong SOC had significantly lower CHD risk than those with a weak SOC (p for trend 0.04). If the reference group were white collar workers with a weak SOC, then the RRs with 95% CI for those with moderate or strong SOC would be 0.54 (0.33–0.89) and 0.60 (0.38–0.96) respectively. This result persisted even when age, alcohol and smoking were adjusted for. Now the difference between the blue-collar workers with a weak SOC and the white-collar workers with a strong SOC is negligible (p = 0.73).

In the case of cancer the pattern was reversed: there was a clear trend (p = 0.04) of decreasing cancer risk with increasing SOC among blue-collar workers, but not among white-collar workers. Among blue-collar workers those with a strong SOC had a 35% lower risk than those with a weak SOC (p<0.05), but among white-collar workers hardly any difference could be seen.

Blue-collar workers with a weak SOC emerged as the group with the highest rate of injury. There was a significantly decreasing trend (p = 0.02) for injuries with increasing SOC among blue-collar workers resulting in a 30% lower age adjusted RR (p<0.05) of injuries among those with a strong SOC compared with those with a low SOC. No such trend was seen among white-collar workers.

In the case of all-cause mortality, those white-collar workers with a weak SOC had the highest risk of all groups considered, and a 54% (p = 0.02) higher RR than blue-collar workers with a weak SOC. Furthermore, there was a clear stepwise decreasing trend of risk (p = 0.02) with increasing SOC among white-collar workers, resulting in a 55% lower age-

adjusted RR among those with a strong SOC compared to those with a weak SOC. No such trend was seen among blue collar workers. Adjustment for age, alcohol and smoking slightly elevated the RRs.

Table 4. Incidence rate per 1000 person-years and joint effects of occupation and the sense of coherence (SOC) on risk of coronary heart disease (CHD), cancer, injury and all cause mortality with 95% confidence intervals (CI).

Occupation	SOC	Incidence		Adjusted for age		p for trend	Adjusted for age, alcohol and smoking	
		N	Rate	RR	95% CI		RR	95% CI
CHD								
Blue-collar	Weak	123	13.3	1.00			1.00	
	Moderate	144	17.1	1.29	(1.01–1.64)*		1.28	(1.01–1.64)*
	Strong	135	14.5	1.09	(0.85–1.39)	0.52	1.09	(0.85–1.39)
White-collar	Weak	36	20.1	1.56	(1.07–2.26)*		1.59	(1.10–2.31)*
	Moderate	26	10.9	0.84	(0.55–1.28)		0.86	(0.56–1.31)
	Strong	35	12.4	0.94	(0.64–1.36)	0.04	0.97	(0.66–1.41)
Cancer								
Blue-collar	Weak	57	5.9	1.00			1.00	
	Moderate	39	4.4	0.73	(0.48–1.10)		0.73	(0.49–1.10)
	Strong	39	4.0	0.65	(0.44–0.98)*	0.04	0.66	(0.44–0.99)*
White-collar	Weak	7	3.7	0.65	(0.30–1.42)		0.66	(0.30–1.44)
	Moderate	12	4.9	0.87	(0.46–1.61)		0.89	(0.47–1.65)
	Strong	12	4.1	0.69	(0.37–1.28)	0.96	0.65	(0.34–1.25)
Injury								
Blue-collar	Weak	100	10.7	1.00			1.00	
	Moderate	69	8.0	0.75	(0.55–1.02)		0.75	(0.55–1.02)
	Strong	71	7.4	0.70	(0.52–0.95)*	0.02	0.71	(0.52–0.97)*
White-collar	Weak	14	7.6	0.69	(0.40–1.21)		0.69	(0.39–1.20)
	Moderate	14	5.9	0.54	(0.31–0.94)*		0.54	(0.31–0.94)*
	Strong	24	8.3	0.77	(0.49–1.20)	0.70	0.76	(0.48–1.18)
All-cause mortality								
Blue-collar	Weak	66	6.8	1.00			1.00	
	Moderate	53	5.9	0.86	(0.60–1.24)		0.87	(0.61–1.25)
	Strong	63	6.4	0.92	(0.65–1.30)	0.65	0.95	(0.67–1.34)
White-collar	Weak	19	10.0	1.54	(0.92–2.57)		1.57	(0.94–2.62)
	Moderate	16	6.5	1.01	(0.58–1.74)		1.07	(0.62–1.84)
	Strong	14	4.7	0.69	(0.39–1.23)	0.02	0.69	(0.38–1.25)

* p<0.05

5.5   Joint effects of the sense of coherence and alcohol consumption on health risks

The joint effects of alcohol and the SOC on risk of CHD did not show any trend when alcohol was used as a dichotomised variable as was the case here. For cancer there was no significant difference in risk among the drinkers (p = 0.62), but among non-drinkers the trend was linear and significant, showing that cancer increases with decreasing SOC (p = 0.05).

Alcohol drinkers with a weak SOC had the highest risk of injuries, while non-drinkers with a strong SOC had the lowest RR 0.57 (95% CI 0.38–0.85, p = 0.006). The RRs among non-drinkers for those with a weak and moderate SOC were quite low, and of borderline significance. The rest of the RRs were in-between, with one other group reaching significance, namely alcohol drinkers with a moderate SOC. Adjusting for age, occupation and smoking did not change the risk for injury.

Alcohol had the most noticeable effect on mortality; all non-drinkers, irrespective of their SOC, had a significantly lower risk of death than drinkers with weak SOC. The higher the SOC, the better the RR in general, but the trend was not significant. Compared with the high risk group of drinkers with weak SOC those non-drinkers with strong SOC had a much lower RR = 0.47 (p = 0.001). See Table 5.

Table 5. Incidence rate per 1000 person-years and joint effects of alcohol and the sense of coherence (SOC) on risk of coronary heart disease (CHD), cancer, injury and all cause mortality with 95% confidence intervals (CI).

Alcohol[1]	SOC	Incidence		Adjusted for age		p for trend	Adjusted for age, occupation and smoking	
		N	Rate	RR	95% CI		RR	95% CI
CHD								
Drinker	Weak	82	14.5	1.00			1.00	
	Moderate	97	17.8	1.21	(0.90–1.62)		1.24	(0.92–1.66)
	Strong	73	12.8	0.87	(0.63–1.19)	0.41	0.89	(0.65–1.22)
Non-drinker	Weak	68	14.2	0.91	(0.66–1.25)		1.02	(0.73–1.41)
	Moderate	67	13.9	0.91	(0.66–1.26)		1.01	(0.73–1.40)
	Strong	85	14.8	0.96	(0.70–1.30)	0.75	1.06	(0.78–1.44)
Cancer								
Drinker	Weak	28	4.8	1.00			1.00	
	Moderate	27	4.7	0.94	(0.56–1.60)		0.97	(0.57–1.65)
	Strong	26	4.4	0.88	(0.51–1.50)	0.62	0.90	(0.52–1.53)
Non-drinker	Weak	32	6.4	1.15	(0.69–1.91)		1.29	(0.77–2.17)
	Moderate	22	4.4	0.81	(0.46–1.41)		0.89	(0.51–1.57)
	Strong	23	3.8	0.68	(0.39–1.19)	0.05	0.72	(0.41–1.27)
Injury								
Drinker	Weak	66	11.6	1.00			1.00	
	Moderate	41	7.3	0.64	(0.43–0.94)*		0.64	(0.43–0.95)*
	Strong	54	9.3	0.81	(0.57–1.17)	0.24	0.82	(0.57–1.18)
Non-drinker	Weak	38	7.7	0.70	(0.47–1.05)		0.68	(0.45–1.02)
	Moderate	38	7.8	0.70	(0.47–1.04)		0.69	(0.46–1.03)
	Strong	37	6.3	0.57	(0.38–0.85)**	0.35	0.55	(0.37–0.83)**
All-cause mortality								
Drinker	Weak	51	8.6	1.00			1.00	
	Moderate	35	6.1	0.67	(0.44–1.03)		0.70	(0.45–1.07)
	Strong	39	6.5	0.72	(0.48–1.10)	0.12	0.74	(0.49–1.12)
Non-drinker	Weak	30	5.9	0.58	(0.37–0.92)*		0.71	(0.45–1.12)
	Moderate	27	5.3	0.54	(0.34–0.87)*		0.63	(0.39–1.01)
	Strong	29	4.8	0.47	(0.30–0.74)**	0.40	0.53	(0.33–0.85)**

[1] Alcohol consumption per year: non-drinker < 250 cl, drinker ≥ 250 cl
* p<0.05, ** p<=0.01

5.6 Joint effects of the sense of coherence and smoking on risk to health

Smoking is a well-known risk factor for coronary heart disease. This can be seen clearly, because the SOC does not play much of a role in determining the risk. The risk levels for CHD of both groups, smokers and non-smokers, are significantly apart from each other, but the variation by SOC within the group is minimal.

The risk for cancer decreased with increasing SOC in regular steps, starting with smokers with a weak SOC to non-smokers with a strong SOC. The trend was clear without reaching significance, however. The joint effect on the risk was significant.

When evaluating the effect of the SOC jointly with smoking on the risk of injury, smokers and non-smokers seem to have similar patterns of risk. The low SOC tertiles have the greatest risk and the remaining tertiles somewhat lower non-significant risk.

Smoking has the most dramatic effect on all-cause mortality, more than on CHD. Adjusting for age, alcohol and occupation did not change the risk. The SOC had a non-significant weak effect on the trend that those with a strong/moderate SOC have a smaller risk of death than those with a weak SOC. See Table 6.

In the following figures incidences are presented visually in addition to Tables 4 to 6. A glance at Figure 3 reveals that the joint effects of occupation and the SOC are most obvious among blue-collar workers for injury and cancer while white-collar workers show the effect for all-cause mortality and CHD.

The joint effects of alcohol consumption and the SOC are most obvious among non-drinkers for cancer. Other combinations do not show any significant effects. See Figure 4.

Table 6. Incidence rate per 1000 person-years and joint effects of smoking and the sense of coherence (SOC) on risk of coronary heart disease (CHD), cancer, injury and all cause mortality with 95% confidence intervals (CI).

Smoking	SOC	Incidence N	Rate	Adjusted for age RR	95% CI	p for trend	Adjusted for age, alcohol and occupation RR	95% CI
CHD								
Smoker	Weak	68	18.4	1.00			1.00	
	Moderate	79	22.5	1.22	(0.88–1.69)		1.22	(0.88–1.68)
	Strong	68	18.0	0.96	(0.68–1.34)	0.88	0.95	(0.68–1.33)
Non-smoker	Weak	91	12.4	0.64	(0.47–0.88)**		0.64	(0.46–0.88)**
	Moderate	91	12.5	0.65	(0.47–0.89)**		0.64	(0.47–0.89)**
	Strong	102	12.2	0.63	(0.47–0.86)**	0.91	0.63	(0.46–0.86)**
Cancer								
Smoker	Weak	26	6.7	1.00			1.00	
	Moderate	22	5.9	0.86	(0.49–1.52)		0.87	(0.49–1.54)
	Strong	21	5.3	0.74	(0.42–1.32)	0.28	0.75	(0.42–1.34)
Non-smoker	Weak	38	5.0	0.67	(0.41–1.11)		0.68	(0.41–1.13)
	Moderate	29	3.8	0.51	(0.30–0.87)*		0.52	(0.31–0.90)*
	Strong	29	3.3	0.44	(0.26–0.75)**	0.09	0.45	(0.26–0.78)**
Injury								
Smoker	Weak	39	10.2	1.00			1.00	
	Moderate	29	7.9	0.79	(0.49–1.27)		0.81	(0.50–1.31)
	Strong	26	6.7	0.67	(0.41–1.10)	0.10	0.69	(0.42–1.14)
Non-smoker	Weak	75	10.2	1.05	(0.71–1.55)		1.12	(0.76–1.67)
	Moderate	54	7.3	0.75	(0.50–1.13)		0.81	(0.53–1.24)
	Strong	69	8.1	0.83	(0.56–1.23)	0.16	0.91	(0.61–1.36)
All-cause mortality								
Smoker	Weak	44	11.1	1.00			1.00	
	Moderate	28	7.4	0.65	(0.40–1.04)		0.67	(0.42–1.08)
	Strong	42	10.5	0.89	(0.58–1.36)	0.62	0.92	(0.60–1.41)
Non-smoker	Weak	41	5.3	0.43	(0.28–0.66)***		0.47	(0.30–0.72)***
	Moderate	41	5.4	0.43	(0.28–0.67)***		0.47	(0.30–0.72)***
	Strong	34	3.9	0.31	(0.20–0.48)***	0.15	0.33	(0.21–0.52)***

* p<0.05, ** p<=0.01, *** p<0.001
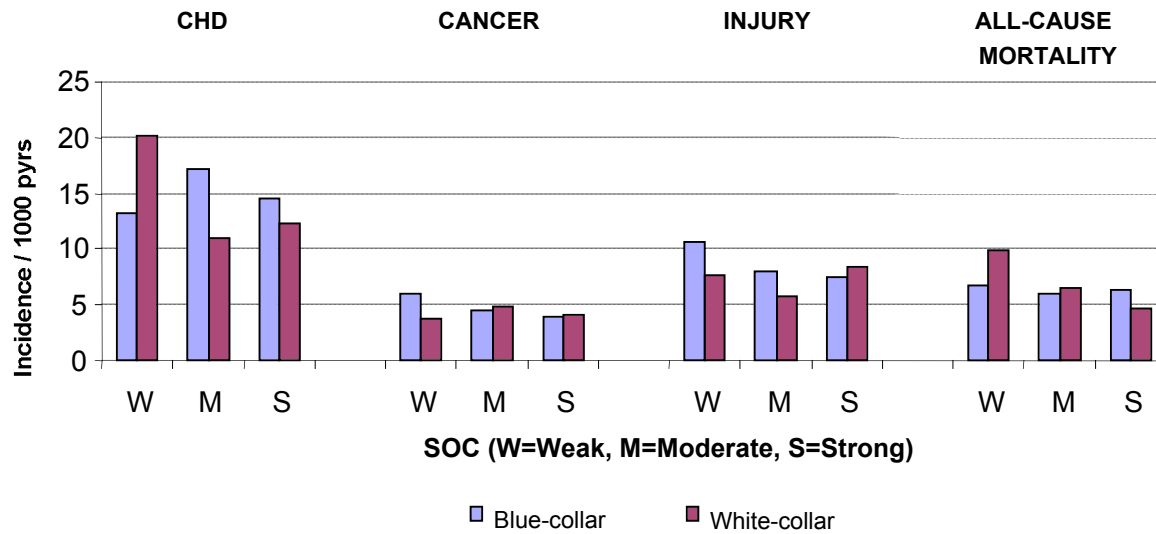
Figure 3. Incidences per 1000 person-years of CHD, cancer, injury and all-cause mortality by occupational group and the SOC.
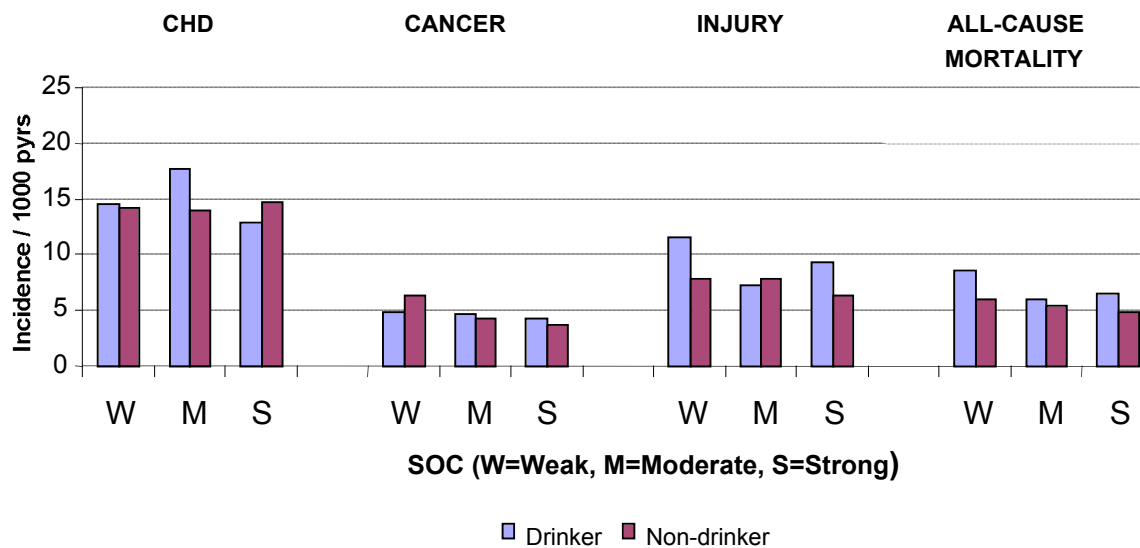

Figure 4. Incidences per 1000 person-years of CHD, cancer, injury and all-cause mortality by alcohol consumption and the SOC.

The joint effects of smoking and the SOC are mild; smoking alone accounts for most of the effect. There are no significant trends within the SOC, but the histogram bars for smokers are uniformly higher for all-cause mortality, CHD and cancer while injury does not show any difference between smokers and non-smokers. See Figure 5.
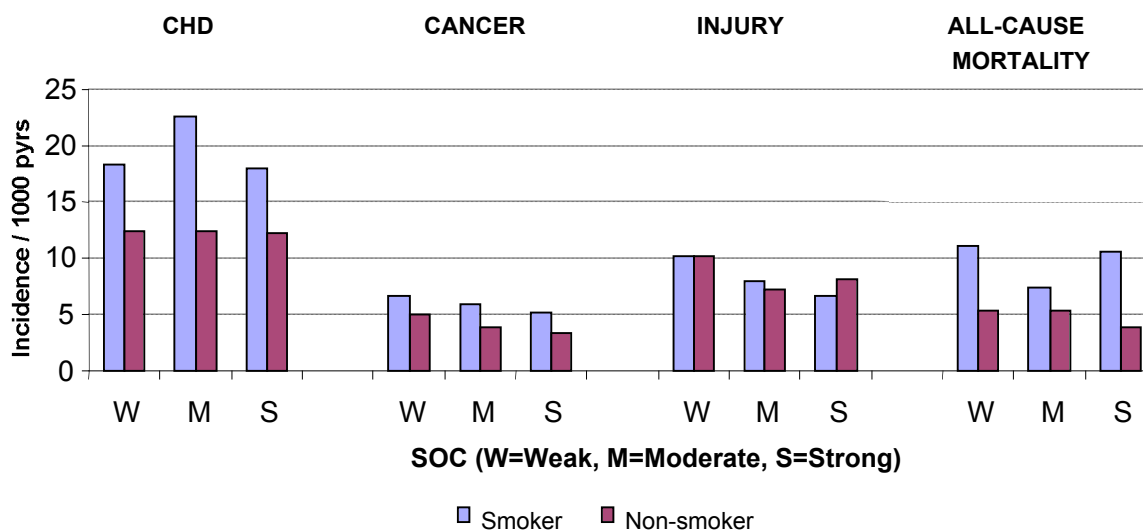
Figure 5. Incidences per 1000 person-years of CHD, cancer, injury and all-cause mortality by smoking status and the SOC.

6. DISCUSSION

6.1 Measuring the sense of coherence

The SOC score in this study was obtained from the original SOC-29 questionnaire. The Finnish version of the SOC-29 has not been validated separately, since the correlation of the SOC-29 with the SOC-13 has been very high and therefore the SOC-13 was preferably taken for research purposes and validation has been done on the shorter version. The latest validation study has proven the Finnish SOC-13 questionnaire to have relatively high structural validity and high stability (Feldt et al. 2007).

In this summary reference is made to an important study, the EPIC-Norfolk Study. In that study they used the SOC-3 questionnaire developed in Sweden (Lundberg and Nyström Peck 1995). Later it has received criticism that after publishing the SOC-3 no other study has provided test criteria. Schumann et al. (2003) assessed the reliability and validity of the SOC-3 by comparing it to the SOC-29. They found Cronbach alpha to be 0.45 for the SOC-3 while it was 0.91 for the SOC-29. The authors came to the conclusion that reliability and validity of the SOC-3 are so poor that they developed a new 3-item questionnaire they call the Brief Assessment of Sense of Coherence (BASOC). The assumption that the SOC-3 correlates with the SOC-29 was made, however, ignoring the criticism by Schumann et al. when comparing the results of the EPIC-Norfolk Study and the study by Lundberg (1997) to the results presented here. After all, the findings in the EPIC-Norfolk Study as well as the above mentioned Swedish study are in line with each other and this study, too, without major discrepancies in spite of poor internal validity measurements.

6.2 The sense of coherence as a predictor of health outcomes

6.2.1 Coronary heart disease

In general a weak SOC is more of a risk factor than a strong SOC is a health promoting factor. This can be seen in Figures 2 to 4, where the low SOC tertile usually shows the highest incidence. Occupation often modifies the SOC. Since there are more blue-collar workers in the study, the imbalance causes the overall results to reflect more blue-collar workers' findings than those of white-collar workers. It is important to bear this in mind when considering the applicability of the results.

Among white-collar workers high and moderate SOC scores were significantly protective against coronary heart disease. In practice the results in Table 4 showed lower significance for CHD than if the comparison had been made with extreme values that the baseline results showed. However, the reference group in Table 4 above was chosen according to the hypothesis. An alternative presentation of the results would have meant that if the white-collar weak SOC were the reference, the moderate SOC white-collar workers would have had RR 0.54 (95% CI 0.33–0.89) and the strong SOC white-collar workers would have had RR 0.60 (95% CI 0.38–0.96). Another group would still have been significant, namely blue-collar workers with a weak SOC, RR 0.64 (95% CI 0.44–0.93).

Although there are studies indicating that moderate alcohol use is beneficial to the cardiovascular system, the findings in this population were neutral concerning the joint effect of the SOC and alcohol on CHD. There are very few studies on the SOC and alcohol consumption. A Finnish study on the SOC and disability pensions analysed alcohol consumption as well (Suominen et al. 2005). Their finding was that non-drinkers had the highest average SOC but simultaneously the highest number of disability pensions granted. Although those having a strong SOC are supposed to be healthier than those with a weak SOC, it could be hypothesised that their abstinence could be due to the health problem behind the disability pension.

In the well-known Whitehall II Study the effects of alcohol consumption on CHD and all-cause mortality were observed in the late 1980's. The time span was about the same as in this summary and the study population was also civil servants. A U-shaped relationship was found between volume of alcohol consumed per week and outcome. Compared to

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those who drank moderately (10–80 g alcohol per week), non-drinkers and those drinking more than 248 g per week had approximately a twofold increased risk of mortality. The optimal frequency of drinking was between once or twice a week and daily, after adjustment for average volume consumed per week. Those drinking twice a day or more had an increased risk of mortality (male hazard ratio 2.44, 95% CI 1.31–4.52) compared to those drinking once or twice a week. Drinking only once a month or only on special occasions had a 50% increased risk of mortality. The usual amount consumed per drinking session was not indicative of increased health risk in this cohort. The authors concluded that epidemiological studies should collect information on frequency of drinking in addition to average volume consumed in order to provide sensible drinking advice (Britton and Marmot 2004). This is a good point, partly explaining the mild effects of alcohol in this study. Our classification of alcohol consumption was too insensitive to detect a frequent use of small amounts of alcohol. Besides, there were some other problems collecting the amount consumed, mostly due to the fact that the occupational health service collected the data. Therefore there were many non-responders causing bias. In case of injury especially, more detailed information on frequency of consumption of alcohol would have been essential to able to evaluate its health risk more accurately.

Smoking is a typical risk factor for CHD. A Finnish study (Qiao et al. 2000) found that adjusted ratios for 35-year all-cause mortality were 1.62 (95% CI 1.40–1.88) in current smokers and 1.13 (CI 0.93–1.36) in former smokers compared with non-smokers. The hazards ratios for 35-year coronary heart disease mortality were 1.63 (CI 1.24–2.13) and 1.39 (CI 1.00–1.94) respectively. A Danish population study (Schnohr et al. 2002) found that smoking caused an RR for CHD of 1.41 (95% CI 1.24–1.60). The risks in those two studies are of similar magnitude and significance. The difference between all-cause mortality and coronary mortality was small in the above-mentioned Finnish study, indicating that all-cause mortality is mainly due to CHD.

Smoking does not seem to play a part in failed coping strategies as alcohol does, but perhaps their simultaneous use is common. In this study the joint effect of the SOC and smoking are non-significant only in injuries. Non-smokers have a third less CHD than smokers. The SOC does not play a role in this effect. The risk of injury among non-smokers is the same irrespective of their SOC.

There was a small difference between the white and blue-collar workers concerning their BMI, systolic blood pressure, total cholesterol and smoking. All lifestyle indicators showing risk for CHD were less favourable for the blue collar group. Among white-collar SOC tertiles the low SOC group smoked more. It seemed that the level of systolic blood pressure and smoking were partly determined by occupation, while physical activity

depended more on the SOC. No other variable showed such notable variation between the SOC tertiles as physical activity. The differences in traditional risk factors for CHD between white and blue-collar workers in this study were even smaller than the differences found in the LiVicordia Study, where the only significant difference was systolic blood pressure (Kristenson et al. 2001).

The SOC moderated CHD incidence among white-collar workers. It appears that white-collar workers experience stress more and it shows. The white collar workers in the HHS were mainly supervisors caught in-between the interests of the workers and factory management, thus adding stress to daily life. A vast majority of blue-collar workers belonged to strong unions and therefore had fewer hassles at the workplace.

The EPIC-Norfolk Study reported by Surtees et al. (2003) showed that the association between a strong vs. a weak sense of coherence and cardiovascular mortality, after adjustment for age, prevalent disease, social class, and cigarette smoking history was RR 0.87 (96% CI 0.66–1.15) among males. The EPIC-Norfolk Study differs from the HHS in some ways. From the whole population the English study recruited 30,414 men and women aged 40–74 years at baseline. Therefore, the proportion of active male labour force was smaller than in the HHS. In addition, the HHS studied CHD morbidity contrary to mortality in the EPIC-Norfolk Study. The 5-year interval between baseline clinical screening and the measurement of the SOC in the HHS were also other dissimilarities between the two studies.

6.2.2 Cancer

The hypothesis was confirmed among blue-collar workers – those with a strong SOC had the fewest cancers. Among white-collar workers the cancer incidence was evenly spread between the strong and the weak SOC and those with a moderate SOC had the fewest cancers. Mediating effects among blue-collar workers could be sought in behavioural factors combined with occupational exposures.

The joint effect of the SOC and occupation on cancer according to the hypothesis was seen to reach significance only among blue-collar workers. This is line with observations that white-collar workers consume more alcohol and blue-collar workers have more occupational exposures. Behavioural and lifestyle factors mediate the effect.

The effects of the SOC on cancer mortality were reported in the EPIC-Norfolk Study (Surtees et al. 2003). The rate ratio after adjustment for age, prevalent disease, social class and cigarette smoking history for cancer was 1.0 for a weak SOC and 0.66 (95% CI

0.49–0.88) for a strong SOC. The difference of this result compared to the results in this summary concerning CHD, cancer and injuries is that the EPIC-Norfolk Study reported mortality. Most cancers can be treated. Treatment prolongs life often so much that the cause of death is other than cancer.

6.2.3 Injuries

In the findings on injuries there was a significant negative gradient of injury risk with increasing SOC among blue-collar workers but not among white-collar workers. Occupational injuries occur mainly among blue-collar workers, and workers with a high SOC have good social networks so that they can obtain instrumental support in their work, while workers with a low SOC may be more isolated. The occupational category may even entail other, lifestyle related behavioural factors. White-collar workers with a strong SOC were the only exception to having a high risk of injury. It can be assumed that the income of this group is higher with more opportunities to engage in activities in leisure time as well as for higher alcohol consumption.

The only joint effects of the SOC and alcohol of significance were those on injury and all-cause mortality. In the case of injury the level of effect was roughly similar among all subgroups besides the reference, alcohol drinker with a weak SOC. The strong SOC non-drinker had the fewest injuries showing that he did not abuse alcohol as a coping mechanism. Although white-collar workers with a strong SOC consumed just as much alcohol as others, it could be that the frequency and quantity were favourable to health.

Smoking does not seem to have a joint effect with the SOC on injuries. This would be expected, however, if there is a high correlation between the use of alcohol and tobacco. Perhaps the measurements of their use were too crude to reveal such simultaneous use.

The findings that, firstly, the effect of the SOC on injury risk was more reduced if adjusted for alcohol than for smoking or occupation, secondly, that the high risk was seen among those with a weak SOC if alcohol drinkers and low risk if non-drinkers, and thirdly that there was no trend in risk by the SOC among non-drinkers – all suggest that alcohol may be a key pathway between the SOC and risk of injury. This result was confirmed by a recent study (Neuner et al. 2006) and the association of alcohol and injury has also been confirmed (Gmel et al. 2006, Paljärvi et al. 2005).

6.2.4 All-cause mortality

There was a significant trend of increasing all-cause mortality with decreasing SOC among white-collar workers. Those with a strong and moderate SOC had lower all-cause mortality rates than those with a weak SOC. The effect of the SOC did not change when adjusted for confounders. Therefore, the SOC can be seen as an independent factor and occupation was a modifier of the effect of the SOC on all-cause mortality. Another reason for the finding could be that CHD is behind most of the mortality, since cancer incidence in this age group has not yet peaked; it is still on the rise.

In an American study blue-collar mortality was about two times higher than white-collar mortality (Armstrong et al. 2003), but the difference between mortality in this study was 1.79 per 100,000 person years for white-collar workers and 1.75 per 100,000 person-years for blue-collar workers. There are several reasons for this, not only are the white and blue-collar work and social conditions different, but there are more African Americans in blue-collar jobs than in white-collar jobs. Finnish society has fewer inequalities in health and the selection of this group of civil servants and some skilled labour from industry made it very homogenous. But even other Finnish studies have found blue-collar workers' rate ratio of mortality to be 1.53 compared to that of white-collar workers. Therefore, it could be the "healthy worker effect" and the secure employment by the government and government owned companies having an additional salutogenic effect on the health. According to the findings of a Finnish study (Lehto and Sutela 2004) elderly employees value the long-term security of their employment most.

The joint effects of the SOC and smoking and of the SOC and alcohol on all-cause mortality were significant. The effect did not vanish after adjusting for age, alcohol and occupation. Smoking and alcohol consumption are behavioural factors and the SOC modifies them.

Surtees et al. (2003) reported in their study that a strong sense of coherence was associated with a reduction in mortality from all causes for men (rate ratio = 0.73, 95% CI 0.61–0.87, adjusted for age, prevalent disease, social class, and cigarette smoking history). Their result shows more effect compared to the findings in the present study. The reason for this could be their higher average age and general population. There is a distinctive selection, "the healthy worker effect", as only men active in working life were included in the HHS.

6.3   Salutogenic or pathogenic?

Although Antonovsky's approach was salutogenic, it was often difficult to follow the salutogenic way of thinking and epidemiological tools were often found to be best suited for a pathological approach. The fact that the health status of a strong SOC person is not better than that of an intermediate SOC person (Lundberg 1996) raised the question whether the salutogenic theory applies to the positive health end of the 'ease–disease' continuum at all. It would be easier to ask why people with a weak SOC fall ill rather than adopt Antonovsky's original idea to ask why people with a strong SOC stay healthy.

This summary responds to Lundberg's discussion when he assumed that the above mentioned finding could have resulted from the effect of his simplified 3-item questionnaire. This study confirms Lundberg's result with a SOC-29 questionnaire. In this summary the RRs of the high and moderate SOC tertiles were usually similar compared to the RRs of the low SOC tertile (see Table 3).

6.4   The stability of the sense of coherence

According to Antonovsky, the SOC remains fairly stable throughout life, but in such a way that a strong SOC is easily maintained, but a weak SOC rather deteriorates. He had the individual with a strong SOC in mind when he stated that the SOC is stabilised at the age of 30. Writing about the person with a weak SOC he actually states:

> "I am suggesting that adulthood will show an increasing disparity in the strength of the SOC between those who embark on this period of life with a strong SOC and those with a moderate SOC, and even greater disparity between these and those with a weak SOC." (Antonovsky 1987, p 123).

The issue of the stability of the sense of coherence is important when analysing the follow-up periods. The assumption was that the SOC remained stable during follow-up. The SOC seemed to have improved with age at all SOC levels. If the view that a strong SOC improves and a weak SOC deteriorates were true, then the differences in the SOC levels should increase with increasing follow-up time, and differences in their effects should also steadily increase – in our case the effects on cancer incidence. Some increase

over follow-up time was seen, but only among those over 55 years of age. The question whether the age dependence of the SOC–cancer association is due to special features in the stability of the SOC remains open. See Article **II** for more details of the SOC–cancer association. As the SOC was measured only once, this cross sectional study does not add our knowledge about the development of the SOC on time axis.

Ignoring the criticism by Schumann et al. (2003) and assuming that the SOC-3 correlates to the SOC-29, I would like to recall about one aspect brought up by Antonovsky (1987), namely the issue of the rigid and inauthentic SOC. Antonovsky (1987, p. 27) explains the phenomenon:

> "The true believer, then, with a strong rather than rigid SOC, is not at all an automation. He or she is indeed committed to and guided by fundamental principles, fixed rules. But there can be considerable individual autonomy with regard to the strategies applied in a given environment. When the larger system – in our case, the church, the school of thought, the party – freezes in history, prohibiting such autonomy, disregarding feedback, then indeed the true believer's SOC will be rigid, or else the transformation will not be tolerated."

Antonovsky seems to refer to a political system, most likely communism, in that statement. He was very up-to-date, mentioning even fundamentalism later in his book (p. 106). By the phenomenon of a rigid SOC in the context of this summary and Finland I refer to individuals having earlier a strong SOC but who have failed to keep up with the rapid economic changes brought by globalisation, having had initially too much faith in their party, church or other ideology. This could be one factor levelling out the difference between the effect of the strong SOC and the moderate SOC. One can infer that rather than thinking of a strong SOC as being a health enhancing factor, in practice a weak SOC seems to be a risk factor because the weak SOC stands out alone more often from the rest of the SOC levels.

6.5   Limitations of the study material and the validity of the findings

6.5.1 Recruitment of the participants

The study participants were solely middle-aged males in employment recruited for a clinical study. Therefore the applicability of the study results is somewhat limited, while women, unemployed, farmers, entrepreneurs and other age-groups were excluded.

One explanation for our finding of no difference in all-cause mortality between blue and white-collar workers lies in the study design: the study population consisted of employees of reliable and stable employers with good occupational health services. The range of the white-collar jobs of those employers was rather limited – only office work and supervisory work not the well-known low mortality white-collar jobs like lawyers, clergy, teachers and medical doctors. This cohort represented stable employment and over represented subjects with high cholesterol values. It is doubtful that this selection affected the relative risks, as there was enough variation by occupation and the potential confounder cholesterol was not correlated with the sense of coherence (Article **I).** Smokers have a high risk of death (Doll and Peto 1981), and in this study, too, smokers had a significant 2.15 fold risk of death compared to non-smokers. The variation in mortality by the SOC could not be accounted for by alcohol consumption or by smoking. There was a gradient with alcohol consumption in total mortality, which was expected (Mäkelä et al. 1997, Mäkelä 1999), but non-significant.

6.5.2 *Measurement of the covariates*

There was a time gap of five years after the clinical screenings and the collection of the psychosocial data. The study was cross-sectional for the psychosocial data. Alcohol consumption measurement constituted a problem, since the participants were reluctant to respond at their occupational health clinics. This was resolved by sending the responses direct to the HHS office. However, this resulted in 238 fewer answers than the total number of responses for other confounders. Hence those answers were analysed separately. Heavy drinkers may have omitted this section, likewise those who felt that it invaded their privacy. This hypothesis is supported by the fact that the highest crude mortality was among those who did not respond to the questions about alcohol consumption. The mean SOC of this non-responder group was above average, thus showing an attempt to control if not the amount of alcohol they use, at least the information given to others about their consumption. Alcohol consumption was often analysed as a dichotomous variable. As the occasionally heavy drinking group could not be identified, that group was embedded in the group of "alcohol drinkers" and the injury risk was attenuated accordingly. Consequently the risk pattern of the joint effect was probably also attenuated.

Age was taken as a covariate in three of the studies. In Article **II** on cancer the effect of age was studied. The salutogenic effect of the SOC may vary in different age groups. As only one study took this topic for closer scrutiny, it could not be included in this summary. The topic remains for future research.

6.5.3 Linkage to registers

The Finnish Registers are well known for the accuracy of the diagnoses of cardiovascular origin in Article **I** (Joensuu and Näyhä 1992, Pietilä et al. 1997) and for cancer in Article **II** (Teppo et al. 1994). In Article **III** the national hospital discharge register and the cause of death statistics were used, meaning that virtually all severe traumas and injuries were recorded and analysed excluding minor injuries treated in outpatient clinics. Detailed information as to whether the injury was work-related or occurred during leisure time was not available. Linking has been shown to be reliable (Mähönen et al. 2000).

7. CONCLUSIONS

Our findings support earlier reports that a strong SOC promotes health.

A strong SOC individual in a white-collar environment has approximately half the risk of CHD compared to a weak SOC individual. A new finding is that in a blue-collar working environment the risk of CHD does not comply with the theory of SOC.

The incidence of cancer was lower in individuals with a strong SOC than in those with a weak SOC. Those with a strong SOC had the fewest cancers among blue-collar workers. Among white-collar workers the cancer incidence was evenly spread between the strong and the weak SOC and those with a moderate SOC had the fewest cancers.

Expressed in the salutogenic way: among blue-collar workers the health promoting qualities of a strong SOC in the risk of injury were confirmed. A lack of salutogenic effect on injuries (as measured by the SOC) among white-collar workers and among non-drinkers of alcohol was observed. To express the result the pathogenic way: a weak SOC combined with alcohol consumption and blue-collar occupation is a significant risk factor for injuries.

Higher overall mortality was found among those with a weak SOC than among those with a strong SOC, but further analysis revealed that this was only among white-collar workers. Those with a weak SOC had more than double all-cause mortality than those with a strong SOC.

8. SUMMARY

The hypotheses were tested that people with a strong sense of coherence (SOC) have decreased incidence of coronary heart disease, cancer and injuries and decreased all-cause mortality.

The original 29-item version of the "Orientation to Life" questionnaire designed and validated by Antonovsky (1993) was used (see Appendix).

Participants in the Helsinki Heart Study (4,405 Finnish middle-aged employed men) were followed up for coronary heart disease, cancer, injuries and all-cause mortality for eight years.

Clinical findings such as total cholesterol, systolic and diastolic blood pressure and body-mass index had been measured earlier. Lifestyle factors such as smoking, alcohol consumption and leisure time physical activity were also recorded. Occupation was obtained from Statistics Finland according to the code for occupation in the 1980 Finnish version of the Nordic Classification of Occupations.

The relative risks (RR) of coronary heart disease, cancer, injuries and death were estimated using Cox's regression models. The analyses were performed using the statistical packages Egret for Windows and SPSS 12.0.1 for Windows. The differences of mean SOC values in groups by other risk factors for injuries were tested using ANOVA and the t-test, while the significance of differences in percentage levels was assessed using the Chi square test.

In white-collar work environment the low SOC tertile had a high CHD incidence of 20.1 per 1000 person-years as the respective incidences in the moderate and high SOC tertiles were 10.9 and 12.3. No similar effect was seen in blue-collar work environment. Contrary to theoretical expectations, the low SOC tertile had the lowest incidence of CHD. The difference in the CHD incidence pattern depended on the blue and white-collar grouping. The civil servants showed a similar incidence pattern to that in the manufacturing industry.

For all cancers combined in the follow-up, those with a weak SOC had a higher RR of cancer 1.52 (95% CI: 1.12–2.06). The greatest risk was seen in a subcohort consisting of those aged $\geq$55 years at baseline: the RR of those with a weak SOC compared with those with a strong SOC was 1.65 (1.12–2.43). A strong SOC seemed to delay the onset of cancer more clearly among men over 55 years of age

The SOC was inversely associated with risk of injuries, with a significant 25% lower incidence in the highest tertile of the SOC (7.6 per 1000 person-years) compared with the lowest tertile (10.2 per 1000 person-years). The association remained significant if adjusted for age or occupation, but not if adjusted for alcohol consumption. Alcohol drinkers with a weak SOC emerged as a high risk group with an incidence of 11.7 per 1000 person years, while all other combinations showed a 24–45% lower risk. When considered jointly with occupational category, the injury risk showed a decreasing trend (p = 0.02) with increasing SOC among blue-collar but not among white-collar workers. There was an effect of the SOC on the incidence of injury especially among blue-collar workers. A substantial part of the effect was mediated by alcohol consumption.

Using Cox proportional hazards models the crude relative risk for all-cause mortality for the low SOC tertile when compared to the high SOC tertile was 1.23 (95% CI: 0.90–1.68). Adjusting for age, smoking, alcohol and occupation increased the risk slightly to 1.35. Occupation was an effect modifier, since among white-collar workers the corresponding relative risk of the low SOC tertile was 2.27 (95% CI: 1.12–4.59, p = 0.02) and among blue-collar workers the relative risk for all-cause mortality was stable (1.33–1.52) in each SOC tertile. The classic risk factors, smoking and alcohol, showed higher relative risks than the SOC. The effect of the health-promoting qualities of the SOC upon all-cause mortality was significant among white-collar workers, but not among blue-collar workers.

To summarise the effects of the SOC, it can be concluded that they vary with age, illness and occupation. A strong SOC protects against CHD, but in a white-collar environment only. Among blue-collar workers those with a strong SOC had the fewest cancers. In general the trend is clearly in line with the health promoting qualities of the SOC, but significant in only two out of four studies. The effect of the SOC is objectively measurable. In analysing subgroups the effect varied from negative effect to 2.28-fold risk of all-cause mortality for those white-collar workers with a weak SOC compared with those with a strong SOC. The risk for CHD of the same group was only 1.67-fold, so it does not explain fully the high white-collar mortality (white-collar 1.00 and blue-collar 0.89). Could it be that stress management plays a more important role for white-collar workers and the SOC is part of this coping mechanism? Alcohol consumption is also an important risk factor for mortality as well as for injury, but data on alcohol consumption is not presented for comparison between white and blue-collar workers.

9.   ACKNOWLEDGEMENTS

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11. APPENDIX

Orientation to Life Questionnaire

Here is a series of questions relating to various aspects of our lives. Each question has seven possible answers. Please mark the number which expresses your answer, with number 1 to 7 being the extreme answers. If the words under 1 are right for you, circle 1; if the words under 7 are right for you, circle 7. If you feel differently, circle the number which best expresses your feeling. Please give only one answer to each question.

1. When you talk to people, do you have the feeling that they don't understand you?

    1   2   3   4   5   6   7

    never have this feeling   always have this feeling

2. In the past, when you had to do something which depended upon cooperation with others, did you the feeling that it:

    1   2   3   4   5   6   7

    surely wouldn't get done   surely would get done

3. Think of people with whom you come into contact daily, aside from the ones to whom you feel closest. How well do you know most of them?

    1   2   3   4   5   6   7

    you feel that they are strangers   you know them very well

4. Do you have the feeling that you don't really care about what goes around you?

    1   2   3   4   5   6   7

    very seldom or never   very often

5. Has it happened in the past that you were surprised by the behavior of people whom you thought you knew well?

    1   2   3   4   5   6   7

    never happened   always happened

6. Has it happened that people whom you counted on disappointed you?

    1   2   3   4   5   6   7

    never happened   always happened

7. Life is:

    1   2   3   4   5   6   7

    full of interest   completely routine

8. Until now your life has had:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

no clear goals or purpose at all   very clear goals and purpose

9. Do you have the feeling that you're being treated unfairly?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

very often   very seldom or never

10. In the past ten years your life has been:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

full of changes without your   completely consistent
knowing what will happen next   and clear

11. Most of the things you do in the future will probably be:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

completely fascinating   deadly boring

12. Do you have the feeling that you are in an unfamiliar situation and don't know what to do?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

very often   very seldom or never

13. What best describes how you see life:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

one can always find a solution   there is no solution
to painful things in life   to painful things in life

14. When you think about your life, you very often:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

feel how good   ask yourself why
it is to be alive   you exist at all

15. When you face a difficult problem, the choice of a solution is:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

always confusing and hard to find   always completely clear

16. Doing the things you do everyday is:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

a source of deep pleasure   a source of pain
and satisfaction   and boredom

17. Your life in the future will probably be:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

full of changes without your   completely consistent
knowing what will happen next   and clear

18. When something unpleasant happened in the past your tendency was:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

"to eat yourself up"   to say "ok, that's that, I
about it   have to live with it" and go on

19. Do you have very mixed up feelings and ideas?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

very often   very seldom or never

20. When you do something that gives you a good feeling:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

it's certain that you'll   it's certain that something
go on feeling good   will happen to spoil the feeling

21. Does it happen that you have feelings inside you would rather not feel?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

very often   very seldom or never

22. Do you anticipate that your personal life in the future will be:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

totally without meaning   full of meaning
and purpose   and purpose

23. Do you think that there will *always* be people whom you'll be able to count on in the future?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

you're certain there will be   you doubt there will be

24. Does it happen that you have the feeling that you don't know exactly what's about to happen?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

very often   very seldom or never

25. Many people – even those with a strong character – sometimes feel like sad sacks (losers) in certain situations. How often have you felt this way in the past?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

never   very often

26. When something happened, have you generally found that:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

you overestimated or   you saw things in the

underestimated its importance   right proportion

27. When you think of difficulties you are likely to face in important aspects of your life, do you have the feeling that:

1	2	3	4	5	6	7

you will always succeed in   you won't succeed in over-
overcoming the difficulties   coming the difficulties

28. How often do you have the feeling that there's little meaning in the things you do in your daily life?

1	2	3	4	5	6	7

very often   very seldom or never

29. How often do you have feelings that you're not sure you can keep under control?

1	2	3	4	5	6	7

very often   very seldom or never

12. ORIGINAL PUBLICATIONS

The sense of coherence, occupation and the risk of coronary heart disease in the Helsinki Heart Study

Esko Poppius [a,*], Leena Tenkanen [a,b], Raija Kalimo [c], Pertti Heinsalmi [a]

[a]*Helsinki Heart Study, Kalliolinnantie 4, FIN-00140, Helsinki, Finland*
[b]*School of Public Health, University of Tampere, Tampere, Finland*
[c]*Finnish Institute of Occupational Health, Helsinki, Finland*

Abstract

The risk of coronary heart disease (CHD) was studied in 4405 Finnish middle-aged working men in different occupations according to their sense of coherence (SOC). The study design was prospective and the follow-up time was eight years. Clinical findings such as total cholesterol, systolic blood pressure and body-mass index showed differences when comparing blue and white collar workers. Lifestyle factors such as smoking also differed, but leisure time physical activity depended on SOC. In the white collar work environment the low SOC tertile had a high CHD incidence of 20.1 per 1000 person-years; the incidences in the medium and high SOC tertiles were 10.9 and 12.3, respectively. A similar effect was not observed in the blue collar work environment. There, contrary to theoretical expectations, the low SOC tertile had the lowest incidence of CHD. The difference in the CHD incidence pattern depended on the blue and white collar dichotomy and not on the branch (state agencies vs. industry). The SOC had a salutogenic effect among white collar workers, but failed to have any consequent effect on the health of blue collar workers. Further study is needed to look at the psychosocial factors among blue collar workers. © 1999 Elsevier Science Ltd. All rights reserved.

Keywords: Sense of coherence; Coronary heart disease; Occupation; White and blue collar workers; Finland

Introduction

The sense of coherence

An unconventional type of approach to the origins of illness has been proposed by Antonovsky (Antonovsky, 1979, 1987). He calls it a salutogenic approach and it focuses on factors keeping an individual healthy rather than on factors making him ill.

Antonovsky formulated his ideas after making observations of holocaust survivors and wondering how it was possible to live a normal life and keep one's sanity after such life experiences. Antonovsky came to the concept of the 'sense of coherence' (SOC). It has been described as a global orientation that expresses the extent to which one has a pervasive, enduring though dynamic feeling of confidence that (1) the stimuli, deriving from one's internal and external environments in the course of living are structured, predictable and explicable, (2) the resources are available to one to meet the demands posed by these stimuli, and (3) these demands are challenges, worthy of investment and engagement (Antonovsky, 1987, p. 19). These are the

* Corresponding author. Tel.: +358-9-8184837/+358-40-5458933; fax: +358-9-8184824

E-mail address: esko.poppius@finnair.fi (E. Poppius)

three components in the SOC construct, namely comprehensibility, manageability and meaningfulness. The first of the three components, comprehensibility, reflects typically solid capacity to judge reality. A person high on the SOC sees his or her future as predictable, things will work out as well as can reasonably be expected and in case of surprises like failures, death or unemployment, such a person can make sense of them. A person low on the SOC will have contrary feelings, sometimes with a touch of paranoia, thinking that he or she is a loser. The second component, manageability, refers to the extent to which one perceives that resources are at one's disposal which are adequate to meet the demands posed by the many stimuli in life. One is confident of one's own resources and one can trust others. A person high on the SOC will not feel victimised by events or feel unfairly treated by life. If unpleasant things happen in life, one will be able to cope and not grieve endlessly. The third component, meaningfulness, represents the motivational element in the construct. It refers to the extent to which one feels that life makes sense emotionally. One sees that the problems and demands posed by living are worth investing energy in, are worthy of commitment and engagement, are challenges that are welcome rather than burdens that one would much rather be without. When unhappy experiences are imposed on such a person he or she will willingly take up the challenge, will be determined to seek meaning in it, and will do his or her best to overcome it with dignity.

Although theoretically the three dimensions are well founded, in practice they present a rather unidimensional variable. Antonovsky (1987) wrote: "The reader is duly warned, then, that the present version of the SOC scale is not wisely used to study component interrelations". Later, Antonovsky (1993) still repeated his plea not to separate the components by writing "as the evidence indicates, this is impermissible on technical grounds".

The SOC measures outlook on life. According to Antonovsky persons high on the SOC are more likely to stay more often healthy than individuals low on the SOC. The SOC is presented as an independent factor influencing health and mediating factors are not hypothesised. Factors influencing SOC are, however, identified as stressors, adaptation and coping. But as Antonovsky's outlook is salutogenic, the stressors are not always the negative stressors, but positive like eustressors, activation responses or potentiation. Salutogenic orientation means that instead of the dichotomy healthy/sick one should look at an individual on a multidimensional ease/disease continuum. One should also take a holistic approach to a human being instead of concentrating on the aetiology of a given disease. Furthermore, instead of focusing on stressors one should focus on coping resources, ask what factors were involved in maintaining or improving one's location on the ease/disease continuum instead of asking what caused it. In contradistinction to the search for magic-bullet solutions, one should search for all sources of negative entropy that may facilitate active adaptation of the organism to the environment. Summing up: thinking salutogenically not only opens the way for, but compels one to devote one's energies to, the formulation and advance of a theory of coping (Antonovsky, 1987).

There are concepts similar to SOC like Kobasa's hardiness (Kobasa, 1979), Boyce's sense of permanence (Boyce et al., 1985), Moos's family environment scale (Moos, 1984) and Reiss's family's construction of reality (Reiss, 1981). All these concepts have in common the assumption that the outlook on one's life and environment is a decisive factor in coping and health outcome. Naturally other factors and illnesses influence the SOC. For example, one cannot expect a person who suffers from depression to have a high SOC.

Antonovsky developed his theory during the 1970's (1979), but the actual widespread use of the SOC concept came with the use of the 'Orientation to Life Questionnaire' (Antonovsky, 1983) which is a 29-item questionnaire with a seven-point semantic differential scale to respond between a definitive yes, don't know or definitive no.

Occupational and social aspects of SOC

Antonovsky (1987) stresses the important role of high social class promoting a strong SOC. Other studies support the suggestion (Geyer, 1997; Lundberg, 1997). There are not many studies on the difference of SOC between occupations, since most published studies have been made on homogenous groups like students (Smith and Meyers, 1997), social workers (Gilbar, 1998), health care personnel (Lewis et al., 1994), patients (Santavirta et al., 1996) and the deprived (Nyamathi, 1991). In a review of all so far published SOC studies (Antonovsky, 1993), however, some occupational groups can be found like factory supervisors, production workers and faculty members and their SOC scores are compared.

According to a Swedish study (Larsson and Kjellberg, 1996) men had significantly higher average mean SOC than women. Occupation was significantly related to SOC as well as income and the number of friends. The only non-significant socio-economic variable was education. The correlation between self-reported health status and SOC was very high, as expected. In a regression analysis SOC had the highest relative importance of the independent variables. Age was a consolidating factor, participants aged 50 and over reported stronger SOC than those between 30 and 49 years of age. The authors recommend further stu-

dies with a prospective design including chronic illnesses, biological markers and other assessments of health-related behaviours.

The stability of SOC

Some criticism has appeared in journals regarding certain shortcomings in the SOC construct. For example, Geyer (1997) points out that "little empirical evidence concerning the stability of SOC is available, well-educated and privileged people have anyway more opportunities for decision-making and that high negative correlations between SOC and depression/anxiety suggest that the instruments used may assess the same phenomenon, but with inverse signs". Lundberg (1997) questions the widespread belief that Antonovsky himself would have said SOC is stable — on the contrary. In his study SOC becomes weaker with age, contrary to the previously mentioned Swedish study (Larsson and Kjellberg, 1996). Antonovsky (1987, pp. 120–123) has suggested that those with a strong SOC will at best be able to maintain this strong SOC, whereas others are most likely to experience decreasing levels of SOC throughout life. One critic of the construct found evidence that the sense of coherence (short-form) measure is plagued with emotionality (Korotkov, 1993).

There is a study on short-term stability of SOC measuring it prior to, during and after a stressful situation (McSherry and Holm, 1994). The study supports Antonovsky's concept. Low SOC subjects reported significantly more stress, anxiety and anger throughout the experiment than did either moderate or high SOC subjects. Low SOC subjects were also significantly less likely than high SOC subjects to believe they possessed the personal resources necessary to cope with the situation. Furthermore, low SOC subjects showed no physiological changes within the anticipation phase, whereas high SOC subjects showed decreases in pulse rate during the last minute of anticipation. Antonovsky's hypothesis to explain this phenomenon is that before taking action the strong SOC individual will have mobilised resources to confront the stressor, whereas the weak SOC person will have been more likely simply to have given up at the outset (Antonovsky, 1987).

SOC and coronary heart disease

The number of studies on this topic is very limited, although in Western affluent societies coronary heart disease is the leading cause of death and morbidity among middle-aged males. If high and intermediate SOC scores really have a general salutogenic effect, a lower incidence of CHD could be anticipated among those with high SOC compared to those with a low SOC. In a study on patients with CHD who survived cardiac arrest, SOC was measured to predict quality of life (Motzer and Stewart, 1996). The hypothesis was that physical and emotional consequences of a chronic illness, such as CHD, coupled with an acute event, like surviving a cardiac arrest, would influence quality of life negatively through the degree of instability of the chronic illness trajectory as well as through the amount of work required to manage and shape the trajectory. Furthermore, the cardiac arrest survivors with a strong SOC would be more satisfied with their quality of life than those survivors with a moderate or weak SOC. The measurements used were the 15-item Flanagan Quality of Life Scale (Flanagan, 1982), social status, the 24-item Burckhardt Perceived Support Score (Burckhardt, 1985), the 5-item Duke Health Profile Self-Esteem Scale (Parkerson et al., 1990) and other personal information about treatments and symptoms, even the NYHA Functional Class. The SOC questionnaire was the 13-item version. The authors had a 6-step regression model adding first data on social status, then social support, self-esteem, symptoms, etc. In the last step the SOC score was added. The response rate of the study was 58%. In the findings the explained variance in quality of life measured by the Flanagan Quality of Life Scale (QOL) prior to the entry of SOC into the model was 50% and the independent contribution of SOC improved the variance by 15%. There was a high correlation ($r = 0.73$) between the QOL and SOC, so there seems to be an overlapping of these concepts. The study supported the hypothesis that persons with high SOC had higher quality of life than persons with low SOC. In another study (Kravetz et al., 1993) SOC and Kobasa's hardiness construct were tested on 164 males in rehabilitation due to CHD. The aim of the study was to compare the two constructs and no clinical data was given or explored. No longitudinal studies are available about SOC and the risk of CHD. A Swedish study (Larsson and Setterlind, 1990) had 217 male wood company supervisors who were all clinically examined (blood pressure, cholesterol, triglycerides, glucose, BMI) and they filled out questionnaires about their smoking habits and even the sense of coherence questionnaire, but unfortunately it was modified to a 19-item 'self-image' questionnaire. Because it is neither the 13 nor the 29-item version, we cannot compare the results here.

The aim of the study

Our aim was to explore the predictive value of the salutogenic resource factor SOC in coronary heart disease and to study whether this predictive value differed across occupational groups. The aim moreover was to find out whether the classical risk factors for CHD would mediate the association between low SOC and CHD.
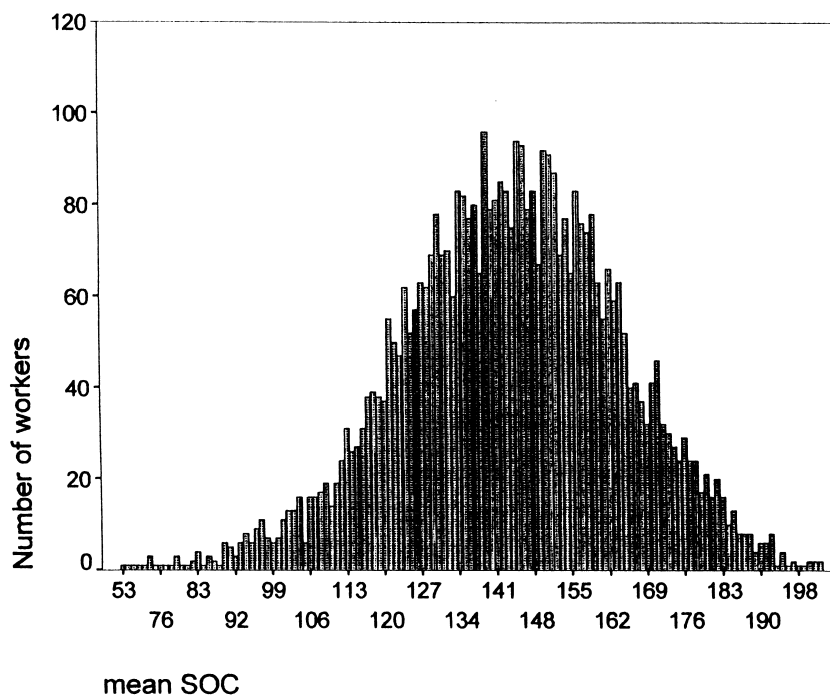
Fig. 1. The distribution of mean SOC among all subjects.

Materials and methods

Subjects and their follow-up

The Helsinki Heart Study was a placebo controlled, double blind primary prevention trial to test whether pharmacological modulation of serum lipid levels by giving gemfibrozil 600 mg twice daily against placebo would prevent coronary heart disease (Frick et al., 1987; Manninen et al., 1988). The participants for the study were employees aged 40–55 recruited from the Finnish Posts and Telecommunications, Finnish State Railways and five industrial companies. All the male employees ($N = 23531$) were invited for screening tests for cholesterol. The first screening was attended by 18,966 men in the years 1981–1982 and those with non-HDL cholesterol $> = 5.2$ mmol/l were able to take part in a second screening within one to three months. After exclusions 4081 participants were chosen for the pharmacological trial. Volunteers were eligible for the trial if they met the lipid criterion at both screenings and if they had no evidence of coronary heart disease or any other major illness. Along with the primary prevention trial a secondary prevention trial was performed among subjects from the second screening that fulfilled the lipid criterion, but not the criterion of being without evidence of CHD or any other major illness (Frick et al., 1993). At the end of the double blind trial 1986–1987 a psychosocial ques-

tionnaire was sent to participants of both the trials, but also to a control group of 2432 subjects chosen from among those first screening participants who did not fulfil the lipid criterion and also to all those 1164 participants who failed to fulfil that criterion at the second screening. A total of 5885 males responded with an overall response rate of 73%. After excluding those who had been pensioned during the drug trial, a total of 4405 participants remained for analysis. All those who are subjects in this study were active in working life at the time of the measurement of the psychosocial factors.

After the double blind trial phase the treatment group was revealed to the participants and they could choose whether they would continue or start with the medication or not. In both treatment groups about 68% chose to continue on medication. In the present study, where normolipidaemic control groups were also included, 41% of the participants were on gemfibrozil during the follow-up time.

The study cohort was followed up from the time of completing the psychosocial questionnaire 1986–1987 to the end of 1995 with a mean follow-up time of eight years. The CHD events were obtained by linking the hospital discharge diagnosis from the National Hospital Registry or the diagnosis from the Cause of Death Registry kept by Statistics Finland to the material. The first event was considered as the end point in the follow-up. The diagnosis used was in non-fatal

Table 1
Pearson's correlation between SOC and classical risk factors of CHD

Variable	Pearson's correlation to SOC
Age	0.017
BMI	−0.017
Total cholesterol	−0.020
HDL cholesterol	−0.014
Diastolic BP	−0.005
Systolic BP	0.016
Leisure time physical activity	0.087
Smoking	−0.017

cases ICD9 410 and in fatal cases ICD9 410–414. All causes of death were recorded in order to calculate follow-up times.

The SOC construct

In order to study the interrelations of the three components — comprehensibility, manageability and meaningfulness — we performed a factor analysis, although this procedure is not recommended as already mentioned above. In the analysis of the 29 items of the questionnaire the Eigenvalues of the first factors were 8.8, 1.7, 1.4, 1.1 and 1.0, respectively. The first factor was thus fairly dominant explaining 30% of the total variance, while all five together explained only 48%. When reliability was calculated from the 29 questions, Cronbach's alpha was 0.91 ($N = 5823$). The alpha remained the same when the pensioned persons were left out (alpha = 0.91, $N = 4405$). To explain the difference between the blue and white collar workers we checked, if these two groups had answered any differ-

ently, but the alphas were identical (white collar alpha = 0.9129, $N = 918$ and blue collar alpha = 0.9123, $N = 3487$). Therefore, for the reasons mentioned here, we used the SOC calculated from all 29 items and did not use or analyse the components. The distribution of mean SOC (143.5, $N = 4405$) was close to normal as can be seen in Fig. 1. The SOC had no correlation to other variables as can be seen in Table 1.

Occupation

The code for occupation was taken from the 1980 Finnish version of the Nordic Classification of Occupations. It was obtained from the census of 1980 by record linkage at Statistics Finland. There are ten major occupational classes. We consider classes 0, 1 and 2 white collar work and classes from 3 to 9 blue collar work. Table 2 shows the distribution of major occupational classes in our study population. We used the dichotomisation by branch (state agencies/industry) in addition to the white/blue collar categorisation as the distribution of occupations was not in balance due to the large number of transport workers among civil servants.

Life-style factors, blood pressure and serum lipids

All the background factors used in the present study were recorded at the first screening visit in the years 1981–1982.

In interview smoking habits were recorded on a 7-point scale, taking into account the number of cigarettes smoked and the time at which the respondent had given up smoking. In the present study a dichoto-

Table 2
Work description of major occupational groups among civil servants and industry, number of subjects in each group, the division between white and blue collar work according to occupational codes and mean SOC and standard deviation

| Occupational code	Work description	Industry N	Civil servants N	Total N	Mean SOC	SD
White collar						
000–008	engineers	63	58	121	148.3	19.5
010–019	technicians	221	237	458	144.3	19.2
020–028	chemical research and lab work	13	6	19	141.6	16.0
040–119	administrative work	101	81	182	150.0	19.1
130–239	office and sales work	56	78	134	144.9	21.0
Blue collar						
300–340	forestry and agriculture	85	32	117	146.8	18.0
500–599	transport work	53	1727	1780	143.6	20.7
600–669	metal and electrical work	220	511	731	141.5	19.9
670–790	wood, paper and pulp work	613	167	780	140.9	21.9
800–830	service work	35	14	49	147.0	21.3
900–999	not classified work	9	16	25	144.2	25.5
total		1469	2927	4396	143.5	20.6
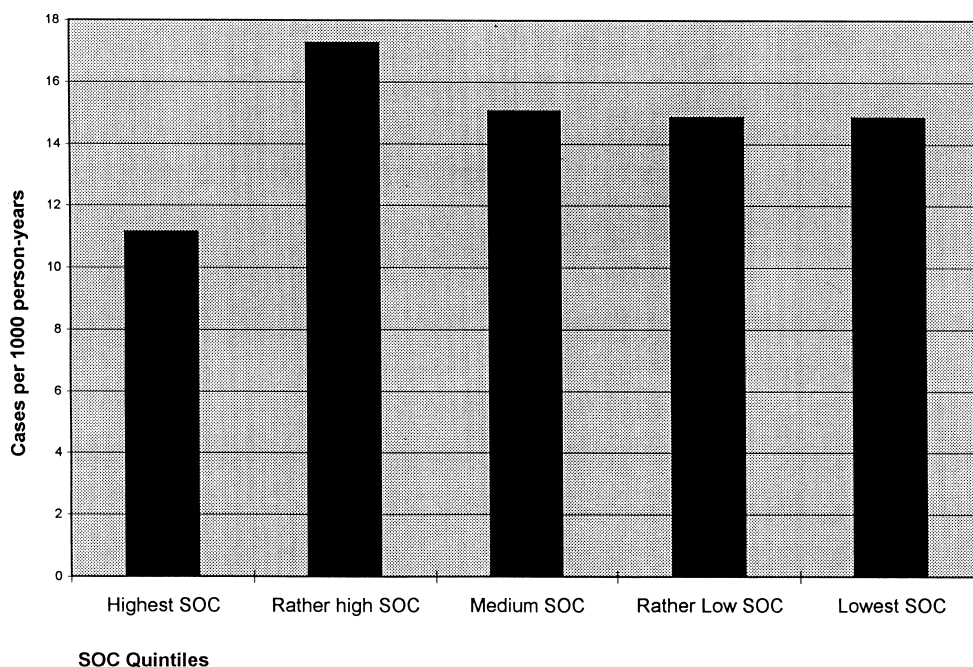
Fig. 2. Incidence of coronary heart disease, cases per 1000 person-years by quintiles of the SOC scores.

mised variable was used, 0 for never or past smoking and 1 for current smoking.

Leisure-time physical activity was recorded with the 4-point Gothenburg scale (Wilhelmsen et al., 1971), but in our study we divided the subjects into three categories. The first group was the inactive individuals, the second moderately active and we combined the Gothenburg point three (very active) and four (professional) activities into a 'very active' category, because there were very few subjects left in the professional category. Body mass index (BMI) was calculated as weight in kilograms per square meter of height. Blood pressure was recorded from the right arm at the first screening visit with calibrated mercury sphygmomanometers with cuffs measuring 12×40 cm. The measurement was carried out in sitting position before the blood sample was taken.

The lipid measurements have been described in detail elsewhere (Frick et al., 1987). Briefly, at the first screening visit serum samples from the local clinics were mailed daily to the central laboratory at the National Public Health Institute in Helsinki. The total cholesterol concentration was determined directly from serum and the HDL-cholesterol was measured after precipitation of VLDL and LDL with dextran sulphate magnesium chloride by an enzymatic method.

Statistical methods

Mean values, quintiles and tertiles of the 29-item

sum score of SOC were used when studying the associations of SOC with occupational class or incidence of CHD. The incidence of CHD, i.e. unadjusted incidences calculated as cases per 1000 person-years, was calculated by tertiles or quintiles of the SOC score to show the shape of the association of SOC with CHD. Relative risks of CHD were estimated by categories using Cox proportional hazards models to control for the effect of the other covariates.

Results

SOC and coronary heart disease

Subjects were divided into quintiles according to their SOC to test the hypothesis that a high SOC would have a protective effect on CHD. The result was in accordance with Antonovsky's theory, since the lowest incidence of CHD was in the highest SOC quintile. It was 25% ($p = 0.05$) lower than the incidence in the lowest SOC quintile. However, the second to highest SOC quintile presented the highest incidence of CHD, as can be seen in Fig. 2. This inconsistency in the pattern of CHD incidence led us first to explore the distribution of mean SOC by occupational class to see the possible modifying effect of occupational class which could also, with some restriction, serve as a proxy for social class and other related socio-economic factors.
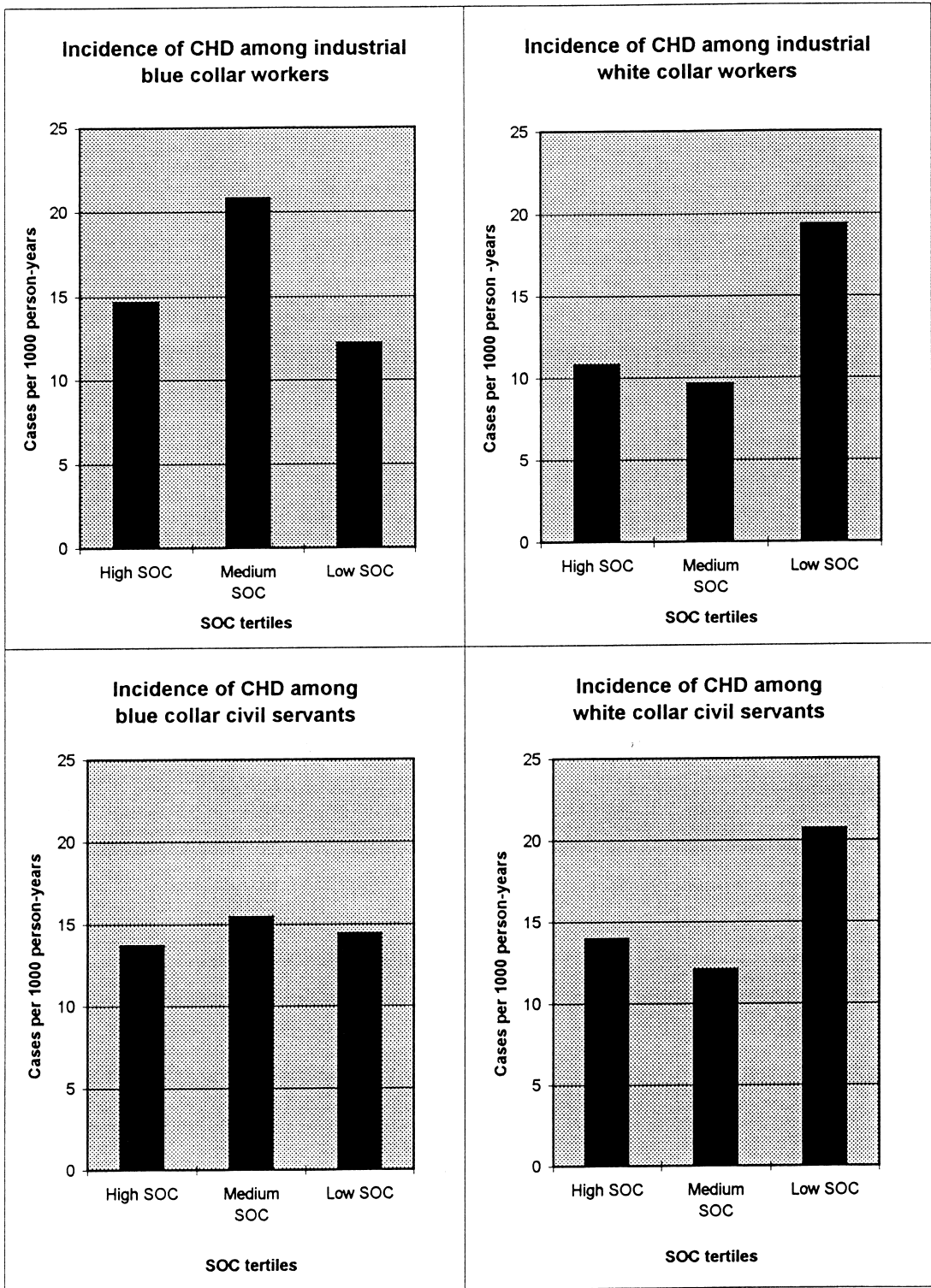
Fig. 3. Incidence of coronary heart disease, cases per 1000 person-years by combined categories of SOC tertiles and occupational groups.

Table 3

Relative risks (RR) of coronary heart disease among white and blue collar workers in SOC tertiles for all subjects and for those not taking gemfibrozil. The RRs were calculated using Cox proportional hazards models with high SOC white collar subjects as the reference group

SOC tertile	*N*	CHD *N*	Non-adjusted		Adjusted for age		Adjusted for age and physical activity		Adjusted for age, smoking, cholesterol and systolic BP	
			RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
All subjects										
White collar										
high SOC	371	35	1.00		1.00		1.00		1.00	
moderate SOC	307	26	0.89	0.53–1.47	0.90	0.54–1.50	0.93	0.56–1.54	0.91	0.55–1.50
low SOC	240	36	1.63	1.02–2.59	1.67	1.05–2.65	1.60	0.99–2.56	1.62	1.02–2.58
Blue collar										
high SOC	1200	135	1.17	0.80–1.69	1.16	0.80–1.69	1.18	0.81–1.73	1.07	0.74–1.56
moderate SOC	1095	143	1.37	0.95–1.98	1.37	0.94–1.98	1.38	0.95–2.00	1.27	0.88–1.84
low SOC	1192	123	1.07	0.73–1.56	1.07	0.74–1.56	1.09	0.74–1.59	0.97	0.67–1.41
Those on gemfibrozil excluded										
White collar										
high SOC	222	18	1.00		1.00		1.00		1.00	
moderate SOC	183	14	0.95	0.47–1.90	0.98	0.49–1.96	0.99	0.49–1.99	1.00	0.50–2.01
low SOC	143	23	2.06	1.11–3.80	2.18	1.18–4.05	2.06	1.10–3.83	2.12	1.14–3.93
Blue collar										
high SOC	700	66	1.14	0.67–1.91	1.12	0.67–1.89	1.13	0.67–1.90	1.03	0.61–1.74
moderate SOC	636	65	1.24	0.74–2.09	1.23	0.73–2.07	1.21	0.72–2.04	1.15	0.68–1.93
low SOC	699	48	0.81	0.47–1.39	0.82	0.48–1.41	0.82	0.47–1.41	0.75	0.43–1.29

SOC and occupation

The average mean SOC was highest among participants doing administrative and managerial work and lowest in manufacturing work. Engineers had the second highest average mean SOC. Among blue collar workers the service trade had the highest average mean SOC. To explore service work more in greater detail we found that the occupations were guards ($N = 23$), caretakers ($N = 17$), firemen and policemen ($N = 9$) and physical fitness instructors ($N = 2$). The nature of work for the majority of these occupations is structured and very orderly, like military work. There is also a high degree of selection in this type of work. In three studies on Israeli army officer trainees (Antonovsky, 1987) the mean SOC was high (SOC = 159, 160 and 159, respectively). The differences between the occupational classes in our study were significant. For a general view of mean SOC in major occupational classes see Table 2.

The joint effect of SOC and occupation on risk of coronary heart disease

The distribution of mean SOC across occupational groups led us not only to explore the incidence of cor-

onary heart disease among civil servants (i.e. Finnish State Railways, Posts and Telecommunications) versus industrial workers, but also to compare the incidences among the white and blue collar workers. For the analysis we divided the mean SOC values obtained into tertiles and divided occupations into groups, white collar vs. blue collar and civil servants vs. industrial employees.

Interestingly, the patterns of CHD incidence among the SOC tertiles were nearly identical among the white collar workers in state agencies and industry as can be seen in Fig. 3. The incidence patterns among the blue collar workers were also similar, irrespective of their employer. In contrast to white collar workers no consistent risk pattern was seen among blue collar workers.

To study the above mentioned finding more closely we calculated the relative risks using Cox regression models, and compared the results when putative mediating or confounding factors, namely age, smoking, leisure time physical activity, total cholesterol and systolic blood pressure were included in the model and when they were not included. (See Table 3.)

As the interaction between occupational category and SOC was statistically significant, it supported the finding seen in Fig. 3, that the effect of SOC might be

Table 4
Clinical and life style data among white and blue collar workers by SOC tertiles

Occupational group	SOC tertiles	BMI	Total Chol (mmol/l)	HDL Chol (mmol/l)	Diast BP (mmHg)	Syst BP (mmHg)	Smoking (%)	Physically very active (%)
White collar								
	high SOC	25.8	6.81	1.24	90.2	138.8	29	47
	moderate SOC	26.1	6.71	1.24	90.2	138.5	29	42
	low SOC	25.8	6.85	1.24	88.5	136.5	32	33
Blue collar								
	high SOC	26.3	6.90	1.24	90.6	140.7	34	47
	moderate SOC	26.3	6.90	1.25	89.9	139.2	34	41
	low SOC	26.4	6.91	1.25	90.9	140.9	34	35

different among white collar subjects from that observed among blue collar subjects. We thus studied the risks by joint categories of SOC and occupation to take into account the interaction in the model. Indeed, white collar workers with low SOC had a 63% higher CHD risk than those with high SOC and this pattern persisted when age, smoking, leisure time physical activity, total cholesterol and systolic blood pressure were adjusted for, while no such pattern was seen among blue collar workers Table 3. It seems that neither the life style factors considered nor cholesterol levels mediate the effect of SOC on risk of CHD.

When those on treatment with gemfibrozil were excluded from the analysis, the risk pattern emerged even more clearly. This may be due to some effect of gemfibrozil, but also due to the fact that nearly 70% of the dyslipidaemic subjects were excluded and the effect of other risk factors were not overshadowed by the effect of dyslipidaemia.

Classic risk factors of coronary heart disease

Although the classic risk factors do not mediate the effect of SOC, there are differences within the clinical data consisting of total cholesterol, HDL cholesterol, systolic and diastolic blood pressure and BMI as well as the subjects' smoking and leisure time physical activity. Physical activity, diastolic blood pressure and HDL cholesterol levels were very even across both occupational groups, but for the total cholesterol the lowest mean values were among the medium and high SOC white collar employees. The difference of mean total cholesterol between the blue and white collar workers was statistically significant ($p = 0.004$). The difference in smoking among the worker groups ($p = 0.007$) was likewise significant. The highest significance for the difference between the blue and white collar workers was in systolic blood pressure and BMI ($p = < 0.000$). It is interesting to note that smoking behaviour seems to depend more on occupation and social status while leisure time physical activity is

clearly related to SOC. Since the number of subjects in our study is large, significance was obtained with rather small actual differences. (See Table 4.)

Discussion

The main findings in our study were, firstly, that among white collar workers high and intermediate SOC scores were significantly protective against coronary heart disease. The second finding was, however, that no such salutogenic effect could be seen among blue collar workers, as there was no consistent trend in the CHD incidences across the SOC tertiles. This was most probably not due to any selection bias in the data, as the differences in lifestyle factors and CHD risks between white and blue collar workers in this study were similar to the differences found in other comparable studies.

SOC and occupation

In Table 2 the group with the highest SOC was the managerial and administrative workers. Engineers had the second highest SOC. The civil servants had average levels in their mean SOC. Manufacturing work showed the lowest mean SOC values. Other studies have shown low mean values like Fiorentino (1986), who reported a mean SOC of 133.0 among US production workers (78% female). "The situation is unfavourable for those with semi-skilled and unskilled jobs as flexible thinking, independent judgements and responsibility are neither primary nor secondary goals. Instead, these jobs entail restrictiveness, high division of labour, fixed sequences of events, time pressure, narrow opportunities for individual variations (e.g. working on an assembly line) and external control. Thus, experiences of success and opportunities for developing and maintaining a high sense of control are rare" (Geyer, 1997). In view of this, even though there were hardly any

unskilled workers in the study, our findings are in line with the theoretical grounds.

SOC, coronary heart disease and the white and blue collar working environment

Although Antonovsky's approach was salutogenic, it is often difficult to follow the salutogenic way of thinking and one frequently finds epidemiological tools best suited for a pathological approach. On the other hand the fact that the health status of a high SOC person is not better than that of an intermediate SOC person (Lundberg, 1996), raises the question whether the salutogenic theory applies to the positive health end of the 'ease–disease' continuum at all. One would find it easier to ask why people with low SOC fall ill rather than adopt Antonovsky's original idea to ask why people with high SOC stay healthy. Lundberg's claim is confirmed in our study by the white collar workers with the 29-item questionnaire. Our study responds to his discussion when he assumed that the previous finding could have resulted from the effect of his simplified 3-item questionnaire.

A study on a Swedish population sample presented similar results to our white collar group (Langius and Björvell, 1993). In this study health status was measured with the sickness impact profile (SIP) questionnaire (Bergner et al., 1981) and a single question about general health using the 100 mm visual analogue scale (VAS). In our study (Fig. 1) the incidence of CHD was about 10 per 1000 person-years in the high and moderate SOC tertiles and it was about 20 in the low SOC tertile. The general health points were distributed similarly in the Swedish study. The SIP points were about 1.0 for the high and moderate SOC tertiles and about 3.0 for the low SOC group. The difference was greater using SIP with its 136 items, because it measured and emphasised the dysfunctions in physical, emotional and social activities caused by health deficits, i.e. pathology in greater detail.

What could be the mediating factor that causes such a dramatic difference between white and blue collar workers? Since the difference could be related to the nature of work — responsibilities, skills, education, salary, physical vs. mental work — and not the line of work — manufacturing, transport, posts and telecommunications — the focus of further studies should be on the job qualities, for example, decision latitude and job demands. Is it possible that blue collar workers with low SOC seek monotonous jobs, because they do not want to make decisions and take responsibilities and that they stay healthy in such jobs because they prefer external control? On the other hand why can a white collar employee make use of his good SOC to promote his health in contrast to his blue collar counterpart? The answer to this at least in part could

be in the rigid and hierarchical work organisation and persistent class differences in Finland. In blue collar working life the strong unions offer support to individuals to protect their interests, which makes the low SOC person do well in working life just as the high SOC blue collar worker. The high SOC individual might be even more frustrated with his blue collar work, because of an incongruence between his competence for control and responsibility and the work culture with limited autonomy. The role behaviour adopted in the working culture may be generalised into other social spheres with leisure time activities posing no challenges.

Lundberg (1996) reported that among those who reported mental problems the amount of low SOC individuals was double compared to those who reported no mental problems. Blue collar workers might have psychological or psychosomatic problems leading to greater risk of having an illness other than CHD due to poor coping resources. In the same study Lundberg hypothesised that for a low SOC individual the risk of contracting a disease is higher and high SOC is a protective factor only after the individual has contracted an illness. This we cannot confirm with our result since our low SOC group had the lowest incidence of CHD among the blue collar workers. Lundberg (1997) proposes more detailed analysis about working conditions as well as health-related behaviours. We agree that further studies are required, especially about all the factors affecting the health of blue collar workers with low SOC.

Socio-economic conditions and life style factors

On the basis of previous findings white collar workers should have a higher mean SOC than blue collar workers. In our data the combined white collar employees' ($N=918$) mean SOC was 146.0 compared with the combined blue collar workers' ($N=3487$) mean SOC 142.8. The difference is significant ($p<0.000$ with 95% CI for the difference 1.78–4.66). Blue collar workers' mean SOC did not differ significantly (civil servants = 143.2 and industrial workers = 141.9). Assuming that a comparison between social classes would be equal to the comparison between the blue and white collar workers, since the Finnish Classification of Occupation assigns many academics to groups 0 to 2 and the rest from group 3 to 9 are mostly involved with manual labour (see Table 2), then this finding would be in accordance with the theory and studies that high social class promotes a strong SOC (Antonovsky, 1987; Lundberg, 1997; Geyer, 1997). "In the highest social positions optimum conditions for the development of SOC and for putting it into action are present. In the lowest social classes the situation is the exact opposite, as neither the pre-

conditions for developing a higher SOC nor many options for making choices will be found. A high SOC may be an appropriate pattern of attitudes for professionals, executives and for the upper middle class, who comprise only a small proportion of the entire population" (Geyer, 1997).

The results also followed the usual pattern when the lifestyle factors were studied. A difference between the white and blue collar workers was seen with BMI, systolic blood pressure, total cholesterol and smoking. All lifestyle indicators were more favourable for the white collar group. Among the white collar SOC tertiles the low SOC group smoked more, as expected. It seems that the level of systolic blood pressure and smoking are determined by occupation, while physical activity depends strongly on SOC. No other variable showed such notable variation between the SOC tertiles.

Methodological considerations

The weak points of our study are, firstly, that it included only men. Secondly, there was a time gap of five years after the clinical screenings and the collection of the psychosocial data. Thirdly, the study was cross-sectional for both the clinical and psychosocial data. The strong points are that, firstly, for the risk of coronary heart disease the study is prospective with a large population base. Secondly, the follow up time was also sufficiently long for reliable data collection for CHD and the Finnish Registers are well known for their accuracy (Joensuu and Näyhä, 1992, Pietilä et al., 1997).

General conclusion

In conclusion, our findings support previous reports that high SOC promotes health, but in a white collar environment only. According to our study a high SOC individual in a white collar environment has approximately half the risk of CHD compared to a low SOC individual. A new finding is that in a blue collar working environment the risk of CHD does not comply with the theory of SOC and, thus, it needs further exploration.

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