Working Conditions,
Income Differences,
and Sense of Coherence
in Relation to Ill Health

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Abbreviations

CVD    Cardiovascular disease
DCQ    The Swedish Demand-Control Questionnaire
HPA    Hypothalamic-pituitary-adrenocortical system
LNU    Level of Living Survey
SAM    Sympathetic-adreno-medullary system
SOC    Sense of coherence
ULF    Survey of Living Conditions
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Introduction

The two independent, yet interrelated, empirical studies of this licentiate thesis focus on the relationship between working conditions and wage income, and on the relationship between working conditions and sense of coherence in relation to ill health. Despite the beneficial effects of having work, long-term exposure to adverse working conditions may lead to deteriorating health. Previous research has defined a number of adverse working conditions, both of physical and psychosocial character, that are potential risk factors for ill health. On the other hand, people tend to possess a variety of resources that may protect their health against adverse conditions at work.

One such resource may be a high socioeconomic status. Wage income reflects an individual’s social standing at work, and as such income is a dynamic measure of a person’s socioeconomic status in a society. There is a clear association between people’s income and their health (Fritzell et al., 2004), even though a rise in wages does not seem to be the answer to improving workers’ health (Hemström, 2005a). Working conditions tend to be unevenly distributed according to income. Therefore, this thesis undertook to explore whether working conditions contribute to income differences in cardiovascular disease.

Another individual resource believed to be protective of health is a strong sense of coherence, a way of seeing our inner and outer world which helps us to cope successfully with complex stressors of daily life (Antonovsky, 1987a). The second study of this thesis investigated whether a strong sense of coherence acts as a buffer against adverse working conditions, and as such is a health protective factor in working life.

Adverse working conditions, poor wage income and a weak sense of coherence are important social and psychosocial determinants of ill health, with a common biological mechanism. Being frequently or unremittingly exposed to these factors evokes the body’s stress response. The long-term effect of the physiologic response to stress, referred to as allostatic load, is associated with an increased risk of ill health and disease (McEwen & Seeman, 1999). Work-related ill health may manifest itself in a number of kinds of disease and symptom (Marmot et al., 1999). This thesis focuses on cardiovascular disease (Study I), musculoskeletal pain, and psychological distress (Study II) among the working population in Sweden.
Aim of the thesis

The overall aim of the thesis was to study the associations between working conditions, wage income and sense of coherence in relation to cardiovascular disease, musculoskeletal pain, and psychological distress among the working population in Sweden.

Specifically,

1. to study whether working conditions, measured as physical demands and job control, contribute to income differences in cardiovascular disease, and whether the contribution differs with regard to prevalence and mortality outcomes (Study I)

2. to study whether sense of coherence moderates the impact of working conditions, measured as physical demands and job strain, on musculoskeletal pain or psychological distress (Study II)
Background

The purpose of this background is to present the theoretical and empirical framework of the two studies included in the thesis.

Figure 1

Figure 1 presents some theoretical, empirical and hypothesized associations between the central components under study. It should be noted that the figure does not make an attempt to present a comprehensive model of all possible theoretical and empirical associations between socioeconomic status, psychosocial factors and ill-health. Such extensive models can be found elsewhere (see e.g. Diderichsen & Hallqvist, 1998, p. 34; Levi, 2000, p. 70; Lahelma, 2001, p. 78; Lundberg, 2003, p. 205). The aim of Figure 1 is simply to demonstrate to the reader how the central components under study in this thesis are assumed to be related to each other. The associations that are explored in the thesis are marked with bold letters and arrows in the figure, and the theoretical and hypothesized connections which are not explicitly in focus are in light print.

Firstly, adverse working conditions, measured as physical and psychosocial exposure, are assumed to have a detrimental effect on worker health. This effect may be direct, such as when a high physical work load leads to musculoskeletal pain. The effect may also be linked to ill health via allostatic load, i.e. when psychosocial exposures lead to long term activation of the body’s stress response. Secondly, adverse working conditions are assumed to contribute to social inequalities in health. In this thesis, income is chosen as the principal indicator of socioeconomic status since income is closely related to working conditions. Income level may have a direct effect on health, or vice versa, and some of the income effect on health may be mediated by working conditions. Thirdly, sense of coherence is assumed to have a direct effect on health. People with a low sense of coherence are assumed to have poorer health than those with a high sense of coherence. It is hypothesized that a strong sense of coherence buffers against adverse exposure at work. This buffering effect could theoretically act upon several associations, e.g. between income and ill health, between working conditions and allostatic load, and between allostatic load and ill health. In this thesis, however, the moderating role of sense of coherence is studied with regard to the relationship between adverse working conditions and ill health.
Working conditions and ill health

The relationship between people’s health and adverse working conditions is widely documented (see e.g. Cox et al., 2000; see e.g. Cooper et al., 2001). Adverse working conditions are broadly divided into physical and psychosocial hazards at work.

Physical hazards

Physical hazards may be of biological, biomechanical, chemical or radiological character. Most of the physical hazards are objectively measured and monitored in the workplace, and exposure to these hazards is regulated by existing standards. In addition to their direct effect on the human body, physical hazards may have a psychological effect through the worker’s fear that such exposures might be detrimental to health. This fear can affect the worker’s task performance and physical and mental health (Cox et al., 2000). Physical hazards interact with one another and with psychosocial hazards in creating their effects (Schrijvers et al., 1998; Wigaeus Tornqvist et al., 2001).

In ergonomic epidemiological research, exposure variables are usually defined according to posture, motion/repetition, material handling, work organization, and external factors (Hagberg, 1992). Thus, physical workload or physically demanding job characteristics are usually measured in studies as unsuitable work postures, repetitive movements, carrying and heavy lifting, and strenuous muscular work. High physical workload is a potential risk factor for musculoskeletal and cardiovascular diseases, and depression (Alfredsson et al., 1982; Hagberg, 1992; Hallqvist et al., 2000; Paterniti et al., 2002). Many people in Sweden still have physically demanding jobs, but this is often forgotten in the contemporary discussion. Equally, it is sometimes assumed that high physical demands are almost exclusively characteristics of blue collar jobs, and that physical demand is therefore a valid measure of socioeconomic position. However, in Sweden it is relatively common for non-manual workers to have jobs with considerable physical exposure, while not all manual workers report physical exposure (Statistics Sweden & Swedish Work Environment Authority, 2002).

Psichosocial hazards

Psichosocial hazards may be defined as:

“those aspects of the design and management of work, and its social and organisational contexts, that have the potential for causing psychological or physical harm” (Cox et al., 2003, page 195).

Several conceptual models have been developed that connect psychosocial working conditions to ill health (Cooper, 1999; Levi, 2000). One frequently used model in the field of psychosocial work stress research is the demand-control model by Karasek and Theorell (1990).

The demand-control model

According to the theory of the demand-control model, the interaction between psychological demands and decision latitude at work determines the adverse effect of psychosocial working conditions on employees’ health (Karasek, 1979; Karasek & Theorell, 1990; Hallqvist et al., 1998; 1998; 2000). The model postulates that the most detrimental reactions to job strain occur when the psychological demands are high and the employee’s decision latitude over his or her work is low. Such psychosocial working conditions prevent optimal coping (Karasek et al., 1982). Job strain is a risk
factor for many kinds of health outcome, such as poor psychological well-being (Bourbonnais et al., 1998; van der Doef & Maes, 1999), cardiovascular disease (Schnall et al., 1994; Belkic et al., 2004), sickness absence (Ala-Mursula et al., 2005; Kondo et al., 2006), and to some extent also musculoskeletal diseases (Bongers et al., 2002; Theorell et al., 2002). Yet, social support at work may moderate the adverse effect of job strain on health (Johnson & Hall, 1988).

High psychological demands in combination with high decision latitude, defined as active work, lead to learning and growth. Employees with an active job are supposed to be the most active group outside work, despite heavy psychological demands. Passive work, characterised by low psychological demands and low decision latitude, is presumed to give rise to learned helplessness, since the job rejects the employee’s initiatives and does not encourage using skills and talents at work. However, both active and passive work is associated with increased risk of ill health (Hemmingsson & Lundberg, 1998; Rostila, 2004). Theoretically, the ideal job with regard to strain would be the low strain job, combining low psychological demands and high decision latitude (Karasek & Theorell, 1990; 2000).

Psychological demands concern “how hard you work”, and involve work pace, time pressure, mental arousal, and coordination responsibilities. Physical demands are not addressed by the demand-control model, even though physical exertion is likely to be a source of mental arousal. Working hard includes high physical demands for many groups of workers (Karasek & Theorell, 1990; 2000). Concern has been expressed that quantitative job demands are poorly defined by the demand-control model and that the demand items mean different things to different respondents, e.g. men and women, or manual and non-manual workers (see e.g. de Jonge et al., 2000; Kristensen et al., 2004).

Decision latitude (also called job control) comprises two components: decision authority and skill discretion. Decision authority is a socially agreed form of control over job performance. This means that the employee can decide how and when to do the job. Skill discretion refers to control over the use of one’s skills in the job. It is implied that decision latitude is unequally distributed in modern organizations, since the highest level of knowledge legitimizes the exercise of the highest level of authority (Karasek & Theorell, 1990; 2000). The level of decision latitude varies systematically across socioeconomic positions, and it has been suggested that this contributes to health inequalities (see e.g. Marmot et al., 1997; Bosma et al., 1998a; Bosma et al., 1998b; Matthews et al., 1998).

One review finds more support for decision latitude than for psychological demands in relation to cardiovascular disease (Schnall et al., 1994). However, high demands, and less consistently low decision latitude, were found to predict coronary heart disease incidence in white collar workers (Kuper & Marmot, 2003). High demands were also found to be related to self-rated health among high income earners but not among low income earners (Hemström, 2005a). These findings indicate that the significance of psychological demands and decision latitude may vary between occupational groups, and also depending on the health outcome under study.

The Swedish Demand-Control Questionnaire (DCQ) (Theorell, 1996) contains five questions on psychological demands, six questions on decision latitude (two on authority and four on skill discretion), and six questions on social support. Many of the previous studies on the demand-control model based on Swedish data use fewer items to operationalize the model than the DQC (e.g. Karasek, 1979; Karasek et al., 1981; Alfredsson et al., 1982; Alfredsson et al., 1985; Tåhlin, 1987). Since the criticism of self-report bias, meaning that self-reports do not accurately describe the degree of control which individuals have over their working environment (Muntaner & O’Campo, 1993), psychological demands and decision latitude have also been objectively assessed
The socioeconomic distribution of physical and psychosocial working conditions in Sweden

In 1999, daily exposure to unsuitable work postures was quite prevalent among unskilled manual workers (38% of men, 44% of women), skilled manual workers (26% of men, 33% of women), and lower level non-manual workers (15% of men, 26% of women). Middle level non-manual workers (8% of men and 15% of women), and high level non-manual workers (6% of men and 10% of women) were less exposed to unsuitable work postures in 1999. Exposure to unsuitable work postures increased among female unskilled and skilled workers between 1991 and 2001, and the shares were relatively stable among other occupational classes. Among middle level non-manual employees, 13.5% of men and 17% of women had physically demanding job tasks in 1999. The share of twisting and forward bending working postures among both male and female lower level non-manual employees increased between 1989 and 1999. Women have an equal share of many of these physical exposures, and for some factors women are more exposed than men. Physical work demands increased among women between 1991 and 2000, and decreased among men during the same period (Statistics Sweden & Swedish Work Environment Authority, 2002; Hemström et al., forthcoming).

Between 1981 and 1991 the share of job strain increased in all occupational classes, and among both men and women in Sweden. The increase was largest among female skilled manual workers, from 8% to 31%. The corresponding increase among male skilled manual workers was from 10% to 11%. The share of active jobs also increased in most occupational classes, middle level non-manuals being an exception. All in all, psychological demands increased during the 1980s, but decision latitude did not, which worsened working conditions in general and specifically in jobs where women are predominant (Szulkin & Tåhlin, 1994). This negative trend of rising job strain continued in the 1990s when, unlike in the 1980s, there was actually a decline in decision latitude along with increasing psychological demands (le Grand et al., 2001). As a consequence, work-related ill health grew in the 1990s, even among people with active jobs (Rostila, 2004). Other Swedish studies confirm the increase in job strain from the middle of the 1980s until the middle of the 1990s, with a decline in job strain apparent at the end of the decade. The risk of job strain was found to be greatest among women and people born outside Sweden (Fritzell et al., 2000).

Socioeconomic position and ill health

The traditional measures of a person’s socioeconomic position are educational level, occupational class, and income. According to studies applying a life career perspective, the chronological order of the different measures of socio-economic position typically goes from educational level to occupational class and finally to income (Cavelaars et al., 1998). The relationship between socioeconomic position and health is well-established; the socioeconomically better-off score better on most measures of health status (Antonovsky, 1967; Vägerö & Lundberg, 1989; Lundberg, 1990; Feinstein, 1993). Socioeconomic position incorporates social, economic and cultural factors that influence the position that a person occupies in the structure of a society. These structural positions are powerful determinants of the probability of health damaging exposure, and of possessing specific health enhancing resources. In theory, the choice of
measure of socioeconomic position should depend on how one assumes socioeconomic position is linked to health damaging exposure and health protective resources (Lynch & Kaplan, 2000). Others argue that it is the psychosocial pathways associated with a person’s relative social position which add to socioeconomic inequalities in health (Marmot & Wilkinson, 2001; Marmot, 2004). Socioeconomic inequalities in exposure to stressors are vividly described in a seminal quote by Richard Wilkinson:

“To feel depressed, cheated, bitter, desperate, vulnerable, frightened, angry, worried about debts or job and housing insecurity; to feel devalued, useless, helpless, uncared for, hopeless, isolated, anxious and a failure: these feelings can dominate people's whole experience of life, colouring their experience of everything else. It is the chronic stress arising from feelings like these, which does the damage. It is the social feelings which matter, not exposure to a supposedly toxic material in the environment.” (Wilkinson, 1996, page 215)

According to a number of studies, working conditions are among the leading factors contributing to occupational class disparities in health (e.g. Marmot & Theorell, 1988; Lundberg, 1990; Marmot et al., 1997; Schrijvers et al., 1998; Borg & Kristensen, 2000) and to income differences in health (Hemström, 2005b).

**Income differences in ill health**

Even if education, occupational class and income are related, they measure different underlying phenomena and tap into different causal mechanisms in relation to health (Geyer et al., forthcoming). Consequently, they should not be used interchangeably as indicators of a hypothetical latent social dimension when we study socioeconomic inequalities in health (ibid.). According to Geyer and Peter (2000), the effects of income on mortality override those of educational level and occupational class. Since income can be measured on a continuous scale, unlike educational level or occupational class, income may be considered a more detailed indicator of socioeconomic position.

Income is a dynamic measure of socioeconomic position because it connects directly to the material conditions that may affect health, that is to say income level influences health because of what money can buy (Lynch & Kaplan, 2000). Impaired health could directly cause a fall in income. Hence, the causal relationship may run from poor health to low income rather than, or at least as much as, vice versa (Benzeval et al., 1996). It has been suggested that the strong relationship between income and health is due to a low share of labour force participants in the low income strata, meaning that ill health is more prevalent in lower income groups, or that poor health reduces the numbers of hours spent in paid work due to sick leave or disability pension (Benzeval et al., 1996; Stronks et al., 1997). Income is strongly connected to work role, and job related rewards in the form of wage income may be of central importance in giving individuals a status and socioeconomic position in society (Hemström, 2005b). According to Wilkinson (1997) it is relative income and status in society that make a difference to health, rather than absolute material living standard.

The measurement of income is intricate: absolute or relative, individual income or family disposable income can be measured, and family income can be adjusted for family size. Income and poverty levels can be compared; other sources than wages can be included in income, and even wealth including total assets can be measured (Kaplan & Keil, 1993). A small number of studies have used an absolute income measure. These studies tend to find a curvilinear relationship between income and health. In other words, the health returns of an improved income are greatest at very low levels, and they tend to diminish at very high levels of income (Backlund et al., 1996; Ecob & Davey Smith, 1999; Der, 2001; Fritzell et al., 2004; Fritzell, 2005). Most studies of
income and health tend to use an income measure based on the income distribution in the data such as quartiles, quintiles or other comparable strata (e.g. Lynch et al., 1996; Hemström, 2005b). Some analyses have used individual annual earnings as a measure of income (Fritzell & Lundberg, 1994; Lynch et al., 1996; Geyer & Peter, 2000; Fritzell et al., 2004) or family income adjusted for family size (Åberg Yngwe et al., 2001). The results tend to be relatively similar, no matter which income measure is used (individual or family disposable): those classified as having a high income have better health than those in the lower income strata, with a health gradient for the intermediate income groups. However, Rahkonen et al. (2000) recommend the use of household equivalent income as the principal measure in studies of income and health. They found that individual and household income was related to poor health among British and Finnish men. For British women, and to a lesser extent for Finnish women, the association between income and health depended strongly on the income measure used, and for British women individual income had almost no effect on health (ibid.). However, results from Sweden indicate that wage income is a more important determinant of women’s ill health than of men’s (Hemström, 2005b).

Nevertheless, when measured as annual individual wages classified into quartiles, quintiles or other comparable groups, income level does indicate an individual’s relative position in the income distribution on the labour market. Measured like this, income and working conditions are closely related. This is less so for disposable income or household income, which is an indicator of family status and material resources averaged over all household members. Yet there are not many studies on social inequalities in health which focus on the intertwined relationship between wage income and working conditions (see e.g. Lynch et al., 1997a; Lynch et al., 1997b; Hemström, 2005a, 2005b).

Health protective personality factors as related to stress and socioeconomic position

Adverse working conditions and a poor socioeconomic position are powerful stressors which have an impact on people’s health and well-being. However, individual differences may affect how we perceive a challenging situation and thus how the body’s stress response is activated. Personality traits refer to individual differences in the tendency to think, behave and feel in certain consistent ways (Caspi, 1998). According to the Big Five personality traits taxonomy, the broad personality traits are (1) extraversion, (2) agreeableness, (3) conscientiousness, (4) neuroticism, and (5) openness to experience. Each trait is composed of more specific personality characteristics, or lower-order facets. These five dimensions represent personality at the broadest level of abstraction, and the taxonomy does not imply that personality differences can be reduced to only five traits (John & Srivastava, 1999).

Personality traits may act as resources in the stress process (Vollrath, 2001). Personality constructs such as hardiness (Kobasa, 1979), optimism (Scheier & Carver, 1992), self-efficacy (Bandura, 1977), locus of control (Rotter, 1966), and sense of coherence (Antonovsky, 1979; 1987a), to mention but a few, have been investigated in order to pick up positive appraisal and successful coping in response to stressors. According to previous findings, hardiness, optimism, self-efficacy, locus of control, and sense of coherence load on personality factors of neuroticism, extraversion and conscientiousness, which are part of the five-factor model of personality (Vollrath, 2001). In the light of the transactional theory of stress and coping, personality traits appear too global and they do not take into account contextual factors in order to fully
catch the complexity of the stress process (Lazarus & Folkman, 1984). Stress arises when the demands of a challenging situation exceed the resources at an individual’s disposal. In other words, stress is the result of a continuous relationship, referred to as transaction, between the individual and the environment (Folkman & Lazarus, 1988).

Yet a number of studies indicate that effective coping modes are unequally distributed in society, with men and the socioeconomically better-off being better at coping successfully (Pearlin & Schooler, 1978). Stronks et al. (1998) demonstrate that neuroticism is associated with low socioeconomic status; high neuroticism is thus suggested to contribute to socioeconomic inequalities in health. However, exposure to stressors such as negative life events and long term difficulties contribute to socioeconomic inequalities in perceived health, even after differences in neuroticism are controlled for (ibid.). Moreover, sense of coherence is found to be associated with age and social class, with middle-aged white collar workers having the strongest sense of coherence (Lundberg, 1996).

Sense of Coherence

Salutogenesis focuses on the origins of health, and on factors that promote good health. Sense of coherence (SOC) is the core construct of Antonovsky’s salutogenic model and it is defined 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, 1987a, p. 19)

SOC is based on three components, namely comprehensibility, manageability and meaningfulness. These components together form an individual’s global orientation towards life in general. According to Antonovsky (1987a; 1993), the three components are interrelated, and all of them are needed for successful coping. A person with a high SOC score is considered to be better able than a person with a low SOC score to maintain good health in spite of experiencing stress.

SOC is regarded as a fairly stable dispositional orientation of personality (Antonovsky et al., 1990; Sagy et al., 1990), which is assumed to be fully developed and stabilized around the age of 30. SOC is seen to arise from internal and external generalised resistance resources, such as wealth, ego strength, cultural stability, and social support. The more of these resources an individual possesses, the better are his or her chances of developing a high SOC. Thus, having adequate generalised resistance resources and being able to use them properly facilitates successful coping with stressors (Antonovsky, 1979, 1987a). Some maintain that people in the highest social positions, unlike those in the lowest social positions, enjoy the optimum conditions for developing a strong SOC (Geyer, 1997). Despite the hypothesized stable nature of SOC in adulthood, major life events, for instance radical changes in working conditions, unemployment, or divorce, may affect an individual’s general resistance resources and thus substantially change the strength of sense of coherence, even in older individuals (Antonovsky, 1987b; 1987a; 1991).

SOC has been studied in life stress circumstances in a variety of settings and in relation to numerous health-related outcomes (e.g. Kivimäki et al., 2000; Suominen et al., 2001; Surtees et al., 2003; Lindfors et al., 2005; Ristikari et al., 2005; Savolainen et al., 2005; Suominen et al., 2005). The general findings from previous studies tend to indicate that SOC is associated with health in general (Lindstrom & Eriksson, 2005),
and primarily with psychological measures of health (Flensborg-Madsen et al., 2005). SOC has also, to a lesser extent, been studied in work-related settings. Most of such studies have focused on psychosocial exposure at work in relation to SOC (Kalimo & Vuori, 1990; Ryland & Greenfeld, 1991; Søderfeldt et al., 2000; Albertsen et al., 2001; Kalimo et al., 2002; Agardh et al., 2003; Kalimo et al., 2003; Nasermoaddeli et al., 2003; Hoge & Bussing, 2004; Hogh & Mikkelsen, 2005). Only a few studies have also focused on physical exposure at work in relation to SOC (Feldt, 1997; Kalimo et al., 2002; Kalimo et al., 2003). Regarding the moderating role of SOC, there is some evidence that people with a high SOC cope more efficiently with stressors at work than people with a low SOC (Feldt, 1997; Albertsen et al., 2001). However, SOC does not seem to moderate the relationship between violence at work and stress reactions (Hogh & Mikkelsen, 2005). Because of the small number of studies in this research area, it is difficult to draw conclusions about whether a strong sense of coherence actually does buffer against adverse working conditions.

The Orientation to Life Questionnaire is an instrument for assessing SOC, and the questionnaire exists in a long (29 items) and a short (13 items) version (Antonovsky, 1987a), and in an array of alternative instruments (for a review see Eriksson & Lindstrom, 2005). In addition, there is a Swedish 3-item measure of SOC developed to fit survey questionnaires addressed to population samples (Lundberg & Nyström Peck, 1995).

Mechanisms, how stressors affect health

Exposure to stressors such as adverse working conditions, poor wage income and a weak sense of coherence may activate the body’s stress response, which is one the physiologic mechanisms between stressors and ill health, explaining how stressors “get under the skin” (Lundberg, 2005). Other physiologic mechanisms may be present in connection to psychosocial working conditions and musculoskeletal disorders (for instance Theorell et al., 2002). The allostatic load model presents not only the physiologic reaction to a stressor but a more complex picture of many factors influencing the physiologic response to stress, such as the impact of genetic burden, life-course experiences and lifestyle differences that influence a person’s behavior and physiologic reactivity.

The stress response

The stress response, also known as the fight-or-flight response, helps humans and other mammals to react to emergency and to cope with change. This response is initiated in the brain, but involves glands, hormones and the immune, cardiovascular and respiratory systems simultaneously. The stress response provides the body with energy, muscle power, oxygen, pain resistance, and mental lucidity when we are faced with any kind of stressful event. The function of the stress response is to ensure our safety and survival under acute conditions. However, when this powerful system is activated chronically or is out of balance it can give rise to an array of illnesses, since the whole body and mind are involved in the stress response (McCarty, 2002; McEwen & Norton Lasley, 2002).

The two main systems of the stress response are the sympathetic-adrenomedullary system (SAM) and the hypothalamic-pituitary-adrenocortical system (HPA)(McCarty, 2002). When we are faced with a stressor, the hypothalamus sends signals via the sympathetic nervous system to the medulla of the adrenal glands which
starts to secrete adrenaline, thus kicking off the stress response. The SAM system is the first phase of the body’s defence against stressors and adrenaline is the main hormone of this system. The second and adjusting phase of the stress response consists of the HPA axis, which is a co-operation of the nervous, endocrine and immune systems. Cortisol is the main hormone of this defence system. The HPA axis is activated by the hypothalamus but uses hormones as carriers instead of the sympathetic nervous system. Consequently, the response of the HPA axis is slower compared to the SAM system. It takes thirty to forty minutes before the cortisol levels reach their peak after facing a stressor, compared to adrenaline which circulates in the system within a minute. Cortisol reloads the body’s energy reservoirs with glycogen and fat after the adrenaline rush, and helps the body to adjust to change and prolonged states of stress (McEwen & Norton Lasley, 2002).

The SAM system is the body’s active defence mechanism against stressors and it prepares the body to fight or to flee. The HPA axis represents a defeat reaction or a passive stress response. In prolonged exposures to stressors the HPA axis tends to be the predominant stress response (Ljung & Friberg, 2004). When a stressful event is perceived as overwhelming, the fight-or-flight response becomes futile and is substituted by a defeat reaction. Compared to the fight-or-flight response, which is similar to an attack or a retreat reply, the defeat reaction is more like being subjected to a siege. HPA axis activation is also caused by smoking and alcohol intake (Björntorp, 1996).

The allostatic load model

The allostatic load model explains how the long-term activation of the stress defence systems leads to ill health. Allostasis refers to the body’s ability to achieve stability (homeostasis) by adapting to change, and as such it is crucial to survival. Allostatic load is the long-term effect of the physiologic response to stress, and it arises when the chronic overactivity or underactivity of allostatic systems (SAM, HPA axis, the cardiovascular, metabolic and immune systems) cause some measure of wear and tear. This wear and tear also reflects the impact of genetic burden, life-course experiences and lifestyle differences that influence a person’s behavior and physiological reactivity. Allostatic load is the cumulative cost to the body of allostasis. Hence, the concept of **allostatic load** represents not only the physiologic reaction to a stressor but a more complex picture of many factors influencing the physiologic response to stress (McEwen, 1998; McEwen & Seeman, 1999).

As verified already by Hans Selye (1956), a pioneer in the field of stress research, the stress defence systems not only protect the body but also damage it and contribute to development of disease (Cooper & Dewe, 2004). According to McEwen and colleagues (1998; 1999; 2002), the allostatic systems protect the body in the short run, but in the long run allostatic load and the hormones associated with stress cause disease. Both acute and chronic stress can have long term consequences, and the effects of chronic stress can be aggravated by a fatty and sugary diet and substance abuse (e.g. alcohol and tobacco). Moderate exercise reduces the adverse effects of chronic stress (McEwen, 1998). Negative health outcomes of allostatic load are impaired immunity, obesity, atherosclerosis, loss of bone minerals, and the atrophy of nerve cells in the hippocampus (McEwen, 1998; McEwen & Seeman, 1999). Allostatic load is also present in common mental disorders such as depressive illness and anxiety disorders (McEwen, 2003).

Four situations are believed to lead to allostatic load. First, frequent exposure to stressors leads to increased levels of stress hormones which in turn cause blood pressure surges and accelerate atherosclerosis. Second, failure to habituate (get used) to repeated
challenges can lead to heightened cortisol levels. Third, the inability to shut off allostastic responses causes allostatic load. For example, blood pressure may fail to recede after mental or physical stress and lead to hypertension, accelerated atherosclerosis and elevated SAM system and HPA axis activity. Fourth, inadequate allostatic response triggers a compensatory rise in other allostatic systems. For example, if cortisol does not increase enough due to stress, cytokines start to increase (McEwen, 2000; 2001).

In a study by Seeman (1997) and co-workers, allostatic load is measured as a multisystem summary indicator of physiological activity across a range of regulatory systems, and those subjects in the highest quartile of the summary index are defined as having a high allostatic load. Elevated allostatic load predicts an increased risk of impaired cognitive and physical functioning, and cardiovascular disease in older people (ibid.). Moreover, there is an association between allostatic load and socioeconomic status, with people of low socioeconomic status tending to have a more elevated allostatic load than people of high socioeconomic status (for a review, see Szanton et al., 2005). In a Swedish study, Lindfors et al. (forthcoming) demonstrate that allostatic load is better than a clinical risk indicator in predicting future sense of coherence, and that allostatic load is associated with a weak sense of coherence at follow-up in Swedish middle-aged women.
Materials and methods

Study I was based on cross-sectional survey data (ULF), and on the Swedish census of 1990 (FoB90) linked to the national cause of death registry (follow-up period 1990-1995). Study II was based on longitudinal survey data (LNU). The samples included employed men and women residing in Sweden, aged 40-64 (Study I) and 18-64 (Study II), respectively.

The Swedish Level of Living Survey (LNU) has been carried out by the Swedish Institute for Social Research at Stockholm University on five occasions, in 1968, 1974, 1981, 1991 and 2000 (Fritzell & Lundberg, 2000). The Survey of Living Conditions (ULF) has been performed annually since 1975 by Statistics Sweden (Statistics Sweden, 2003). Both surveys include several questions on work life, working conditions, and health. The surveys comprise a random sample of the adult population residing in Sweden.

In Sweden, population censuses were carried out every decade during the period 1860-1930, and after that every fifth year. The first general housing census was carried out in 1945. Since 1960, the population and housing census (FoB) has been combined and performed every fifth year. The latest population and housing census was performed in 1990 (Statistics Sweden, 1999). The Cause of Death Registry is administered by the National Board of Health and Welfare and it comprises all deceased individuals during a calendar year if the person was registered in Sweden at the time of death. The registry includes data from 1952, and it is updated every year (The National Board of Health and Welfare, 2006).

Study I, based on ULF and registry data, focused on the mediating role of working conditions on the association between wage income and CVD (prevalence and mortality). Logistic regression analyses were used to estimate the associations between wage income and CVD prevalence, and Poisson regression analyses were applied to estimate the associations between wage income and mortality from CVD. Working conditions were measured as self-reported job control and physical demands in the cross-sectional survey data, and as objectively imputed job control based on occupational titles in the census. The testing of the mediating role of working conditions for the association between wage income and CVD was carried out according to common practice (Baron & Kenny, 1986).

Study II was based on longitudinal panel data from LNU surveys for the years 1991 and 2000. The focus was on the moderating role of sense of coherence on the impact of working conditions on musculoskeletal pain or psychological distress. Sense of coherence was measured with a previously validated three-item measure, and working conditions were measured according to the theoretical assumptions of the demand-control model (job strain) and an index of physical demands. Healthy individuals at baseline in 1991 were included. Sense of coherence and working conditions were measured at baseline. Logistic regression analyses were used to estimate the interaction effect of sense of coherence and working conditions on the nine-year cumulative incidence of musculoskeletal pain or psychological distress.
Discussion

The aim of Study I was to examine the explanatory role of adverse working conditions for the association between income and CVD, and to study possible differences across prevalence and mortality outcomes, and different ways of measuring working conditions. People’s position in the income hierarchy is closely related to their working conditions, but this fact has not been extensively discussed in the contemporary debate. The analyses here consequently focused on the association between wage income and CVD, and whether this relation was mediated by working conditions. Working conditions contributed 8 -10 % of the association between income and CVD prevalence, and 10 % of the association between income and CVD mortality. These findings are in line with a previous study which estimates the contribution of working conditions to the association between occupational class and CVD mortality to be 8 % (Virtanen & Notkola, 2002). According to a Danish study, the aetiologic fraction of working conditions to premature CVD mortality is between 16 and 22 % (Olsen & Kristensen, 1991).

The association between individuals’ relative wage income and CVD was found to be stronger than the corresponding one between working conditions and CVD (prevalence and mortality), regardless of the method used to measure working conditions (self-reported versus objectively). The study by Virtanen and Notkola (2002) also found income to have a strong effect on CVD mortality differences, and the impact of working conditions on occupational class mortality differences to be moderate. CVD is regarded as an important outcome in studies of the association between working conditions and health since many factors, social as well as biological, contribute to its development (Theorell, 2000). However, when studying income differences in CVD, working conditions do not seem to be among the most important contributing factors. Early life conditions and life course factors, such as smoking and body mass index (Hemmingsson & Lundberg, 2005), may be of greater importance for CVD aetiology than working conditions. However, the effect of working conditions on CVD morbidity and mortality may be obscured by a web of causation, with adverse working conditions leading to changes in lifestyle factors, for instance increased smoking. It could also be that working conditions are related to certain non-lethal diseases, such as depression, which in turn increase the risk of later CVD.

In Study I, in order to meet the criticism of common method variance (see e.g. Kline et al., 2000) in cross-sectional studies based on self-reported data, a validation test was performed by analysing CVD mortality by objectively imputed job control and a similar income variable in the mortality follow-up. The results of this validation test suggest that the effect of job factors on CVD prevalence in the cross-sectional sample was if anything underestimated rather than overestimated. This finding is of methodological importance for research into working conditions and ill health since longitudinal data and objective outcomes are widely believed to be superior to cross-sections and self-reported health measures. Lahelma (2001), however, states that health measures are by their very nature self-reported, and working with people’s own reports is an inherent characteristic of several medical sociological studies. In Study I, the self-reported CVD indicator included only doctor-certified diagnoses and no vague
symptoms, and hypertension was also excluded. Thus, with regard to cross-sectional data, researchers in the field of working conditions and CVD are probably more likely to find negative (insignificant) effects, due to the well-known healthy worker effect, than inflated associations due to cross-sectional study design based on self-reported data.

Because of low power in the cross-sectional survey sample of Study I, it was not possible to study men and women separately. This limited the study of gender differences in the association between wage income and CVD, and the contribution from working conditions. However, results from the mortality follow-up indicate that the impact of income on CVD mortality was stronger among men than women, and the impact of job control on CVD mortality was somewhat stronger among women than men. Both in the survey and in the mortality follow-up, the income distributions were reversed between men (about 40% in the highest income quartile and 10% in the lowest income quartile) and women (about 10% in the highest income quartile and 40% in the lowest income quartile), showing that low wage income was accumulated among women. The distribution of job control was also reversed between men (about 50% among high job control and 10% among lowest job control) and women (about 11% among high job control and 30% among lowest job control). In other words, women in Sweden have a more disadvantaged socioeconomic position than men, which is reflected in lower wages, poorer working conditions, and consequently poorer health. Since narrowing the gender differential in wages, which is about 8% (see e.g. Statistics Sweden, 2004) does not seem to be on the political agenda in Sweden, more research is needed to scrutinize and highlight the consequences of women’s disadvantaged socioeconomic position for health. Evidently, a gender theoretical perspective is needed to explain why the more disadvantaged socioeconomic position of women persists in an advanced industrialized nation such as Sweden in the 21st century.

The aim of Study II was to analyze whether sense of coherence moderated the impact of adverse working conditions on psychological distress or musculoskeletal pain in the working population in Sweden. Adverse working conditions were measured as physical and psychosocial exposure. Physical exposure was assessed by an additive index consisting of four items which measured physical work demands. Psychosocial exposure was measured according to the theoretical assumptions of the demand-control model. The results from the longitudinal analyses indicated that a strong sense of coherence did indeed buffer against adverse exposure at work, but not in a consistent way. The moderating role of sense of coherence depended on gender, type of adverse exposure and health outcome. Most substantially a strong sense of coherence buffered the impact of physical demands on musculoskeletal pain incidence in both men and women. There was also some evidence that a strong sense of coherence moderated the impact of job strain on psychological distress, mainly in women.

The moderating role of sense of coherence on the impact of adverse working conditions has not been studied extensively, and previous findings tend to be inconclusive. In addition, most previous studies have focused on psychosocial exposure at work only. Some results suggest that people with a strong sense of coherence cope more efficiently with adverse psychosocial working conditions than people with a low sense of coherence (Feldt, 1997; Albertsen et al., 2001). According to two cross-sectional studies from Sweden, a weak sense of coherence in combination with low decision latitude increased the risk of type 2 diabetes in Swedish women (Agardh et al., 2003), and a weak sense of coherence combined with emotional job strain increased the risk of exhaustion and depersonalization in a small sample of Swedish civil servants (Söderfeldt et al., 2000).

Physical working conditions in combination with sense of coherence have hardly been studied before. Feldt (1997) showed that sense of coherence moderated the effect
of poor lighting, soundproofing, noise, dirt and dust and crowded working space on emotional exhaustion. However, these results were based on a relatively small sample (n=989) consisting of mainly male technical designers in Finland, and the study design was cross-sectional (ibid). Thus, the main contribution of Study II was to demonstrate that sense of coherence moderated the impact of high physical demands on musculoskeletal pain incidence in a representative sample of the working population in Sweden. Thus, in line with Antonovsky’s sense of coherence theory (Antonovsky, 1979; 1987a; 1987b), viewing the world, and most likely also working conditions, as comprehensible, manageable and meaningful helped these men and women to cope better with daily stressors in the workplace and to protect themselves against musculoskeletal pain. However, people with a strong sense of coherence and high physical demands also demonstrated an increased risk of musculoskeletal pain. This indicates that the main focus of occupational stress research should be on working conditions.

The longitudinal analyses of Study II also revealed gender differences regarding the predictive role of adverse working conditions and sense of coherence on psychological distress. Both physical and psychosocial exposure at work significantly increased the risk of psychological distress in men, and to a lesser extent also in women (job strain only). However, a weak sense of coherence increased the risk of future psychological distress more than two-fold in women, while it had no effect in men. This could indicate that viewing the world as comprehensible, manageable and meaningful is more important for women’s psychological well-being than men’s. In other words, women’s worlds may be more complex than men’s, since women more often than men have to divide themselves between home duties and work life challenges. According to a Swedish study, employed women's health was determined by the interaction between conditions at work and household duties, whereas men responded more selectively to long working hours (Krantz et al., 2005). Thus, it might be the case that strengthening women’s sense of coherence in both private and working life spheres, and facilitating the balance of these spheres, could promote psychological well-being in women. It should be borne in mind, however, that the women in the Study II sample at both measuring times had a slightly greater share of strong sense of coherence than men. Consequently, because of this gender difference in the predictive role of sense of coherence for psychological distress, the findings about the moderating role of sense of coherence for the impact of job strain on psychological distress also need to be interpreted carefully.

Study II showed that adverse working conditions and a weak sense of coherence predicted ill health in a representative sample of the working population in Sweden. However, the specific kind of ill health that was manifested differed by gender. It seems evident that the factors that play a role for future ill health differ for men and for women in Sweden. These results are in line with previous findings. According to a Canadian study, there are real differences in the factors that predict women's and men's health (Denton & Walters, 1999). Social structural factors – i.e. being in the highest income category, working full-time, caring for a family and having social support – appear to play a more important role in determining women’s health. Smoking and alcohol consumption seem to be more important determinants of men’s health, while body weight and being physically inactive seem to be more important for women than men (ibid.). Even if similar numbers of women and men are in gainful employment in Sweden, they tend to have different kinds of jobs. There are also big gender differences in part-time working and in the reasons for working part-time (see e.g. Evertsson, 2004). These factors probably also contribute to the gender differences in ill health found in Study II.
Conclusions

The studies in the present dissertation suggest that:

- Irrespective of study design or way of assessing working conditions, the latter contribute to income differences in CVD prevalence as well as CVD mortality.

- Sense of coherence moderates, yet not consistently, the impact of working conditions on psychological distress and musculoskeletal pain. The moderating role seems to vary by work exposure, gender and health outcome. Hence, the results do not support the hypothesis that sense of coherence is a global health-protective factor.

Future research into working conditions and employees’ health would benefit from including income in the analyses since wages are closely related to working conditions and to people’s position on the labour market. In addition, focusing on individual resources such as sense of coherence increases our understanding of how individual differences in coping with adverse working conditions may affect health. The present results also revealed considerable gender differences, suggesting that the factors that determine future work-related health are different for men and women. Hence, in order to focus on the working life circumstances which may have consequences for men’s and women’s health, it is important to study men and women separately.
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