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ASSOCIATIONS AMONG WORKING CONDITIONS AND BEHAVIORAL RISK FACTORS: The Helsinki Health Study with International Comparisons

ACADEMIC DISSERTATION

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IV Lallukka T, Martikainen P, Reunanen A, Roos E, Sarlio-Lähteenkorva S, Lahelma E. Associations between working conditions and angina pectoris symptoms among employed women. Psychosomatic Medicine 2006;68:348-354.

ABSTRACT

Adverse health behaviors as well as obesity are key risk factors for chronic diseases. Working conditions also contribute to health outcomes. It is possible that the effects of psychosocially strenuous working conditions and other work-related factors on health are, to some extent, explained by adverse behaviors. Previous studies about the associations between several working conditions and behavioral outcomes are, however, inconclusive. Moreover, the results are derived mostly from male populations, one national setting only, and with limited information about working conditions and behavioral risk factors.

Thus, with an interest in employee health, this study was set to focus on behavioral risk factors among middle-aged employees. More specifically, the main aim was to shed light on the associations of various working conditions with health behaviors, weight gain, obesity, and symptoms of angina pectoris. In addition to national focus, international comparisons were included to test the associations across countries thereby aiming to produce a more comprehensive picture. Furthermore, a special emphasis was on gaining new evidence in these areas among women.

The data derived from the Helsinki Health Study, and from collaborative partners at the Whitehall II Study, University College London, UK, and the Toyama University, Japan. In Helsinki, the postal questionnaires were mailed in 2000-2002 to employees of the City of Helsinki, aged 40–60 years (n=8960). The questionnaire data covered e.g., socio-economic indicators and working conditions such as Karasek's job demands and job control, work fatigue, working overtime, work-home interface, and social support. The outcome measures consisted of smoking, drinking, physical activity, food habits, weight gain, obesity, and symptoms of angina pectoris. The international cohorts included comparable data. Logistic regression analysis was used. The models were adjusted for potential confounders such as age, education, occupational class, and marital status subject to specific aims.

The results showed that working conditions were mostly unassociated with health behaviors, albeit some associations were found. Low job strain was associated with healthy food habits and non-smoking among women in Helsinki. Work fatigue, in turn, was related to drinking among men and physical inactivity among women. Work fatigue and working overtime were associated with weight gain in Helsinki among both women and men. Finally, work fatigue, low job control, working overtime, and physically strenuous work were associated with symptoms of angina pectoris among women in Helsinki. Cross-country comparisons confirmed mostly non-existent associations. High job strain was associated with physical inactivity and smoking, and passive work with physical inactivity and less drinking. Working overtime, in turn, related to non-smoking and obesity. All these associations were, however, inconsistent between cohorts and genders.

In conclusion, the associations of the studied working conditions with the behavioral risk factors lacked general patters, and were, overall, weak considering the prevalence of psychosocially strenuous work and overtime hours. Thus, based on this study, the health effects of working conditions are likely to be mediated by adverse behaviors only to a minor extent. The associations of work fatigue and working overtime with weight gain and symptoms of angina pectoris are, however, of potential importance to the subsequent health and work ability of employees.

TIIVISTELMÄ

Epäterveelliset elintavat ja lihavuus ovat keskeisiä kroonisten tautien riskitekijöitä. Myös työolot vaikuttavat terveyteen. On mahdollista, että työolot voivat muovata esimerkiksi terveyskäyttäytymistä. Aiempi tutkimus alueella on kuitenkin ollut epäjohdonmukaista ja osittain ristiriitaista. Lisäksi tutkimusta on tehty enemmän miehillä ja ilman kansainvälistä vertailuasetelmaa. Tutkimuksissa on myös yleensä ollut mukana vain rajattu määrä työoloja ja riskitekijöitä.

Tämä tutkimus kohdistui terveyskäyttäytymiseen ja riskitekijöihin keski-ikäisillä työntekijöillä. Tarkempana tavoitteena oli selvittää, ovatko työolot yhteydessä terveyskäyttäytymiseen, lihomiseen, lihavuuteen ja rintakipuoireisiin. Tutkimus keskittyi Helsingin kaupungin henkilöstön keski-ikäisiin työntekijöihin. Tavoitteena oli lisäksi kansainvälisen vertailun avulla tuottaa laajempi näkökulma työolojen yhteyksistä epäterveellisiin elintapoihin ja lihavuuteen. Koko tutkimuksen tavoitteena oli myös tuottaa uutta tietoja työolojen merkityksestä riskitekijöihin erityisesti naisilla.

Tutkimusaineisto on osa Helsingin kaupungin henkilöstön terveystutkimusta. Vertailuaineistossa on lontoolaisen Whitehall II -tutkimuksen ja japanilaisen työntekijätutkimuksen tietoja. Helsingissä postikyselylomakkeet lähetettiin vuosina 2000–2002 kaikille 40, 45, 50, 55 tai 60 vuotta täyttäville kaupungin työntekijöille (n=8960). Kyselylomakkeella kerättiin tietoja mm. sosioekonomisesta asemasta ja työoloista, kuten työn vaatimuksista ja vaikutusmahdollisuuksista, työväsymyksestä, ylitöistä, työn ja perheen yhteensovittamisesta ja sosiaalisesta tuesta. Vastemittareina olivat tupakointi, alkoholinkäyttö, vapaa-ajan liikunta, ruokavalinnat, lihominen, lihavuus, ja rintakipuoireet. Kaikissa aineistoissa oli mukana naisia ja miehiä. Logistinen regressioanalyysi oli pääasiallinen tilastollinen menetelmä. Analyyseissa otettiin huomioon myös ikä, koulutus, ammattiasema ja siviilisääty.

Työoloilla oli vain vähän ja epäjohdonmukaisia yhteyksiä tutkittuihin vasteisiin. Vähäinen työn kuormittavuus oli yhteydessä terveellisiin ruokavalintoihin ja tupakoimattomuuteen naisilla Helsingissä. Työväsymyksellä havaittiin sen sijaan yhteys alkoholinkäyttöön miehillä ja vähäiseen liikuntaan naisilla. Työväsymys ja ylityöt olivat yhteydessä lihomiseen Helsingissä sekä naisilla että miehillä. Työväsymys, vähäiset vaikutusmahdollisuudet työhön, ylityöt, ja työn fyysinen kuormittavuus olivat lisäksi yhteydessä rintakipuoireisiin helsinkiläisillä naisilla. Myös kansainvälisessä vertailussa todetut yhteydet olivat heikkoja. Kuormittava työ oli yhteydessä tupakointiin ja liikkumattomuuteen ja passivinen työ liikkumattomuuteen ja vähäisempään alkoholinkäyttöön. Ylityöt olivat puolestaan yhteydessä tupakoimattomuuteen ja lihavuuteen. Kaikki todetut yhteydet vaihtelivat kuitenkin maan ja sukupuolen mukaan.

Johtopäätöksenä työolojen yhteydet terveyskäyttäytymiseen olivat heikkoja, vaikka monien työ oli psykososiaalisesti kuormittavaa ja ylitöiden tekeminen yleistä. Tämän tutkimuksen perusteella työolojen ja terveyden väliset yhteydet eivät todennäköisesti juuri välity epäterveellisten elintapojen kautta. Työväsymyksen ja ylitöiden yhteyksillä lihomiseen ja rintakipuoireisiin voi olla merkitystä työntekijöiden terveyden ja työkyvyn kannalta jatkossa.

ABBREVIATIONS

AP	angina pectoris (symptoms)
BMI	body mass index
CI	confidence interval (95%)
CVD	cardio-vascular disease
CHD	coronary heart disease
ECG	electrocardiogram
FFQ	food frequency questionnaire
HHS	Helsinki Health Study
MET	metabolic equivalent task
OR	odds ratio
WHII	Whitehall II Study
WHO	World Health Organization

1. INTRODUCTION

Adverse health behaviors are an increasingly important public health problem. Although the development in health behaviors and risk factors has long been positive (Vartiainen et al. 2000), partially adverse trends have recently been observed in body mass index and alcohol consumption, for instance (Kastarinen et al. 2007). As health behaviors and risk factors explain over half of the mortality from coronary heart disease (Jousilahti et al. 1995, Laatikainen et al. 2005), they compose a relevant motive for further studies. Additionally, while, on one hand, health behaviors largely explain educational differences in both cardiovascular and all-cause mortality (Laaksonen et al. 2007), the transforming world of work may, on the other hand, also threaten the health of employees (Kompier 2006). However, a long separate research tradition and extensive body of literature exist in the areas of both health behaviors and working conditions, whereas studies combining these research traditions are dispersed and have produced inconclusive results (Netterstrøm et al. 1991, Hellerstedt & Jeffery 1997, Otten, Bosma & Swinkels 1999, Siegrist & Rödel 2006).

The four key health behaviors, i.e., smoking, drinking, physical activity and food habits, as well as related obesity are elements of lifestyle and have been considered together as behaviors that are at least partly voluntary (Blaxter 1990, Laaksonen, Prättälä & Karisto 2001). Patterns of these health behaviors can be seen as being based on choices from available options according to life situation (Cockerham, Abel & Lüschen 1993). More importantly, these behaviors also are determinants of subsequent health and well-being (Breslow 1999, Hu et al. 2005, Patja et al. 2005), although they were initially emphasized in disease prevention only (Kasl & Cobb 1966a, Kasl & Cobb 1966b). It has been suggested that while present social, cultural, and economical conditions promote uncertainty and diversity in these lifestyle choices, they also push people toward greater individual responsibility (Cockerham, Rütten & Abel 1997).

Work-related issues are of importance as well, since people spend a large part of their active time in work, highlighting the significance of various working conditions, such as physical and psychosocial exposures for health behaviors and health of employees (Stansfeld & Marmot 2002, Belkic et al. 2004, Kivimäki et al. 2006, Siegrist & Rödel 2006, Stansfeld & Candy 2006). Furthermore, working conditions have undergone dramatic changes during the previous decades (Frese 2000, Stellman 2003, Kompier 2006). While physical demands at work have diminished, psychological and psychosocial demands have increased with the growing complexity of modern society (Theorell 2000). Both these factors may have deleterious health consequences, as the sedentary employees (Brown, Miller & Miller 2003) are further threatened with psychosocially strenuous working conditions (Ferrie et al. 1998, Stansfeld et al. 1998, Marmot, Theorell & Siegrist 2002). New challenges also include modern technologies, while physical and chemical exposures still pose hazards for many employees (Hemström 2001, Ylikoski et al. 2006). Therefore, the current situation emphasizes a need to identify both physical and psychosocial conditions in work that potentially act as contributors of employees' behaviors, weight, and subsequent health.

The challenge of the research in this area is, however, that health behaviors also occur outside work. Nevertheless, they impact weight, physical symptoms, and well-being

of employees and subsequently their work ability and productivity. This highlights the importance of gaining new evidence about the contribution of the working conditions to the modifiable, preventable, behavioral risk factors. One might hypothesize that with high levels of physical activities, other health behaviors, and maintenance of healthy weight, employees can better do their work, while prevention of lifestyle-related chronic diseases can also be achieved. Additionally, it is necessary to seek efficient ways to promote healthy weight among employees by elucidating understanding of the work-related correlates of weight gain and obesity. Some workplace factors may bear potential for beneficial influence as well by, for instance, contributing to healthier food habits (Lallukka, Lahti-Koski & Ovaskainen 2001, Roos, Sarlio-Lähteenkorva & Lallukka 2004).

Especially concerning women, previous studies about the associations between working conditions, work-related factors, and behavioral risk factors are largely lacking, but are of importance as during the previous decades women have increasingly entered the workforce outside their homes (Blau 1998, Ylikoski et al. 2006). Women may, therefore, face even more demanding situations than men due to multiple roles at work and at home (Barnett 2004). Furthermore, the relationship between psychosocial working conditions and behavioral risk factors is likely to be complicated by the simultaneous demands of family roles (Brezinka, Kittel 1995, Lai 1995, Artazcoz, Borrell & Benach 2001). Accordingly, work-related factors such as work-home interface, as well as social support (Sarason et al. 1983, Sarason et al. 1987) need to be examined alongside the working conditions.

Since socio-economic indicators are also linked with working conditions (Schrijvers et al. 1998), it has been suggested that improved working conditions might help reduce socio-economic inequalities in health among employees, i.e., health inequalities may originate from the workplace (Vahtera et al. 1999). Also other later studies imply that the known socio-economic inequalities in health may originate from the workplace (Chandola, Brunner & Marmot 2006). More specifically, the known relationship between occupational social class and health is assumed to be mediated by psychosocial working conditions (Rahkonen et al. 2006). The extent to which the generally socially-patterned behaviors are also correspondingly determined or explained by working conditions warrants, however, further investigation. This is of importance, as adverse health behaviors have been found to be frequent among employees in Finland (Talvi et al. 1998), but show potential for improvements in work-site intervention (Talvi, Järvisalo & Knuts 1999).

Multidimensional explanation profiles, e.g., both psychosocial and physical working conditions, and work-home interface, are innovatively applied in this study. The emphasis is, however, on the psychosocial working conditions. Additionally, a specific emphasis is on increasing understanding about the significance of working conditions for female employees. Most of the previous studies have only examined male populations, single workplaces, one or a few behaviors, or included limited information about working conditions. It is important, therefore, to deepen, clarify, and update our understanding about the significance of various working conditions for employees' health-related behaviors and symptoms.

The main focus of this study is on key behavioral risk factors and on how working conditions might be associated with health behaviors and physical symptoms among

employees. Increasing understanding about working conditions as assumed determinants of behavioral risk factors is needed, in order to prevent the chronic diseases morbidity and mortality, as well as to promote better health and prevent physical symptoms among employees. In addition to focusing on adverse behaviors which are established determinants of future morbidity, early retirement, and mortality (Neubauer et al. 2006), this study also aims to identify work-related factors associated with healthy behaviors that are likely to contribute to health and maintenance of work ability.

2. CONCEPTUAL FRAMEWORK

The need to include work-related factors to occupational health studies has been warranted (Stellman 2003). Thus, this study was set to cover a wide variety of working conditions as potential determinants of several behavioral risk factors and symptoms of angina pectoris (AP). In this study, behavioral risk factors refer to health behaviors, weight gain, obesity, as well as AP symptoms.

The following conceptual examination will present and characterize the key determinants and outcomes used in this study and possible mechanisms linking the two. First, working conditions are conceptualized with a particular focus on areas covered in this study. However, also other related concepts are briefly covered when applicable, i.e., the studied working conditions are connected to a wider theoretical framework as well. Secondly, the behavioral risk factors will be described. Thirdly, the framework of the thesis will be elucidated by linking these areas together, showing the assumed mechanisms and pathways between working conditions, behavioral risk factors, and AP symptoms. As the main focus of the present study is on behavioral risk factors, the approach and emphasis in this conceptual framework will be on the health-related behavioral outcomes. Instead, the actual disease outcomes are beyond the focus of this thesis.

2.1 Working conditions

Working conditions cover various dimensions that can be approached in several ways. In general, working conditions can be characterized as physical and mental conditions relating to the work environment (Cox, Griffiths & Rial-González 2000). Key mental conditions comprise psychosocial strain, work arrangements, and work organizational factors, whereas studying the physical work environment has a long tradition typically focusing on exposures such as noise and workload which, nevertheless, may be also linked with stress, or potentially cause stress (Cox, Griffiths & Rial-González 2000, Stock et al. 2005). Also work-related chemical exposures and noise are of importance as health hazards.

In this study, working conditions are mostly conceptualized from the perspective of psychosocial factors such as job strain and work fatigue. Work arrangements such as working hours are also important (Caruso et al. 2004). Furthermore, other work-related factors such as work-home interface and social support are understood as reflecting broadly psychosocial working conditions alongside the other above-mentioned factors. This approach is derived from previous hypotheses presenting these working conditions as factors potentially shaping health behaviors adversely and subsequently contributing to weight gain, physical symptoms, and disease risk (Stansfeld & Marmot 2002).

Psychosocial working conditions, however, differ from more traditional physical, physiological and chemical exposures at workplace that are directly measurable unlike perceived psychosocial stressors (Marmot, Theorell & Siegrist 2002). Consequently, examining these working conditions is both a theoretical as well as a methodological challenge. Furthermore, utilizing this approach, i.e., including psychosocial working conditions in study designs necessitates relying mostly on self-

assessments, which are prone to variation due to individuals' characteristics and perceptions (Kasl 1981). These differences between individuals subsequently play a crucial role in the assumed etiological chain between work environment and health outcomes.

2.1.1 Physical working conditions

Physical work demands and workload vary largely by occupation (Hemström 2001). More specifically, physical load is mostly related to blue-collar work, while those in upper white-collar positions have the least amount of such exposures. In other words, physical workload is strongly related to social class (Suadicani, Hein & Gyntelberg 1995).

Typically, physical demands or physical exertion refer to physical exposures at work, such as lifting heavy burdens, similar and repetitive motions, standing, walking, difficult and awkward working positions etc. (Green & Johnson 1990, Johnson & Hall 1991, Gutierrez-Fisac et al. 2002, Johansson, Toivanen 2007). It is also possible to more generally examine how strenuous the work is physically (Nishitani & Sakakibara 2006, Ostry et al. 2006). Mechanisms through which physical working conditions may be linked with employee health include direct physical pathway and a psychological stress-mediated pathway (Cox, Griffiths & Rial-González 2000). Physical and psychosocial working conditions are also interconnected. Subsequently, physical working conditions need to be taken into account even when examining psychosocial working conditions in order to produce a comprehensive picture of the area and provide more valid results (Stock et al. 2005).

2.1.2 Psychosocial working conditions

Psychosocial factors relate psychological phenomena to the social environment as well as to adverse physiological changes (Hemingway & Marmot 1999). Consequently, psychosocial working conditions are assumed to act as factors with etiological significance for employees' health, at least when the conditions are of a chronic nature and cause stress (Johnson et al. 1996). However, it needs to be noted that the role of psychosocial factors in the actual etiology of diseases or with potential dose-response effect was strongly criticized a few decades ago (Cassel 1976). Instead, psychosocial processes were suggested to be better envisaged as enhancing susceptibility to disease, while a need for more critical use of the stress concept was emphasized. The general concept of stress was, in turn, popularized by Hans Selye, who separated the concept of distress from stress which can be beneficial as well (Selye 1974). These concepts may also apply to work, although Selye's original views of stress did not relate to the environment, but to bodily reactions and state. The term work stress has, in turn, several dimensions, including the concept of job strain (Muntaner et al. 2006a). It is also important to note that the deleterious effects of chronic stress can be counteracted by aiming to promote healthy behaviors such as physical activity and social support (McEwen 2007).

In general, psychosocial factors at work as well as elsewhere constitute an 'umbrella concept,' since various conditions have been described as psychosocial hazards.

These include factors such as organizational culture, employee roles and role conflicts in organization, and job insecurity (Bartley & Ferrie 2001, Muntaner et al. 2006a, Muntaner et al. 2006b, Hadden et al. 2007).

Key psychosocial working conditions comprise job demands and job control, which is also referred to as decision latitude and reflects employees' opportunities to participate in decision making and develop skills the job requires (Muntaner et al. 2006a). More specifically, two separate components of the control dimension are skill discretion relating to task variety and options to develop and learn new things, and decision authority described as employees' ability to participate in decisions making concerning the actual job (Karasek 1979, Muntaner & O'Campo 1993). Job demands, in turn, refer to time pressures, interruptions, and to how fast and hard the employee has to perform the tasks the job requires. As a critique, job demands and job control have also been seen to merely reflect one's occupational social class, i.e., as a meaningful way to capture information about differences in occupation-related prestige or supremacy that potentially affect health (Braveman et al. 2005). Nonetheless, both working conditions and occupational class are also individually related to health (Rahkonen et al. 2006).

Psychosocial working conditions are, however, more structural than individual, while examining these factors has been mostly conducted by relying on self-reported questionnaire survey data (Benavides, Benach & Muntaner 2002). Previous studies have suggested that job demands and job control should be understood as showing variation both within and between work groups and workplaces, i.e., both individual and group level are of importance when assessing associations between health-related outcomes and these psychosocial working conditions (Van Yperen & Snijders 2000, Hammer et al. 2004). Accordingly, organizational level behavioral and social norms are assumed to be notable additional components of psychosocial work environment generally assessed as individuals' perceptions of job demands, job control, and social support and contributing to employee well-being (Hammer et al. 2004). As the core of the concept of psychosocial reflects both internal social relations at work and external social relations such as family, these should be better taken into account alongside employees' own perceptions of their work (Hammer et al. 2004).

Two theoretical work stress models have been developed that conform to the requirements to identify psychosocially strenuous working conditions and assess the risk for the employee exposed to such conditions (Pelfrene et al. 2003). These models, called job demand-job control model and effort-reward imbalance model have been well-validated and used in numerous epidemiological studies (Karasek et al. 1981, Bosma et al. 1998). Recent reviews and results from meta-analyses suggest that both models are linked with poor health outcomes, and an increase in coronary heart disease (CHD) in particular, which is not explained by conventional biological or behavioral risk factors, nor by physical or chemical exposures at workplace (Peter & Siegrist 2000, Belkic et al. 2004, van Vegchel et al. 2005, Kivimäki et al. 2006).

Job demand-control model

The job demand-control model used to study the effects of work stress on health outcomes describes psychosocial work environment (Karasek 1979). The model has

its origins in the field of occupational health, although the concepts have been applied in other fields with different approaches to the associations between social context and behaviors (Muntaner, O'Campo 1993). Originally, redesigning the work process was suggested to be implemented by increasing employees' job control without affecting the demands in order to reduce mental strain while maintaining the output level of the organization (Karasek 1979). Accordingly, the core of the job demand-job control model describing these work organization features is high job strain, i.e., the assumed outcome of the situation characterized with high job demands coupled with low job control to meet the required demands. Low job strain, in turn, is understood as the outcome of the opposite situation where content of work is characterized with low job demands in interaction with high job control. A combination of low job demands and low job control is considered to be perceived as a passive work environment, while high job demands coupled with high control is assumed to be an active situation with good learning possibilities. According to the original hypothesis (Karasek et al. 1981), employees with prolonged high job strain are at increased risk of developing cardio-vascular diseases (CVD). This hypothesis was supplemented with learning opportunities on the basis of psychosocial job experience (Marmot, Theorell & Siegrist 2002). Thus, the situation characterized with high control over the demands may be connected with the beneficial side of stress, or protect from adverse effects of stress (Selye 1974). However, recent evidence did not support the hypothesis that active work might be connected to learning (Taris et al. 2003). Instead, although high job control is likely to beneficial for learning, it cannot compensate for the adverse effects of high job demands.

Work-related social support was later added as a third dimension to the job demand-job control model (Johnson & Hall 1988, Karasek & Theorell 1990). The most deleterious combination is assumed to be the conjunction of high job demands, low job control, and lack of social support from colleagues and supervisors, which is called isolated strain (iso-strain). Thus, the amount of work-related social support is hypothesized to modify the impact of high psychosocial demands on employee's health. However, a recent follow-up study did not provide any support for the iso-strain model (André-Petersson et al. 2007).

The effort-reward imbalance model

The effort-reward imbalance model is another, more contemporary model to examine the effects of psychosocial working conditions on health outcomes (Siegrist 1996). Originally, effort-reward imbalance was developed for identifying conditions of failed reciprocity in social contracts, particularly at work, in predicting lowered well-being and increased susceptibility for diseases (Siegrist 2002). Conclusions of a recent review supported the extrinsic effort-reward imbalance hypothesis (van Vegchel et al. 2005).

Work fatigue

Work fatigue, the first stage of burnout, also reflects psychosocially strenuous working conditions (Maslach, Jackson & Leiter 1996, Maslach, Schaufeli & Leiter 2001). Moreover, this exhaustive fatigue is described as a central quality of burnout

and its most obvious manifestation, while in lay conversations, the experience of exhaustion is often referred to as burnout (Maslach, Schaufeli & Leiter 2001). Exhaustion also reflects the stress dimension of burnout. Exhaustion is followed by two other dimensions of burnout: cynicism and inefficacy. Thus, work stress and work fatigue are closely linked, as burnout is regarded as a consequence of chronic exposure to stressors at work. In particular, workload and time pressures are linked with the exhaustive fatigue component of burnout (Maslach, Schaufeli & Leiter 2001). Additionally, work fatigue is an indicator of health and linked with the work-home interface (van Hooff et al. 2005). Work fatigue may also interact with age, as it may be more prevalent among women in the younger age groups, whereas the situation might be reversed in men (Reijula et al. 2003).

2.1.3 Work arrangements and other work-related factors

Working time

With regard to work arrangements and their health effects, shift work in particular has been addressed in several studies (Caruso et al. 2004). However, also working time as such needs to be taken into account when considering the psychosocial working environment and its effect on employee health or health-related issues (Caruso et al. 2004, Caruso et al. 2006, Grosch et al. 2006). Furthermore, working hours can be seen as reflecting the amount of exposure for the employee at the workplace.

Working overtime usually refers to hours worked beyond the conventional eight hours a day encompassing working overtime in the evenings, during weekends or holiday times (Spurgeon, Harrington & Cooper 1997). However, many studies have focused on more extreme work hours, such as working over 50 hours a week, whereas less evidence exists about the detrimental effects of moderate overtime hours. While working overtime is prevalent, a comparative analysis of 22 countries suggested an overall preference to reduce overtime work (Stier & Lewin-Epstein 2003). This was especially true in developed countries and among those with more secure living standards and higher incomes.

Nonetheless, working hours are polarized across social class with those in professional positions having regular, but long working hours, whereas those with less education work more irregular hours though they have fewer overall working hours (Johnson & Lipscomb 2006). Additionally, overtime employees are more likely to be middle-aged, white male employees with higher education and income, as compared to full-time employees (Grosch et al. 2006). Working overtime may also be linked with an increase in work-home conflicts and work stress, but also with aspects of job control, i.e., opportunities to influence the situation as well (Grosch et al. 2006, Härmä 2006). Moreover, working long hours is a health and safety risk (Spurgeon, Harrington & Cooper 1997). Thus, even though working overtime is often seen as a benefit for the employer, its subsequent consequences might bear high costs due when health problems among employees increase (Ross & Mirowski 1995, Spurgeon, Harrington & Cooper 1997, Shields 1999, Lynch 2001). Accordingly, long working hours relate to a higher number of medically-certified sickness absences (Ala-Mursula et al. 2006). However, having control over working hours may reduce these adverse

associations, while control may also help the employees combine their paid work with the demands of family life and domestic work.

Work-home interface

Relationships between paid work and family life are increasingly important alongside other psychosocial pressures and time constraints. Furthermore, job strain and working overtime are both connected to work-home conflicts (Devine et al. 2007), while stable and controllable working hours may help decrease work-home conflicts (Bohle et al. 2004). Several different mechanisms linking work and family have been presented, part of which assume no causality between the domains of life, while other models suggest that the situation at work may be family-related (Edwards & Rothbard 2000). Accordingly, in the case of a causal relationship, work fatigue may, in turn, translate into exhaustion and problems at home as well. In general, work-home interface, also referred to as work-home interference, can be characterized as employees' perception of balance between work and family life. This interference can be either positive or negative (Grzywacz & Marks 2000). Moreover, the concept of work-home interface relates not only to family life and domestic affairs, but it is also to be seen as connected to a broader domain of life occurring outside work (Cox, Griffiths & Rial-González 2000). The work-home interface comprises bidirectional conflicts, i.e., work may interfere with family life or vice versa. Both conflicts are also linked with work stress (Hammer et al. 2004). Work-family conflict may also lead to emotional exhaustion (Senécal, Vallerand & Guay 2001).

Particularly among women, considering multiple roles such as employee, mother and spouse has evoked questions whether these demands have any detrimental health consequences (Barnett 2004). This appears to be especially true for mental health (Chandola et al. 2004). Nevertheless, multiple roles may be beneficial for health as well (Lahelma et al. 2002). Conflicts may also arise from type of work contract, with temporary employees potentially suffering from greater work-home conflict than "permanent" employees (Bohle et al. 2004). An unfavorable schedule, a high quantitative workload, and a troublesome relationship with a superior have been observed as work-related antecedents of work-home interference, while having a partner working overtime may be a home-related antecedent of work-home interference (Geurts, Rutte & Peeters 1999). Therefore, work-home interface is not to be determined by being part of a dual career family, parental status, or social support. Sustained work-home conflicts in particular, such as work obligations hampering relaxation at home, may be linked with an accumulation of health complaints (van Hooff et al. 2005).

Social support

Social support, in turn, is understood as support received at work from colleagues or supervisors, as well as support outside work from spouse, significant other or friends at times when facing problems or difficulties (Sarason et al. 1983, Sarason et al. 1987). It also reflects opportunities to interact and meet with others (Johnson & Hall 1988, Karasek & Theorell 1990). In general, high social support may be linked with positive events in life, higher self-esteem, and optimism (Sarason et al. 1983).

Additionally, social support may provide a person with better alternatives to persist at a task when under frustrating conditions such as high job demands. Therefore, in addition to direct beneficial effects, social support may buffer against harmful effect of stress (Winnubst & Schabracq 1996). Social support is also of importance as a psychosocial factor, since it may moderate both the effects of the work environment and health effects strenuous work may cause on employees (Muntaner et al. 2006a). Improving and strengthening social supports were already decades ago presented as a means to deal with stressors and prevent the disease outcomes instead of attempts to reducing the actual exposures (Cassel 1976). Moreover, relationships at work may provide information and tangible assistance for work-related problems, while non-work relationships correspondingly provide support for problems outside work (Lindorff 2005). However, stronger emotional support for both work and non-work stressors is likely to be received from relationships outside the workplace. The role of social support in the process of work stress is seen as primarily to reduce the strains experienced, whereas its secondary function may be to reduce the strength of the stressors, and thirdly, to mitigate the effects of stressors on strains (Viswesvaran, Sanchez & Fisher 1999).

2.2 Behavioral risk factors

Alongside the previously described working conditions, behavioral risk factors are related to employees' health. More specifically, unhealthy behaviors, i.e., smoking, heavy drinking, adverse food habits, physical inactivity, and related risk factors such as obesity are key modifiable determinants of major preventable diseases, in particular, cardiovascular diseases (Hahn, Heath & Chang 1998, Kannel et al. 2002, Wilson et al. 2002, Chahoud, Aude & Mehta 2004, Hu et al. 2004, Ezzati et al. 2005), type II diabetes (Patja et al. 2005) and several types of cancers (Poikolainen 1995, Hu et al. 2005). Accordingly, following recommended food choices as well otherwise healthy lifestyle has been estimated to practically eliminate CHD in the population aged younger than 70 years based on cross-cultural, cohort, and intervention studies (Kromhout et al. 2002). The various behavioral risk factors are both independent and partly interrelated (Laaksonen, Lahelma & Prättälä 2002), with smoking appearing to be a key behavior determining the co-occurrence of other behaviors (Laaksonen et al. 2002). Moreover, health behaviors are also undergoing major and rapid changes (Popkin & Gordon-Larsen 2004). Both physical activity patterns and food habits have changed and are major contributors to the increasing obesity rates.

In the following sections, the key health behaviors, as well as related weight gain, obesity, and symptoms of angina pectoris are presented separately, and linked to the context of health, i.e., justifying the significance for studying these behavioral risk factors as potential contributors of current and future health of the employees. Concerning each of the behaviors, the nature and types of the habit are mentioned and characterized first, followed by their health relevance and correlates. Finally, the framework of this study will show the potential links between working conditions and behavioral risk factors.

2.2.1 Health behaviors

Smoking

Smoking is a complex, bio-behavioral habit affected by several psychosocial as well as bio-physiological factors (Kozlowski, Henningfield & Brigham 2001). In general, smoking may be occasional such as a habit of weekends-only smoking, but typically is regular smoking and reflects more addictive behavior. Also tobacco types as well as intensity of regular smoking may substantially vary. In epidemiological studies smoking usually refers to a habit of regularly smoking cigarettes, cigars or a pipe, whereas non-smokers are comprised of both never-smokers and ex-smokers that can be examined also separately (Kouvonen et al. 2005). The number of cigarettes smoked per day or nicotine dependency can be also assessed as more specific indicators of smoking behaviors (Broms et al. 2004, Panday et al. 2007). With respect to middle-aged smokers, determinants of smoking cessation or intensity and maintenance of the behavior are of particular importance, as smoking is usually initiated in young adulthood (Paavola, Vartiainen & Haukkala 2004).

A focus on current smoking is, nonetheless, vital, since smoking is a harmful habit in terms of adverse health consequences and also due to tremendous financial costs due to increased morbidity and mortality among smokers (Thun et al. 1997, Ezzati et al. 2005, Neubauer et al. 2006). Accordingly, smoking was mentioned as the largest preventable risk factor for morbidity and mortality in developed countries in a recent report assessing the negative health consequences and associated costs of cigarette smoking during a ten-year period in Germany (Neubauer et al. 2006). With regard to cancer, smoking is the number one risk factor worldwide (Shafey, Dolwick & Guindon 2003). Consequently, smoking is a major public health problem and has been discussed in a myriad of studies. Smoking is also closely linked with socio-demographically and socio-economically disadvantaged conditions throughout the life course (Broms et al. 2004, Huisman, Kunst & Mackenbach 2005, Laaksonen et al. 2005a, Rahkonen, Laaksonen & Karvonen 2005). However, most smokers are likely to be willing to quit smoking, while a smaller percentage of consonant smokers also have more other adverse behaviors (Haukkala, Laaksonen & Uutela 2001).

One of the most striking changes in the smoking trends is the increase of female smokers, while socio-economic inequalities in smoking have been persistent (Idris et al. 2007). In Finland, recent trends show, however, that smoking has decreased among men, while smoking among women has remained at the same level during the previous couple of decades (Helakorpi et al. 2007). The number of smoking women highlights an urgent need to study the determinants and correlates of smoking among women in particular.

Drinking

Drinking refers to consumption of alcoholic beverages such as beer, wine, and spirits. Like smoking, drinking alcohol may refer to drinking on special occasions or weekends only, or more frequent behavior (Zins et al. 1999). In addition to general drinking patterns, other drinking behaviors also exist, such as binge drinking and problem drinking (Head et al. 2002, Dawson, Grant & Ruan 2005). Furthermore,

heavy, binge, and problem drinking are likely to reflect at least partially different phenomena and risks than moderate drinking patterns (Thun et al. 1997, Vahtera et al. 2002). While heavy alcohol consumption was related to all-cause mortality, moderate drinking slightly reduced mortality in a very large prospective study of 490 000 U.S. adults (Thun et al. 1997).

Alcohol consumption and its effects on chronic disease risk are, nevertheless, somewhat controversial (Rehm et al. 2003), as is the protective effect of moderate alcohol consumption (Corrao et al. 2000). While some beneficial influence on CHD, stroke and type II diabetes have been observed, alcohol consumption is, however, related to many major diseases such as several cancers, depression and liver cirrhosis in a detrimental fashion (Thun et al. 1997, Rehm et al. 2003). Moreover, despite the potential inverse relationship between alcohol consumption and CHD, an increased intake is not recommended as it is likely to have substantial, unwanted social and medical consequences (Marmot 2001). With regard to the middle-aged Finnish population, alcohol consumption has been suggested to have caused markedly more deaths than what could be prevented by an optimal consumption level (Mäkelä, Valkonen & Poikolainen 1997). In the older age-groups, the numbers of deaths prevented and caused are, in turn, more balanced. Nevertheless, the health benefits of alcohol do not exceed the harms at any level of consumption (Jackson et al. 2005) implying that characterizing healthy or unhealthy drinking is difficult based on the existing evidence. Furthermore, gender differences and cross-cultural variation in drinking behaviors are likely to make these issues even more complicated (Mäkelä et al. 2006). Overall, smoking and drinking alcohol can be considered as behaviors with several adverse consequences both at the individual and public health levels.

Physical activity

Physical activity is a complex set of behaviors characterized as "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen, Powell & Christenson 1985). Physical activities may be categorized into light, moderate or heavy intensity, into willful or compulsory in nature and activity occurring on weekdays or weekends. Typical forms of such activities are walking, jogging, running, lifting, carrying etc, i.e., activities that vary in intensity and aerobic nature. A specific, explicit distinction has been made between exercise and physical activity: exercise is to be conceptualized as a subset of physical activity (Caspersen, Powell & Christenson 1985). Although it corresponds to the above definition of physical activity, it also encompasses elements of planned, structured, and repetitive activity with an aspiration to maintain or improve physical fitness. Furthermore, physical activity may refer to both work-related and leisure-time physical activities (Howley 2001). Additionally, it is possible to focus on either activity or inactivity patterns as well as sedentary behaviors that are likely to reflect somewhat different phenomena. However, work-related and leisure-time physical activity are also likely to be interrelated and have been shown to vary by occupational group (Burton & Turrell 2000, Pomerleau et al. 2000, Schneider & Becker 2005).

In contrast to smoking and drinking, physical activity generally has mostly beneficial effects on various health outcomes. Physical activity is connected with reduced risk of major chronic diseases (Hu et al. 2005, Hu et al. 2007) as well as reduced mortality

even after adjusting for genetic and other familial factors (Kujala et al. 1998). Moreover, focusing on correlates of inactivity is vital, as inactivity can be considered as a major risk factor for morbidity (Schneider & Becker 2005). It has been suggested that declines in physical activity both during leisure time, transportation, and related to work also play a substantial role underlying the epidemic of obesity (Popkin & Gordon-Larsen 2004). However, the risk reduction of chronic diseases as well as enhanced quality of life can be achieved even with smaller changes that increase physical activities in daily life (Pate et al. 1995).

As the prevalence of sedentary behaviors both at work and during leisure time is assumed to be high (Gal, Santos & Barros 2005), new evidence on how to increase physical activity of employees and to identify potential barriers to such activities is needed. Work-related physical activity may, however, be less important, as neither mean body mass index (BMI) nor percentage obesity vary according to work-related physical exposures (Gutierrez-Fisac et al. 2002). A focus on gaining new information about the correlates of leisure-time physical activity may thus be a more relevant approach in the perspective of health promotion and disease prevention than work-related physical activity.

Food habits

Food habits refer to typical foods consumed during a certain time period, and may more generally indicate eating patterns such as having breakfast. In epidemiological studies, several concepts including dietary patterns (Naska et al. 2006), dietary habits (Dynesen et al. 2003), food choices (Drewnowski & Darmon 2005), food habits (Irala-Estévez et al. 2000, Sanchez-Villegas et al. 2003), eating habits (Shahar et al. 2005) and eating patterns (Patrick & Nicklas 2005) have been used to describe consumption of foods or diet more generally. It is also possible to more accurately assess intake of nutrients derived from a variety of foods consumed or from a typical diet (Marks, Hughes & van der Pols 2006).

Food habits differ from all the other risk factors presented above, as everyone has to eat, and only the selected types of foods and quantity eaten may vary among people. Within an individual, however, variation between days and seasons may be substantial. Often, food habits are classified as unhealthy or healthy based on only crude or proxy information about actual food habits (Prättälä, Laaksonen & Rahkonen 1998, Johansson et al. 1999, Martikainen, Brunner & Marmot 2003). However, items included usually represent foods from main segments of dietary guidelines (Roos et al. 1998), which in turn generally represent the recommended intake of all essential nutrients by age and gender (Becker et al. 2004). Nevertheless, some new recommendations display healthy food habits in a more concrete way (American Heart Association Nutrition Committee et al. 2006). This is of importance as concrete messages about healthy food habits, such as how many daily servings of fruit and vegetables are recommended has been suggested to be essential with regard to consumption behaviors (Havas et al. 1998). Food habits are also affected by social desirability, i.e., tendency to describe food habits according to a certain social norm instead of corresponding to the actual situation (Sjöström & Holst 2002, Barros, Moreira & Oliveira 2005), as well as by socio-economic position, and economic difficulties in particular (Lallukka et al. 2007).

From the perspective of health outcomes and consequences, food habits are notable, modifiable determinants of major chronic diseases such as CHD and type II diabetes (Kromhout et al. 2002, Albert 2005, Montonen et al. 2005, Champagne 2006, Kuller 2006). Thus, increasing understanding about the correlates of food habits is important, as food-related ill-health in terms of increased morbidities and mortality also causes substantial financial costs (Rayner & Scarborough 2005). Accordingly, it has been suggested that with the decline in the prevalence of smoking, poor nutrition may become the key risk factor for many diseases (Shahar et al. 2005).

2.2.2 Weight gain and obesity

In general, overweight and obesity refer to excess body fat. Weight gain, in turn, is caused by excess energy intake with regard to energy expenditure. During the previous couple of decades, BMI (weight/height^2) has been universally accepted as an indicator of excess body weight, i.e., overweight and obesity (Seidell 2005). Typically, obesity has usually been defined as a BMI of 30 or more. The BMI distribution varies, however, in different cultures. Accordingly, lower cut-off points have been suggested to be more relevant and suitable to be used to reflect obesity in some Asian populations (Horie et al. 2006, Yang et al. 2007)

Obesity is a complex, multi-factorial issue, and its etiology and determinants are still poorly understood (Rosmond 2004). Nonetheless, weight gain and subsequent obesity are mostly caused by excess and adversity in food habits and physical inactivity (Popkin & Gordon-Larsen 2004). More specifically, food habits such as frequent consumption of snacks, fast food, and sweets (Bowman & Vinyard 2004) as well as activity patterns are known to contribute to body weight among working-aged adults (French et al. 1994). As these behaviors interact, separating their effects on weight gain is difficult (Williamson 1996). Advice on lifestyle change also shows potential for preventing weight gain (Inoue et al. 2005).

From the perspective of health, overweight and obesity-related co-morbidities and risk factor levels increase with weight, causing a notable burden of disease (Must et al. 1999). Accordingly, obesity is related to both severe chronic morbidity as well as mortality (Caterson et al. 2004). Furthermore, the epidemic of obesity is a severe problem in Finland (Lahti-Koski et al. 2000), in other western countries (Silventoinen et al. 2004, Crawford & Jeffery 2005), and in Japan (McCurry 2007). Thus, a need for new evidence about the correlates of obesity and processes that permit others to maintain normal weight has been warranted (Rosmond 2004). Although preventable, obesity is undisputedly a major public health problem, placing a large burden on the health care system (Ofei 2005, Schmier, Jones & Halpern 2006, Laaksonen, Piha & Sarlio-Lähteenkorva 2007).

Since the management of obesity is difficult (Proietto & Baur 2004), focusing on prevention of the epidemic and further studies about the determinants of weight gain and obesity are essential. Furthermore, while obesity produces few symptoms before the age of 40, several complications and symptoms may emerge in the older age groups (Lean 2000). This highlights the need for effective, early prevention of weight

gain and subsequent obesity as middle-aged and aging obese employees may already suffer from the consequences of their excess weight.

2.2.3 Symptoms of angina pectoris

In addition to health behaviors contributing to weight, all of the above presented factors may relate to physical symptoms such as symptoms of angina pectoris (Figure 1). Furthermore, health behaviors and weight changes may independently relate to AP symptoms. Reverse causality is also possible and may dilute the findings of cross-sectional design, i.e., obese employees might attempt to lose weight in order to alleviate their physical symptoms. Accordingly, beneficial changes in health behaviors may also be present. At the same time, AP symptoms may be attributable to strenuous work.

In general, angina pectoris is a condition in which the coronary arteries are narrowed by atherosclerosis causing myocardial ischemia and subsequent chest pain upon exertion. The origin of chest pain can, however, be other than coronary heart disease, i.e., physical, functional, or psychosocial (Nicholson et al. 1999, Macleod et al. 2002). As separating these alternative interpretations is difficult, further studies about the determinants of symptoms of angina pectoris are needed.

Moreover, the actual prevalence of angina pectoris has been estimated to be higher than that diagnosed (Zaher, Goldberg & Kadlubek 2004). This is of importance, as prognosis of undiagnosed versus diagnosed is similar (Hemingway et al. 2003). Additionally, an unsolved paradox is related to AP symptoms: women tend to report these symptoms even more than men, but the coronary endpoints, such as myocardial infarction are more prevalent among men (Cosin et al. 1999), indicating an urgent need for further studies about the determinants of AP symptoms among women in particular. This is further highlighted by the fact that the prevalence of angina among women corresponds to their use of nitrates, i.e., medications for alleviation of the symptoms (Zaher, Goldberg & Kadlubek 2004). Thus, AP symptoms among women may reflect true coronary heart disease. Accordingly, coronary heart disease has been shown to be elevated also in younger women and men with AP symptoms, even among those with a tendency of reporting high levels of general symptoms (Nicholson et al. 1999). AP symptoms measured by the Rose questionnaire (Rose 1965) were also strongly related to cardiovascular mortality among women in the largest epidemiological study testing the questionnaire (Feinleib et al. 1982). The risk of dying was threefold among women with AP symptoms compared to those not reporting the symptoms. Thus, AP symptoms among employed women need to be further examined.

2.3 Framework of the study: linking working conditions to behavioral risk factors

This study seeks to examine the potential links between working conditions, behavioral risk factors and symptoms of angina pectoris. Several pathways and mechanisms may exist that connect the work environment with health-related outcomes. A schematic, simplified, conceptual framework of the study presented in Figure 1 shows the assumed temporal order and relationships between the working conditions and behavioral risk factors, indicated by arrows 1-9. Potential confounders that at least partly precede working life while also being affective through the life-course (Brunner et al. 1999, Kuh & Ben-Shlomo 2004) are displayed as well (arrow 1). All these assumed pathways and mechanisms are next presented and discussed concerning each of the behaviors as well as symptoms of angina pectoris. Finally, confounding factors, general health-relevance, and expected results are described.

In general, studying associations between working conditions and behavioral risk factors is motivated by previous hypotheses about potential mechanisms between job strain and chronic diseases, CVD in particular. These mechanisms through which working conditions may affect health include direct effects on immune functioning, biological and hormonal pathways or indirect effects when working conditions are assumed to be first influencing behavioral risk factors (Stansfeld & Marmot 2002, Siegrist & Rödel 2006). Thus, when the focus is set on the behavioral risk factors, it is possible to shed light on the potential mediating role of these risk factors. If strenuous working conditions predispose employees to several unhealthy behaviors and obesity, a cumulative effect is likely to be a chronic disease, such as CVD.

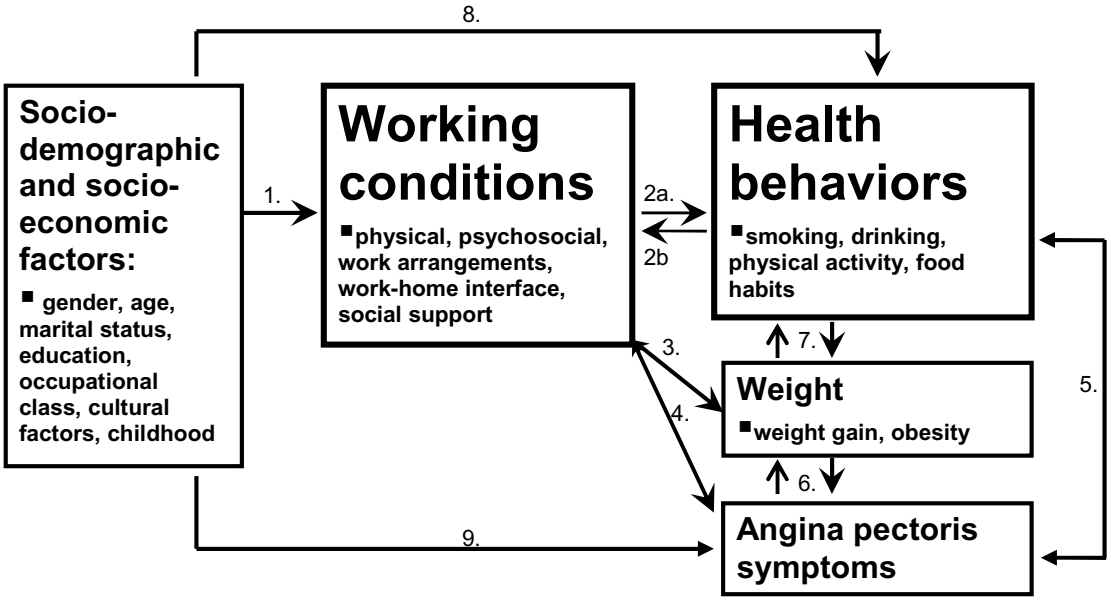

Figure 1. Schematic conceptual framework of assumed temporal order and pathways between working conditions and behavioral risk factors

Theoretically, the pathway between working conditions and behavioral risk factors can be understood as a response of an individual to environmental challenges such as strenuous working conditions that may culminate in behavioral modification as well as psychological or physiological symptoms (Bhui 2002). The arrows 2-4 from working conditions to health behaviors, weight, and AP symptoms refer to these effects and associations.

Even though psychosocial working conditions, work stress in particular, have been mostly linked with cardio-vascular disease (Peter & Siegrist 2000, Belkic et al. 2004, Kivimäki et al. 2006), also other areas such as both mental (Tsutsumi et al. 2001) and physical health (Sekine et al. 2006) are affected by work-related factors. However, relationships between working conditions and risk factors remain to be further corroborated. It is plausible that working conditions and other work-related factors interfere with behavioral changes and thus impact subsequent employee health. Accordingly, employees might show a tendency to compensate strenuous work such as either heavy physical or psychosocial demands with unhealthy behaviors (Prättälä 1998). The next four paragraphs discuss the assumed links from working conditions to smoking, drinking, physical activity, and food habits, as indicated in Figure 1 with the arrow 2a.

First, working conditions are linked with smoking behaviors, especially smoking cessation. As smoking is assumed to ease stress, smokers may smoke most when exposed to strenuous work in order to calm themselves down or to alleviate the perceived stress (Perkins & Grobe 1992, Parrott 1999). Accordingly, high job strain and nicotine dependence have been suggested to provoke physical arousal which the employees might seek to sedate by smoking (John et al. 2006b). However, smoking is also connected with the state of happiness and relaxation, not only with attempts to alleviate perceived stress (Thomsson 1997). Contrary to a common assumption among smokers, successfully quitting smoking may also lower stress and improve psychological wellbeing (Parrott 2000). Thus, an environment with low psychosocial strain might support smokers to quit smoking. In contrast, since willingness to quit smoking is high among smokers (Haukkala, Laaksonen & Uutela 2001), strenuous working conditions may act as barriers to successful cessation of the habit. In other words, under chronic high job strain, it is likely that smoking behavior is maintained to cope with the situation, or high job strain could even induce the quitters to relapse to smoking. Nonetheless, as smoking is a behavior initiated usually as early as the teenage years or in young adulthood (Blaxter 1990, Paavola, Vartiainen & Haukkala 2004), the assumed relationships between working conditions and current smoking are likely to reflect smoking intensity, increase in smoking, maintenance of the harmful habit or smoking cessation (Green & Johnson 1990, Johansson, Johnson & Hall 1991).

In addition to smoking habits, working conditions can be linked with heavy drinking behaviors in particular. Drinking among employees is problematic both from the perspective of health and workplace productivity (Frone 1999). Furthermore, causes of drinking can be both external to the workplace, i.e., due to personal vulnerability and personality traits or arise at least partly from the features of the working environment. The relationships are, however, likely to be complex and bidirectional (arrow 2b), i.e., strenuous work could increase drinking, but heavy drinking might also affect both perceptions about working conditions and the actual work (Zins et al.

1999, Cargiulo 2007). Additionally, personal characteristics in interaction and alongside work-site culture, social pressures and other organization-related norms and factors as well as normative demands more generally can influence drinking patterns (Ragland et al. 1995, Ragland et al. 2000, San Jose et al. 2000, Cockerham, Hinote & Abbott 2006). In general, various past-year stress exposures such as health-, social-, job-, and legal-related stress are associated with heavy drinking (Dawson, Grant & Ruan 2005). While stress does not appear to affect the overall frequency of drinking, moderate drinking may even decrease with increased stress levels. Furthermore, the effects of strenuous working conditions are likely to be dependent both on the level and type of stressors (Dawson, Grant & Ruan 2005). However, if the amount drunk on one occasion is larger when exposed to stress, increased heavy drinking due to stress potentially is a major public health problem. Additionally, time constraints and work-home conflicts as well as lack of social support might be linked with drinking behaviors.

A third behavior potentially associated with working conditions is the amount of physical activity. As low levels of physical activity have adverse health effects (Hu et al. 2005, Schneider & Becker 2005), it is necessary to consider the influence of strenuous work on physical activity patterns. A common assumption about the relationship between working conditions and physical activity is related to working hours and work-related stress as potential barriers to physical activities during leisure-time (Schneider & Becker 2005). However, variation by occupation is likely to be important as well (Burton & Turrell 2000). Additionally, work-home conflicts are potential barriers to physical activity (Roos et al. 2007), highlighting the importance of focusing on factors and life outside work, which may be influenced by work environment exposures. This is understandable, since dissatisfaction in combining paid work and family life might be caused by intensive duties in taking care of family members or otherwise strenuous situations either at work or home thereby limiting both time and opportunities to engage in physical activities during leisure-time. Social support is also likely to contribute to participation in physical activities (Eyler et al. 1999).

Fourthly, working conditions are assumed to affect food habits. However, the patterns of these influences are somewhat convoluted. First, physically strenuous work is likely to influence food habits, most likely in an adverse direction (Prättälä 1998). It is evident that all the effects of working conditions and work-related stress in particular are dependent on both the nature of the stressor and the intensity and duration of these exposures in question. From the perspective of the workplace, psychosocial working conditions potentially predisposing to work stress are of particular interest. Stress may, for instance, increase unhealthy eating, such as consumption of fatty and sweet foods (Hellerstedt & Jeffery 1997, Oliver, Wardle & Gibson 2000). These characteristics are typical of most snacks, which may serve as highly palatable, sensory-rich foods in stressful situations and under time pressures and overtime work. Accordingly, snacking can be increased during stress, while consumption of fruits, vegetables, fish and meat is reduced (Oliver & Wardle 1999). Thus, strenuous working conditions may have adverse health consequences by modifying food habits at least among susceptible individuals (Oliver, Wardle & Gibson 2000, Wardle et al. 2000). Also work arrangements such as overtime hours in particular are likely to similarly influence food habits. Additionally, a need to expand the viewpoint from looking at workplace factors only into seeing the employees in a

larger context outside work contributing to food choices is emphasized, i.e., the relationship between work and food habits should be seen in the context of other roles that the employees have (Devine et al. 2003). Multiple roles at work and at home might predispose employees to choose quick foods of poorer nutritional quality in order to manage time pressures as well as to treat themselves (Devine et al. 2006). Finally, as work takes a large part of active time, a substantial part of energy intake and food choices take place at the workplace. Thus, working conditions, work arrangements, and other workplace features may have a notable influence on food habits. Moreover, these factors could also affect leisure-time choices and eating patterns as well.

In addition to health behaviors, psychosocial working conditions are also assumed to be associated with weight gain and subsequent obesity (arrow 3). As shown in Figure 1, the above described behaviors also contribute to weight gain alongside the examined effects of the working conditions. Potential mechanisms linking work and weight gain include work stress facilitated behavioral and endocrinological modifications, and adverse work arrangements resulting in fatigue and inhibition of behaviors that prevent weight gain and abdominal fat accumulation (Yamada, Ishizaki & Tsuritani 2002). More specifically, psychosocial factors such as work stress might influence weight through the effects on unhealthy food habits, alcohol consumption, and physical inactivity. Furthermore, it is likely that there is an interaction between the categories of initial weight and the influence of work stress on food habits (Hannerz et al. 2004). Working overtime and subsequent time constraints can, for instance, intervene with eating habits and predispose to weight gain and obesity (Nakamura et al. 1998). Since psychosocial and socio-economic disadvantages or barriers, alcohol, and smoking are factors activating the stress centers, psychosocial working conditions are at least partially linked with the risk of weight gain and eventually obesity (Björntorp 2001).

Figure 1 also displays the possible relation between working conditions and reported symptoms of angina pectoris (arrow 4), which may be affected by health behaviors and weight as well (arrows 5-7). More specifically, emerged symptoms could have both detrimental and beneficial influence on health behaviors and weight (arrows 5-6), although these relations are not covered in this study. Moreover, the causal relationships between psychosocial problems and symptoms of angina pectoris are possible either way and a need for more complex models has recently been suggested (Lane et al. 2005, Steptoe & Whitehead 2005). The hypothesis about associations between working conditions and AP symptoms, however, mostly relies on the evidence of a causal pathway between work-related stress and coronary heart disease (Belkic et al. 2004). As angina pectoris is a manifestation of coronary heart disease, and the symptoms are a clear risk factor for future cardiovascular mortality (Feinleib et al. 1982), it is important to increase understanding about the contribution of working conditions to the AP symptoms.

Furthermore, it is likely that all of the potential associations between working conditions and behavioral risk factors vary by gender (arrow 1). Women may be more prone to strenuous work or stress-induced changes in food habits (Weinstein, Shide & Rolls 1997, Oliver, Wardle & Gibson 2000), while adverse and strenuous working conditions could be compensated for by increased drinking among men (Emslie, Hunt & Macintyre 2002), for example.

Moreover, variation by time period and time exposure to strenuous working conditions as well as varying cultural and worksite context are also likely to add to the complexity of the associations, as has been speculated previously (Hellerstedt & Jeffery 1997). In other words, the associations between working conditions and behavioral risk factors driven by one country, setting, workplace, and time period are unlikely to universally apply to all other employees. Additionally, it is possible that adverse behaviors such as smoking and heavy drinking alleviate or alter the perception of psychosocial stress (arrow 2b) resulting in null findings between working conditions and the studied behaviors for some employees (San Jose et al. 2000, Cockerham, Hinote & Abbott 2006). Thus, in a cross-sectional setting this possibly limits the opportunities to examine the effects of working conditions on behavioral risk factors, as causal order cannot be judged.

With regard to other potential confounders and background factors for the associations between working conditions and behavioral risk factors (arrows 8-9), socio-economic factors need to be considered (Yamada, Ishizaki & Tsuritani 2002). Low education, for instance, is likely to determine occupational social class and subsequent working conditions, which in turn are assumed to affect health behaviors (Stansfeld & Marmot 2002, Kuh & Ben-Shlomo 2004). Socio-economic factors are also important as determinants of behavioral risk factors (Laaksonen et al. 2003), weight (Sarlio-Lähteenkorva 2007), and symptoms of angina pectoris (Richards, Reid & Watt 2002). Childhood adverse conditions, such as lack of social support, may also have lifelong effects on behaviors (McEwen 2003). Accordingly, behavioral risk factors such as smoking and obesity have been shown to originate even from childhood with earlier socio-economic position being of particular importance among women as compared to men (Brunner et al. 1999).

Finally, studying the associations between working conditions and behavioral risk factors is driven by a hypothesis that physically and psychosocially strenuous working conditions and other work-related factors extend their effects outside the workplace and influence the behaviors potentially via coping strategies related to drinking, for example (Greenberg & Grunberg 1995). In other words, both physical and psychosocial working conditions as well as work-related factors are assumed to relate to behaviors occurring at work and home subject to the nature of work-related exposure in question.

Thus, by being able to simultaneously assess several working conditions and work-related factors, multiple health behaviors and symptoms of angina pectoris, this study is expected to produce comprehensive results about the associations among the studied variables. Additionally, results are expected to shed light on the gender-specific associations between working conditions and behavioral outcomes, as well as information about similarities and differences across countries. Moreover, key expectations are to be able to confirm the significance of strenuous working conditions to adverse behaviors as well as other chronic disease risk factors such as weight gain and obesity. By studying the symptoms of angina pectoris, the expectation is to elucidate understanding about the significance of strenuous working conditions and work-related factors on women's symptoms, which potentially indicate their major risk of cardio-vascular diseases (Feinleib et al. 1982, Belkic et al. 2004, Kivimäki et al. 2006).

3. REVIEW OF THE LITERATURE

In this chapter, previous studies focusing on working conditions and behavioral risk factors will be reviewed in order to show what is known and to justify the need for further studies. In each section, the associations between physical working conditions and behavioral risk factors will be covered first, followed by the findings for work stress models, their dimensions, and other psychosocial working conditions as well as work-related factors such as social support. Also contradictory findings will be pointed out, as well as studies showing no associations between working conditions and behavioral risk factors. The international comparisons will be mainly reviewed at the end of the sections, subject to available data. When reviewing the results from distant cultural settings such as from Japanese and other Asian cohorts, the aim is to cover the current understanding about the both unique and common associations. In other words, although it is likely that the associations between working conditions and behavioral risk factors vary by country and setting as well as time, some common influences may also be identified. Key results concerning all the outcomes are summarized at the end of each section by pointing out the strength of the evidence and the potential methodological and other reasons for varying results. Finally, concluding remarks are drawn from existing knowledge and needs for further studies are justified by showing the gaps in understanding these areas. Details of the previous studies such as numbers of participants, percentage women, response rates, study designs, adjustments, assessed working conditions, and behavioral risk factors as well as main results can be found in Appendices 1-6, while the text summarizes the findings and presents and discusses main weaknesses and strengths of the previous studies.

3.1 Working conditions and health behaviors

A recent review based on 46 mostly cross-sectional studies found modest support for the consistency of associations between work stress and adverse health behaviors. However, the review only included studies focusing on smoking, drinking and body mass index, while studies about physical activity and food habits were excluded (Siegrist & Rödel 2006). Instead, body mass index was used as a proxy for unhealthy food habits and physically inactive lifestyle. High job strain also shows associations with the co-occurrence of adverse health behaviors (Kouvonen et al. 2007). Similarly, effort-reward imbalance may be associated with an increased risk of co-occurrence of several behavioral risk factors (Kouvonen et al. 2006). In addition to job strain, extended and irregular hours have also shown some associations with adverse health behaviors (Johnson & Lipscomb 2006) and weight gain (Caruso et al. 2004). To corroborate previous evidence, this study examines the associations between several behavioral risk factors and working conditions using separate outcomes. The co-occurrence of health behaviors is not addressed, as patterning of these behaviors is complex with various potential combinations of (un)healthy behaviors (Laaksonen, Prättälä & Karisto 2001). Accordingly, the literature review will first cover the four key health behaviors, followed by a review of studies about weight gain, obesity, and symptoms of angina pectoris.

3.1.1 Smoking

Smoking appears as the most widely studied behavior linked with the work environment. Physical and mental job demands have been associated with smoking, while no relationship existed between work resources such as work process control and learning opportunities and smoking in Sweden (Johansson, Johnson & Hall 1991). Both these results are derived from data collected decades ago, thereby limiting the comparability to the more recent studies due to major changes in working conditions (Kompier 2006) as well as in the prevalence and trends in smoking (Giskes et al. 2005). Additionally, information about working conditions was available for only about half of the Swedish survey sample.

While studies examining physical working conditions in relation to smoking are sparse, associations between job strain, its dimensions and smoking have been quite extensively studied in various settings. A study of U.S. employees reported strong associations between high job strain and heavy smoking and especially with increase in smoking (Green & Johnson 1990). Findings need to be interpreted with caution due to cross-sectional design, partly retrospective items, low response rate, low number of participants, and focus on single worksite and gender (males). However, other and more recent studies have found associations in line with these results. High job demands and high job strain are associated with increased smoking and smoking intensity (Hellerstedt & Jeffery 1997, Bastian et al. 2001, Lindström 2004), for instance. Furthermore, job strain has more specifically been related to nicotine dependence (John et al. 2006b). In a French study, both high demands and high control were associated with smoking among women (Niedhammer et al. 1998). Agreeing with these findings, smoking intensity shows associations with both job strain, effort-reward imbalance as well as their components among a large cohort of Finnish public sector employees, too (Kouvonen et al. 2005). Additionally, lower effort was associated with being an ex-smoker. The found relationships were, nevertheless, weak.

Associations between job strain and smoking have also been studied in non-western populations. Consistent with the above cited results, a small, descriptive study among full-time, Korean male employees reported an association with job demands and smoking (Kang et al. 2005). However, since the data for the study derive from a distant cultural setting as compared with Western working populations, comparability is limited. Smoking prevalence was very high as compared to Western countries, and even highest in the active category of the job strain model, somewhat contradicting the theory (Karasek et al. 1981). The study is further limited by the low number of participants and descriptive design, although employees from 20 worksites were included. Instead, among Japanese rural workers, job strain has shown associations with low prevalence of smoking thereby opposing the findings from North American and Western European studies (Tsutsumi et al. 2003). Thus, the associations between psychosocial working conditions and smoking are also likely to be affected by the surrounding cultural settings.

The impact of social support and other work-related factors on smoking habits has also been assessed in some studies. A noteworthy result of the above-cited study by Green & Johnson (1990) relates to interactions found between age, education, co-worker support and smoking cessation. Among younger men, co-worker support was

not related to smoking cessation, while for older smokers with a high school education or less, co-worker support reduced the likelihood of smoking cessation. Instead, among older men with more education, co-worker support was associated with smoking cessation. Thus, the effect of social support on smoking was dependent on the educational level. Furthermore, the effect of job strain on smoking may be mediated through a pathway including social participation (Lindström 2004). In line with these results, a study conducted among Japanese employees suggests that low work-site social support might increase the number of cigarettes smoked per day (Kawakami, Haratani & Araki 1998). However, work-site social support was equally related to smoking intensity both among daytime and rotating-shift employees. Additionally, the authors observed an interaction between low work-site social support and low work-pace control, which was related to number of cigarettes smoked. Despite the high response rate in the study, the generalization of findings is somewhat questionable, as the Japanese data were derived from one worksite only, albeit a large one. Social support has also been unrelated to smoking in a small cohort of UK nurses with high smoking prevalence (Callaghan 1998).

With regard to other work arrangements, a shift from normal to long working hours increases the likelihood of being a smoker for both men and women (Shields 1999). Working night shifts combined with working over eight hours has also been related to smoking among U.S. nurses (Trinkoff, Storr 1998). A study among workers of a Japanese city office observed, in turn, that smoking men working extended overtime hours smoked more than other groups (Mizoue et al. 2006). However, the survey was undertaken after prohibiting smoking except in some designated areas. Working hours had a U-shaped association with smoking intensity, i.e., those with medium overtime hours smoked less than those with no or extended overtime work. Concerning work-related factors, having high strain at home and multiple roles has been unrelated to smoking (Bastian et al. 2001). However, generalization of this result is questionable, as it is derived from a small sample of a specific ethnic group of women veterans.

Several studies have also reported non-existent associations. A Dutch study failed to find support for the hypothesis that job demands, job control, job strain and iso-strain relate to smoking (van Loon et al. 2000). A major limitation of the study was its low response rate. Furthermore, the analysis was restricted to approximately 15% of the original target population. The percentage was not reported and the authors only assumed that the non-response may have affected the validity of the results. A separate paper about the effects of non-response suggested, however, that while non-response led to bias in prevalence estimates of health behaviors, the studied associations need not be biased (van Loon et al. 2003). Also in another study conducted among the Dutch labor force, job strain and its components were unrelated to smoking (Otten, Bosma & Swinkels 1999). Among men, an inverse association between job control and smoking was, however, observed. These findings are limited by low response rate as well. A German community study did not find an association between job strain and prevalence of smoking either (John et al. 2006b). As a potential explanation for the non-existent association, the authors suggested a high proportion of smokers in the data. Similarly, job demands and job strain were unrelated to smoking in a meta-analysis of five United States databases, however, it used imputed information about job strain dimensions (Pieper, LaCroix & Karasek 1989). As the imputation method misses the within-occupation variation, it excludes reporting bias and provides consistent evidence about the significance of job control

for CVD risk factors. However, job control was again found to be inversely related to smoking. Finally, job strain and its dimensions were unrelated to smoking also in a Canadian study (Shields 1999), in an American study examining young adults (Greenlund et al. 1995), as well as in an American cohort of men of Japanese ancestry in Hawaji (Reed et al. 1989).

To sum up, previous studies have provided partial support for the relation between strenuous working conditions and smoking (Johansson, Johnson & Hall 1991, Kouvonen et al. 2005). Despite the fact that several studies have shown weak, but consistent relationships between job strain and smoking, a number of null findings have also been reported (Reed et al. 1989, Otten, Bosma & Swinkels 1999). Furthermore, western populations differ from employee cohorts from Asia (Tsutsumi et al. 2003) implying that working conditions by definition may not produce similar effects on behavioral risk factors. Instead, surrounding cultural norms and differences make these associations more complex, and limit comparability between studies. In other words, underlying cultural and other factors are likely to affect the observed results. Nevertheless, working conditions also show some common influence on smoking. Additionally, different methodological issues with regard to job strain measures and smoking, varying number of participants, selection bias, time period of the study, and diverse occupational and demographic structure of cohorts hinder strict comparisons between the studies and the validity of the results. Thus, the overall contribution of job strain to smoking is unclear at present. Finally, information about other working conditions as determinants of smoking is much more limited than that of job strain. However, physical working conditions (Johansson, Johnson & Hall 1991) and low social support are potential predictors for smoking behaviors (Kawakami, Haratani & Araki 1998).

3.1.2 Drinking

Adverse working conditions have been observed to be common among both abstainers and drinkers (San Jose et al. 2000). Within drinkers, hazardous physical conditions increased heavy drinking among women and men as well as binge drinking among men. High physical demands combined with low control were also related to higher risk for developing an alcohol disorder, but only among men (Crum et al. 1995). Nevertheless, both of these findings are seriously questioned by a large number of excluded participants due to missing data for various reasons. Furthermore, the measure for job strain in a latter study was an imputed one. It also could not be ascertained whether part of the participants had had early problem drinking at baseline.

With regard to psychosocial job strain, the results are inconclusive. Inconsistent and gender-specific results between job strain and high alcohol consumption were reported already in early 1990s in a Swedish study (Romelsjö et al. 1992). Also another study showed only a statistically non-significant trend in the association between job strain and heavy drinking within urban transit operators employed by a municipal railway in the U.S. (Ragland et al. 1995). A decade later more cross-sectional data were collected, which also comprised virtually all the employees of the

same company (Ragland et al. 2000). The results showed that job-related stressors such as problems with supervisors, having heavy passenger load or being involved in an accident were associated with altogether six studied alcohol-outcomes. Another study conducted in the Netherlands compared heavy and moderate drinking in relation to job strain, but only few stress-related factors were associated with heavy drinking, and merely marginal differences between heavy and more moderate drinking were reported (van Loon et al. 2004). In contrast, findings derived from the cardiovascular disease risk in young adults study showed that high job control and low job strain were associated with increased drinking among white women (Greenlund et al. 1995). Failure to find associations between high job strain and risk factors may, nevertheless, relate to the young age of the participants as well restriction of the analyses to a small part of the original sample only. Thus, these discrepancies contradicting the job strain model need further corroboration. Job strain has, nevertheless, also shown non-existent associations with drinking (van Loon et al. 2000). Null findings have also been reported among men of Japanese ancestry in Hawaji (Reed et al. 1989). In contrast, job strain has been associated with high prevalence of current alcohol drinking in another Japanese study (Tsutsumi et al. 2003).

Dimensions of job strain, i.e., job demands and job control have recently been shown to have some associations with heavy drinking, but the relationships were not consistent and partly in unexpected directions with inverse association between high job demands and alcohol consumption (Kouvonen et al. 2005b). Furthermore, the associations varied by gender, age and occupational group. The study used both work stress models, but neither one of them was identical to the original ones (Karasek 1979, Siegrist 1996), which might partly explain the inconsistent and weak results. Job demands were additionally observed to significantly increase alcohol consumption among women, but not among men in a small study among Canadian adults (Roxburgh 1998). Job demands were conceptualized as a combination of perceived demands and weekly working hours. A large population study in the Netherlands showed associations between job demands and heavy drinking as well (San Jose et al. 2000). Additionally, low job control has been linked with alcohol dependence (Head et al. 2002).

Other features of psychosocial work environment alongside more commonly used job control and job demands have also been assessed as contributors of drinking. A Canadian study (Roxburgh 1998) observed a relationship between job complexity and alcohol consumption implying that jobs low in complexity may predispose employees to alcohol consumption while those in highly complex jobs have lower alcohol consumption potentially adding to the health benefits of their more advantaged positions with higher income and prestige. Job complexity is likely to capture similar partly overlapping aspects of psychosocial working conditions as job control. Contrary to expectations and adding to the complexity of the associations between work factors and drinking, job autonomy has also predicted alcohol problems, i.e., employees with greater control over routines in their jobs have been found to be prone to report negative consequences because of their drinking (Greenberg & Grunberg 1995). A potential explanation for the finding might be a higher socio-economic position among those with job autonomy. Moreover, alcohol drinking as such is likely to reflect somewhat different phenomena than the reported negative consequences of drinking, such as being criticized by friends or at work.

In addition to job strain and its dimensions, a shift from normal to long working hours is associated with an increase in drinking at least for women (Shields 1999). Moreover, employees exposed to successive night shifts may be prone to use alcohol as sleep aid and thus show adverse increases in drinking (Mitchell & Williamson 2000). The possibilities to generalize the results to other employee groups are, however, peremptorily limited due to a very small sample size. The association between night and rotating shifts and alcohol consumption has been reported in a much larger study as well, examining nurses' alcohol use in relation to work schedule characteristics (Trinkoff & Storr 1998). Additionally, among women family demands, having small children in particular, contributed to variation in the likelihood of alcohol use under adverse conditions. Moreover, although the response rate was high, selective non-response or under-reporting of alcohol could not be ruled out. In line with findings from the study among nurses, data among employed middle-aged parents in the U.S. suggest that work-family conflicts are related to heavy drinking (Frone, Russell & Barnes 1996). Similarly, work-family conflicts have more recently been linked with heavy drinking among female employees of the City of Helsinki, and were suggested to be of particular importance concerning problem drinking among both women and men (Roos, Lahelma & Rahkonen 2006). Low social support has in turn been linked with heavier alcohol consumption among women (Niedhammer et al. 1998). However, non-existent associations between social support and alcohol use have also been reported (Callaghan 1998).

One of the very few international comparisons in these areas examined the associations between several alcohol-related measures and effort-reward imbalance as well as job control in men in Russia, Poland and the Czech Republic (Bobak et al. 2005). Annual alcohol intake, annual number of drinking sessions, the mean dose of alcohol per drinking session, binge drinking, and problem drinking were all associated with effort-reward imbalance, but not with job control. When depressive symptoms were taken into account, the associations reduced suggesting that depression might be an antecedent or a consequence of men's drinking behavior. A prospective study among civil servants in London sheds some light on this issue showing that psychiatric disorders are more likely to be predictive of problem drinking (Head, Stansfeld & Siegrist 2004). However, also measures of work stress predicted mental health in the study. Despite comparative study design, the study about Eastern European employees only showed results derived from pooled data, adjusted for the country. Since both alcohol drinking behaviors and other study variables differed by country, it would have been noteworthy to show also country-specific results. Response rates in all the included centers were moderate, and no indication for variation in working conditions or drinking behaviors existed between respondents and non-respondents.

In sum, drinking behaviors have been shown to be somewhat affected by working conditions (Head, Stansfeld & Siegrist 2004), but the evidence partly contradicts the strain hypothesis (Kouvonen et al. 2005b) and is also gender-specific (Romelsjö et al. 1992). Some associations between job strain and heavy drinking have been observed both in western European (Romelsjö et al. 1992) and in culturally more distant Japanese settings (Tsutsumi et al. 2003). In general, previous studies about the associations between various working conditions and alcohol consumption have, however, provided mixed results. The comparability between these studies is tricky, as they have been conducted in varying settings and during different time periods.

Comparability is further limited by measures for drinking that have varied substantially. This is of importance, as moderate and heavy drinking patterns show opposite effects (Dawson, Grant & Ruan 2005). Likewise, measures for working conditions have varied including diverse aspects and combinations of physical, psychological and psychosocial exposures in the work environment. As contradictory (Greenlund et al. 1995) and null findings (Reed et al. 1989) also exist, final conclusions about the effects of psychosocial working conditions on drinking behaviors cannot be stated based on the current evidence.

3.1.3 Physical activity

Some cross-sectional results from the Baltic countries suggest that those with sedentary work have a low level of physical activity also during leisure time, though variation by gender and country exists (Pomerleau et al. 2000). Findings imply that examining physical strain at work may be an important determinant of overall physical activity. In contrast, an older Swedish survey showed that shift work, piecework, hazardous exposures, and physical load tend to be associated with sedentary behavior, while job resources such as personal autonomy predict regular physical activity (Johansson, Johnson & Hall 1991). Patterns varied somewhat between genders. The sedentary category was, however, somewhat heterogeneous, potentially contributing to weakening of the reported associations. Sedentary behavior does not, however, necessarily fully equal to lack of leisure-time physical activity. Nonetheless, these findings highlight the potential connection between work-related physical activity and leisure-time activity patterns. In other words, if those in sedentary positions or in physically less strenuous work are also inactive at leisure-time, this may indicate a double-burden of risk, while benefits of physical activity are missed.

The associations of physical activity and work stress have been examined in large cross-sectional studies of Finnish public sector employees. First, weak, but independent associations were reported between high job strain and low level of leisure-time physical activity (Kouvonen et al. 2005). In another cross-sectional study of Finnish public sector employees, the aim was, in turn, to evaluate the role of the effort-reward imbalance in a sedentary lifestyle (Kouvonen et al. 2006). Furthermore, the study took into account both individual and work unit level in the prediction of sedentary lifestyle. The results suggest that sedentary lifestyle may be attributable to effort-reward imbalance. As the study only used proxy measures of efforts and rewards, this was suggested to have caused weaker associations and a narrower picture about the effects of effort-reward imbalance on a sedentary lifestyle. The relationship was, nevertheless, independent of job strain measured at the work unit level. In accordance with the Finnish results, a Swedish public health survey reported a relationship between low physical activity and high job strain (Ali & Lindström 2006). However, the differences between high job strain and low job strain were mostly explained by education. Although the non-response analysis suggested that the data were largely representative of the total population at the study area (Carlsson et al. 2006), only a restricted subsample of the original target population could be included.

A dimension of job strain, namely low job control has also been associated with reduced physical activity among both women and men (Hellerstedt & Jeffery 1997). Low job control has also been associated with a lower level of work-related physical activity based on a result among Japanese rural employees (Tsutsumi et al. 2003). Both of the studies examined work stress using the job demand-job control model and the time limit between the studies was only few years. However, the U.S. data were overrepresented by those in the higher socio-economic positions and low levels of work-related physical activity, while the Japanese data included more blue-collar employees.

In addition, some attention has also been paid to hours worked in relation to physical activity during leisure time. Some evidence for relationship between hours worked and insufficient physical activity has been reported among the Australian employed adult population, but the patterns differed by gender and furthermore, were hard to interpret explicitly (Burton & Turrell 2000). It was pointed out that hours worked may not explain occupational class differences in leisure time physical activity. A German study also showed low physical activity among employees with overtime hours (Schneider & Becker 2005). Due to a large non-response rate and substantial exclusion of non-eligible participants, the validity of the results is questionable, although the non-response analysis suggested that the data were broadly representative of the target population. In agreement with these findings, a Japanese municipal study also observed that overtime employees were less likely to engage in physical activities (Mizoue, Reijula & Andersson 2001). As the original focus of the study was set on environmental exposure to tobacco smoke, the authors excluded employees who mainly worked outdoors. Thus, concerning physical activity, the result may lack validity and is unlikely to be representative of the target or general population as the information of only those who mainly worked indoors was examined.

With regard to strong work-to-family conflicts, these may act as barriers for adopting or maintaining physically active lifestyle (Roos et al. 2007). It has also been suggested that psychosocial factors outside work, such as social support may mediate the associations between job characteristics and lifestyle (van Loon et al. 2000). Additionally, although obese people are engaged much less in physical activities than those with normal weight, the level of social support received and the beneficial effect on physical activity do not depend on weight (Blanchard et al. 2005). In other words, high social support may influence physical activities equally for normal weight, overweight and obese people. However, interactions of social support with other factors may depend on weight. Finally, based on international comparisons of six European countries, perceived low social support from family, friends or workplace is strongly related to physical inactivity (Ståhl et al. 2001). Non-existent associations were, in turn, reported among UK nurses (Callaghan 1998).

Working conditions and physical activity have been unassociated in many studies as well. A cross-sectional study conducted in the Netherlands failed to find any associations between job strain or iso-strain with physical activity (van Loon et al. 2000). Among men, physical activity was, however, associated with social support in descriptive analysis. Physical activity was unrelated to job strain in an old cohort of men of Japanese ancestry as well (Reed et al. 1989). A study among Japanese rural workers also failed to find significant associations among job demands, job control,

job strain, and leisure-time physical activities (Tsutsumi et al. 2003). Finally, in contrast to the above cited Australian (Burton & Turrell 2000) and German (Schneider & Becker 2005) results, no association between working overtime and changes in working hours and physical activity was observed in a prospective study of Canadian employees (Shields 1999). Similarly, physical activity was not associated with working overtime in a Japanese study of male white-collar employees (Nakamura et al. 1998).

To summarize, previous data indicate some support for a relationship between job strain, its dimensions and lower level of leisure-time activities (Kouvonen et al. 2005, Kouvonen et al. 2006, Ali & Lindström 2006). However, the measures for physical activity have varied, as have the measures for the working conditions. Additionally, some findings imply that working hours may act as barriers to leisure-time physical activity (Schneider & Becker 2005), while others have found no support for such association (Nakamura et al. 1998). Moreover, socio-economic factors may play a larger role in explaining physical activity than working conditions (Ali & Lindström 2006). Additionally, some studies have only controlled for physical activity, while the primary focus has been in some other risk factor.

3.1.4 Food habits

Previous studies on the relationships between food habits and working conditions are almost non-existent, or have used very limited or proxy measures of food habits. Mostly, studies have focused on socio-economic variations in food habits without examining the effect of working conditions (Irala-Estévez et al. 2000, Sanchez-Villegas et al. 2003, Shahar et al. 2005, Naska et al. 2006, Lallukka et al. 2007). Social patterning of food habits is particularly clear, i.e., nutrition plays a major role in socio-economic inequalities in health (De Henauw, Matthys & De Backer 2003). However, the contribution of working condition to these associations is not known. Generally, stress is likely to affect food intake in a detrimental fashion (Oliver & Wardle 1999, Oliver, Wardle & Gibson 2000, Wardle et al. 2000).

Curiously, most of the limited evidence about food habits and working conditions is derived from Japanese settings, which are likely to be different from the European context in terms of working cultures, behaviors, policies, food availability, etc. Also the socio-economic gradient in biological risk factors is opposite to that of Western Europe (Martikainen et al. 2001), potentially reflecting the behavioral trends as well.

A recent Japanese study assessed the relationships between job strain, social support and intake of nutrients measured with dietary history questionnaire (Kawakami et al. 2006). Only weak and inconsistent associations were observed, and the results varied by gender. Response rates largely varied between companies, but non-response analysis was not included. The largest source of potential bias related, however, to the measurement of nutrients. Instead of inquiring about portion sizes, gender-specific average portion sizes for only 31 selected food items were used to estimate nutrient intakes potentially reducing the estimates towards null. In place of nutrients, it might have been interesting to see the results based on food consumed, or differences in the consumption of healthy or unhealthy food items.

Another Japanese study assessed the relationships between job strain, eating behaviors, and obesity (Nishitani & Sakakibara 2006). The study showed that male employees reporting tension/anxiety under work stress had eating behaviors resembling those of obese employees. However, the sample was small and all the participants worked for a single manufacturer, limiting possibilities to generalize the results. Low job control as well as job strain have predicted low vegetable consumption also in a Japanese study among rural workers (Tsutsumi et al. 2003). In contrast to these Japanese findings, no support was found for a hypothesized association between job strain, work hours and consumption of fruit and vegetables in an American setting (Devine et al. 2007). Also a Dutch study failed to find an association between consumption of fruit and vegetables and job strain or social support (iso-strain) (van Loon et al. 2000). However, job demands have been reported to relate to fat intake among men from several Minnesota worksites (Hellerstedt & Jeffery 1997).

With regard to working hours, a Japanese study of male employees did not find correlations between working overtime and qualitative food-related lifestyle variables such as having breakfast, snacking, or showing a preference for fatty foods (Nakamura et al. 1998). However, working overtime correlated with dinner time, which led the authors to speculate that late dinners may alter lipid metabolism and thus promote fat depositions and weight gain. Additionally, it was concluded that some eating habits may reflect a subsequent intervening effect of overtime hours on the increases in BMI and waist circumference. The assumptions received at least partial support from a study assessing differences in meal and sleep patterns and weight changes comparing day-shift and late-shift employees (Geliebter et al. 2000). The late-shift employees had their last daily meal later in the evening, and differed also in their sleeping behaviors from the day-shift employees. Consequently, late-shift employees had gained somewhat more weight since starting the job on the current shift.

Concerning work-related factors such as work-home interface and social support, previous data are largely lacking. However, negative work-to-family spill-over reflecting partially similar aspects as conflicts with work-home interface has been suggested to affect food habits, in particular to reduce the consumption of fruits and vegetables (Devine et al. 2007). Those having strong family-to-work conflicts have been suggested to be less likely to follow recommended food habits (Roos et al. 2007). It has also been suggested that irregular meal (and exercise) patterns arise from work-home conflicts (Bohle et al. 2004). Additionally, social support may relate to the consumption of fruit (Callaghan 1998). Lack of emotional support may in turn be of particular importance for women's stress-driven, unhealthy food habits (Laitinen, Ek & Sovio 2002).

In summary, very little is known about the contribution of working conditions to food habits. Since most of the studies have been conducted in distant cultural settings compared to Western countries, or included only a limited number of employees and proxy measures for food habits, it is difficult to generalize the findings. In other words, the reviewed findings are unlikely to universally apply to various employee groups. However, job strain and job demands have shown a weak effect on food habits based on findings observed both in Asian (Kawakami et al. 2006) and western (Hellerstedt & Jeffery 1997) settings.

3.2 Working conditions, weight gain, and obesity

While reduced physical strain at work (Frese 2000) increases the risk for obesity (Brown, Miller & Miller 2003), several other working conditions and work-related factors might also be of importance with respect to weight gain and healthy weight maintenance. Nevertheless, evidence about the contribution of various working conditions to weight gain and obesity is still inconclusive, and findings come from a few specific, mostly cross-sectional studies with limited information on working conditions and other work-related factors. First, previous studies about working conditions and weight gain will be covered, followed by a review of evidence linking working conditions with body mass index or obesity.

3.2.1 Weight gain

A Danish prospective study among nurses showed that the lowest level of job demands combined with highest job control was associated with weight gain, as was the highest level of job demands combined with lowest job control (Overgaard et al. 2004). Similarly, a U-shaped relationship was also observed between job busyness and weight changes. Thus, the results are partly in line with the evidence of harmful health consequences of high job strain, but the corresponding findings for low job strain are unexpected and contradict to the theory. Nurses are, however, a special occupational group, potentially different from the general population in terms of health-related issues. Additionally, the study was comprised of female employees only, who are likely to differ from men in terms of perceptions and reactions to stress exposures as well as susceptibility to gain weight under stress. Nevertheless, a Finnish prospective study among industrial employees observed that job efforts and increasing mental strain were weakly related with weight gain in men (Lallukka et al. 2007).

The inconsistency of previous findings between job strain and weight changes was tested in a prospective study among British civil servants assessing the bidirectional effects of job strain on BMI (Kivimäki et al. 2006). The results indicate that job strain may have differential effects depending on the initial BMI. Among the leanest quintile of participants, job strain related to weight loss, whereas job strain was predictive of weight gain among the heaviest employees with BMI over 27 at baseline. Thus, these longitudinal results shed light on the previous inconclusive results, suggesting that the effects of job strain should be examined in groups stratified by baseline BMI, or at least the differential effects of job strain need to be considered in the analyses and in the interpretation of the results. Also a study of Danish men found that employees with low or high job demands gained more weight during follow-up if they were obese at baseline, as compared to those with moderate job demands (Hannerz et al. 2004). Instead, among employees with a low BMI, these suboptimal job demands increased the likelihood of losing weight. A large proportion of men were, however, lost to the follow-up or excluded due to missing data. The psychosocial variables were measured using a single item only, which potentially contributed to lower predictive power of these measures. This is a clear lack, as only a few prospective studies about working conditions and weight gain have been conducted highlighting the importance of gaining a more comprehensive understanding of this area.

In addition to job strain, working overtime is prospectively associated with weight gain (Nakamura et al. 1998, Lallukka et al. 2007). Although the results are derived from two different settings, they provide consistent evidence of the weak, but causal relationship between work hours and weight gain. The Finnish study followed a sample of industrial employees over several decades, while the Japanese cohort was comprised of white-collar employees, followed for only a few years. The importance of stable working hours and reasonable workload on healthy weight was highlighted. In general, participants followed for the entire 28 years were healthier and had also a healthier lifestyle than those who were lost to the follow-up (Kirjonen et al. 2006). These results agree with previous findings from Canada, where change from working standard hours to long hours associated with unhealthy weight gain among men (Shields 1999). The result could not, however, be duplicated in women.

With regard to other work arrangements, night and rotating shifts have received some attention. Night and late-shift work have been shown to be associated with weight gain based on some previous studies (Niedhammer, Lert & Marne 1996, Geliebter et al. 2000). However, in a study by Geliebter and his colleagues (2000), the number of studied employees was low. Although the results showed increased weight gain among late shift employees compared to day shift employees, no differences in current body mass index were reported between the groups. Moreover, the authors could not exclude variability of weights and BMI between groups prior starting the current shift as an explanation for their results. Additionally, a change from an 8-hour shift to a 12-hour shift has predicted weight gain, while body weights of those remaining in 8-hour shift did not increase (Yamada et al. 2001). Also several other psychological, biological, and environmental factors as well social support outside work bear potential significance for weight gain (Ball & Crawford 2006). However, although the study conducted among Australian women had a longitudinal, comprehensive design, the non-response rate and loss of participants to follow-up were substantial. Particularly among women, social support has been suggested to play a role in maintenance of normal weight (Jeffery et al. 2000, Laitinen, Ek & Sovio 2002).

To sum up, working conditions bear some impact on weight gain, although the findings are mostly weak (Overgaard, Gyntelberg & Heitmann 2004). However, part of the inconsistent results may be explained by the bidirectional effects of job strain on weight changes (Hannerz et al. 2004, Kivimäki et al. 2006). Job strain may also have a U-shaped association with weight gain (Overgaard et al. 2004). Both high and low job demands have predicted weight gain as well (Hannerz et al. 2004). Additionally, working overtime is of potential importance as a work-related determinant of weight gain, potentially predisposing to obesity (Lallukka et al. 2007).

3.2.2 Body mass index and obesity

Physical demands have been shown to have a negative association with BMI among men, independent of the work stress measures (Ostry et al. 2006). The result was derived from a survey conducted in Australia. Instead, physical workload, hazardous exposures and computer work were only weakly correlated with BMI in a previous study among the employees of the City of Helsinki (Laaksonen et al. 2005b).

A previous review in turn suggested that associations between job strain and body weight are only weakly positive, and no support was found for associations between these perceptions of workload and general or abdominal obesity (Overgaard, Gyntelberg & Heitmann 2004). However, differential effects (Kivimäki et al. 2006) were not pointed out in the conclusions. Thus, the true, but bidirectional, opposing effects of job strain may have been overridden by null findings neglecting the differential nature of the influence of job strain. Nevertheless, the conclusions of the review pointed out the need to take the initial body weight into account when assessing the influence of perceived working conditions. One of the few prospective studies of the cumulative association between job strain and general and central obesity was conducted among the British civil servants (Brunner, Chandola & Marmot 2007). The findings supported the hypothesis that chronic work stress is a contributory factor for both general and central obesity. The strength of the study was its long follow-up. However, sophisticated imputed data were analyzed due to a notable item missing.

Findings in a similar direction with the prospective evidence were reported in an American worksite study, observing that women with high job strain were heavier than other women (Hellerstedt & Jeffery 1997). Because no information about weight changes was provided, the causal effects of these working conditions on actual weight gain and the development of obesity could not be concluded from these results. A more contemporary study among Finnish public sector employees has also shown that high job strain and high effort-reward imbalance are related to a higher BMI (Kouvonen et al. 2005a). The result was derived using aggregated, occupational- and organizational-level scores for work stress. The individual-level results were, nevertheless, of the same direction, but the magnitude of the effect was reduced. An Australian survey also included short versions of both the job strain and effort-reward imbalance model, but found no associations between BMI and these measures of psychosocial work stress (Ostry et al. 2006). However, low rewards and BMI were negatively associated among women, while a positive association was observed between high effort, high job demands, and BMI among men. Finally, an older, small study among middle-aged, Swedish women observed in turn that psychosocial stress including job strain accounts for notable part of social gradient in obesity, too (Wamala, Wolk & Orth-Gomér 1997). While the response rate was high, the sample size was small without adequate information of non-response bias.

Studies focusing on job demands and job control have found many contradictory results as well. Low job demands were related to higher BMI among a large cohort of Finnish male public sector employees (Kouvonen et al. 2005a). The study also showed that lower job control measured at occupational- and organizational-level relates to a higher BMI. Opposed to these results, a study among employed French women and men reported that more women with high demands were overweight, whereas high job control was associated with overweight among men (Niedhammer et al. 1998). However, British women reporting low control at work have been shown to have larger waist circumferences, be heavier, and have higher BMIs than their counterparts with high job control (Steptoe et al. 1999). Moreover, the results could be replicated in the same sample after a 12-month interval. The study is limited by its small sample comprised of school teachers only, and the associations could not be repeated in men. Low job control was associated with higher BMI also in a cohort of Finnish industrial employees (Kivimäki et al. 2002). Nevertheless, this finding also

needs to be interpreted with caution, as only small differences existed even between the extreme categories.

Concerning the Asian population, relationships are also modest and partly contradictory. A small Japanese study failed to find an association between obesity and job demands and job control among male employees of a manufacturing industry (Nishitani & Sakakibara 2006). However, obesity was shown to be related to psychological stress responses of tension and anxiety, which were positively related to job demands and negatively related to job control. Additionally, obese employees in particular were observed to be in stressful state potentially related to high job strain and with a subsequent influence on eating behaviors. Nevertheless, job strain did not relate to BMI in a cohort of men of Japanese ancestry either (Reed et al. 1989). Consistent with the Japanese null findings, a study among Korean employees also did not find any relationship between job dimensions, job strain, and BMI (Kang et al. 2005).

In addition to exposure to work stress measured by the job demand-job control and effort-reward imbalance models, some attention has been paid to working hours as well as shift work in particular. Consistent with the above-cited studies concerning weight gain, exposure to day-night shift work may increase BMI, with the effect being over and above the normative age-related effect on BMI that is shown among day-shift employees (Niedhammer, Lert & Marne 1996, Parkes 2002). Long working hours remained predictive of higher BMI after controlling for work stress models among Australian men as well (Ostry et al. 2006).

With regard to other work-related factors, low work-related social support has been linked with obesity among both women and men in a prospective study among civil servants in London (Head et al. 2002). Furthermore, among women, a lack of emotional support from the spouse, close friends or relatives may predict obesity through stress-related excessive eating and drinking (Laitinen, Ek & Sovio 2002). In other words, previous studies suggest a relationship between social support and maintenance of normal weight (Jeffery et al. 2000, Laitinen, Ek & Sovio 2002). These previous studies have highlighted the importance of social support for the weight of females in particular. Contradicting other previous evidence, also high social support has been linked with overweight among men (Niedhammer et al. 1998).

To sum, job strain appears as a contributory factor to a higher BMI and obesity (Kouvonen et al. 2005a, Kivimäki et al. 2006, Brunner, Chandola & Marmot 2007). However, the observed effects are modest. Thus, job strain is likely to explain only a part of the burden of obesity among employees. Instead, the dimensions of job strain have produced more inconsistent and bidirectional effects in various studies. In other words, the effect of the psychosocial working conditions on body mass index and obesity is more profoundly shown for the interaction between job demands and job control, while examining these dimensions separately has been producing mixed evidence. Work schedule, hours worked and especially shift work have long been noticed as contributing to obesity as well (Parkes 2002, Ostry et al. 2006). The role of work-home interface and social support is, in turn, less clear. Comparison of previous studies is further complicated by the fact that the measures for weight have varied from BMI as a continuous variable to obesity using different cut-off points as well as abdominal obesity more specifically. Additionally, an overall weakness of previous

studies is that most of the studies have been cross-sectional, while development of obesity is usually a slow process. However, the few available prospective studies have shown results that are in accordance with the findings from cross-sectional settings corroborating our understanding about the significance of job strain and working overtime for BMI and subsequent obesity (Nakamura et al. 1998, Brunner, Chandola & Marmot 2007).

3.3 Working conditions and symptoms of angina pectoris

In addition to links between working conditions, health behaviors and weight, also symptoms of angina pectoris as potential indicators of future cardiovascular morbidity and mortality are of importance. Previous studies focusing on working conditions and symptoms of angina pectoris are, however, sparse, and fully comparable study designs are lacking. AP symptoms, for example, may be measured either through self-reported questionnaires (Sorlie et al. 1996, Owen-Smith, Hannaford & Elliott 2003), or assessed by a trained nurse (Netterstrøm et al. 1998). This is likely to contribute to both the prevalence of angina, as well the number of false positive cases and reporting bias. Furthermore, angina outcomes have sometimes combined both self-reported and clinically or otherwise assessed symptoms (Ferrie et al. 1998, Head et al. 2002) making it difficult to compare results with other studies. Most studies have examined and validated AP symptoms and their predictive power for CHD morbidity and mortality outcomes, without having information about working conditions or work-related factors (Cook, Shaper & MacFarlane 1989, Owen-Smith, Hannaford & Elliott 2003).

Self-reported job strain and AP symptoms assessed by a trained nurse were, nevertheless, associated among middle-aged urban citizens in Denmark (Netterstrøm et al. 1998). The finding was independent of coronary risk factors such as blood pressure and serum lipids measured as part of medical examination of the study participants. Adjusting for social status did not attenuate the found association suggesting that job strain can not be seen as a proxy for social status. Instead, both social status and job strain were concluded to be conceptualized as ischemic heart disease risk factors. The study has, nevertheless, several limitations that affect the external validity and relevance of study findings. First, data included only 35 cases of angina pectoris. Thus, the analyses were conducted by combining the genders although the symptoms are known to vary by gender (Harris & Weissfeld 1991). Furthermore, their predictive power for coronary endpoint is different among women and men (Garber, Carleton & Heller 1992). An additional limitation was that the reference category of low job strain did not include any women. However, the inclusion of laboratory measurements of known coronary risk factors and AP symptoms assessed by trained nurse instead of self-reports are clear strengths of the study and add to the validity of the results.

The predictive validity of low job control and effort-reward imbalance for coronary heart disease morbidity as measured by the Rose questionnaire or doctor-diagnosed angina is supported by the prospective study among British civil servants as well (Bosma et al. 1998). Consistent with the study by Bosma et al. (1998), an increase in effort-reward-imbalance is also associated with the risk of incident angina among men, but not among women (Chandola, Siegrist & Marmot 2005). These increases in

effort-reward-imbalance were more frequent for those in lower occupational classes, thus change in working conditions in terms of imbalance contributed to some extent to the social gradient in angina. Employees with higher socio-economic position were also more likely to show a decrease in their effort-reward imbalance levels over time. In contrast to the previous study (Netterstrøm et al. 1998), symptoms of angina pectoris were self-reported. Loss to follow-up, exit from employment, and item missing notably reduced the number of eligible participants. Furthermore, the number of women with incident angina was very low thereby plausibly reducing the precision to estimate the associations between effort-reward imbalance and angina as well as power in statistical analyses. Also, the participants were relatively young with regard to CHD incidence, which may explain the low number of angina cases among women.

In addition to job strain, some of the few studies assessing the relationships between angina and job characteristics evaluated the effects of major organizational changes on the incidence of ischemia (Ferrie et al. 1998). Ischemia was assumed to be presented if the participant reported either AP symptoms or had abnormal electrocardiograms (ECG). Among women, anticipation of changes in the work environment resulted in increase in ischemia, whereas no effect was observed among men, neither among those anticipating changes nor those reporting actual changes. However, it was not reported what proportion of participants were assessed with ischemia by questionnaire and by ECG, and if they overlapped. Consequently, it is difficult to compare these results to those derived using solely the Rose questionnaire. It would have been noteworthy to also show the differences in self-reported angina and abnormal ECG in order to evaluate the validity of self-reported angina. Particularly among women, angina assessed by questionnaire may reflect a negative reporting tendency or be of other than cardiac origin (Nicholson et al. 1999, Macleod et al. 2002) and bias the observed associations. Additionally, adverse health behaviors could only partly account for increases in symptoms or other morbidities.

Although the study (Ferrie et al. 1998) did not examine either of the work stress models, it was reviewed here for two reasons. First, the study population included both genders providing some evidence about the associations between work environment and AP symptoms among women as well. Secondly, job insecurity may serve as a proxy instrument of work-related stress. This hypothesis is in line with results showing the associations between high job demands and AP assessed by the Rose questionnaire and clinically validated angina among women, while low job control was associated with the AP symptoms among men (Head et al. 2002). Job strain was associated with AP symptoms as well, but the analysis was only adjusted for gender. As the majority of the participants were males, it is unclear whether job strain is of importance for the AP symptoms among women.

To summarize, symptoms of angina pectoris as a manifestation of coronary heart disease have shown some associations with job strain (Netterstrøm et al. 1998, Head et al. 2002), effort-reward-imbalance (Bosma et al. 1998, Chandola, Siegrist & Marmot 2005), and other workplace characteristics (Ferrie et al. 1998), which are consistent with the evidence for relationship between work stress and CVD (Belkic et al. 2004). Previous studies about the associations of working conditions and symptoms of angina pectoris are, however, mostly sparse and limited. Finally, the measures for working conditions have varied and thus produced so far an incomplete

understanding about the significance of work environment to the reported symptoms of angina pectoris.

3.4 Concluding remarks and the need for further evidence

Previous literature about the associations between working conditions and behavioral risk factors is, overall, limited and furthermore, inconsistent with several contradictory findings reported. Some previous studies have found associations between job strain and individual behavioral risk factors (Pieper, LaCroix & Karasek 1989, Hellerstedt & Jeffery 1997, Kawakami, Haratani & Araki 1998, Peter et al. 1998, Tsutsumi et al. 2001), but these results have not been supported by all (Netterstrøm et al. 1991, Otten, Bosma & Swinkels 1999). Moreover, most of the reports are based on cross-sectional data with limited applicability to judge the causal or temporal order between the studied variables. Nevertheless, this does not imply that these methods are to be abandond (Theorell & Hasselhorn 2005). Instead, several notable associations have been observed which lay a foundation for further studies as well as help identify the gaps in understanding these areas.

Summary of methodological issues

First, most of previous studies have included only limited information about working conditions, i.e., they have examined only job strain or working hours without simultaneously taking into account various work-related factors, for example.
Additionally, studies about several behavioral risk factors as outcomes are limited. Mostly, the focus has been on only one behavioral risk factor, while the broader approach including all the key behavioral risk factors has seldom been applied. Some exceptions exist, e.g., (van Loon et al. 2000, Tsutsumi et al. 2003, Kouvonen et al. 2006, Kouvonen et al. 2007), but only a very few have been able to include all the key behavioral risk factors (Blaxter 1990). In particular, evidence for food habits is limited, while the focus in most studies has only been on smoking, drinking, physical inactivity, and weight gain or obesity.

Furthermore, the methods to measure psychosocial working conditions have varied substantially between studies. While most studies have examined the interaction between job demands and job control (van Loon et al. 2000, Lindström 2004), others have only analyzed these dimensions of psychosocial work exposure separately (Niedhammer et al. 1998), or applied both of the approaches (Greenlund et al. 1995, Otten, Bosma & Swinkels 1999, Kang et al. 2005). The dominant use of interaction terms is somewhat surprising, as interaction effects are not consistently supported even for CVD (Jones & Fletcher 1996). Instead, it has been suggested that nonlinear associations between the dimensions may result in spurious findings if they are not taken into account in the analyses. Moreover, items to measure job demands and job control have varied in different studies; some studies have only used brief or proxy measures for job strain and effort-reward imbalance (Hannerz et al. 2004, Hannerz et al. 2004, Head, Stansfeld & Siegrist 2004, Kouvonen et al. 2005b, Chandola, Siegrist & Marmot 2005, Ostry et al. 2006), while others have included more items (Reed et al. 1989, Green & Johnson 1990, Greenlund et al. 1995, Hellerstedt & Jeffery 1997).

One of the most important distinctions between the methodological approaches is that while some have examined self-reported data about working conditions, others have imputed data about job strain based on occupational class (Pieper, LaCroix & Karasek 1989, Crum et al. 1995). While the use of aggregated data excludes individual distortion, also variations between work-sites are lost (Theorell 2000). Self-reported working conditions are in turn prone to subjectivity (Kasl 1981). The diverse cut-off points, item scales and other methodological issues and choices further contribute to the complexity of the comparability of contradictory and inconsistent results. Also the response rates in many studies have been quite low, and a large number of participants have been further excluded due to non-working status and subsequent lack of information about working conditions or other item missing.

These concerns highlight the need for international comparisons with similar measures for both work-related factors and behavioral outcomes. However, international comparisons are scarce or practically lacking in these areas. This is a major shortcoming, and the comparability issues between studies carried out with varying number of participants, and in different occupational and age groups, in different cultural settings, and in different time periods remain challenges to be overcome in further research.

Finally, it is also possible that the employment sector plays a role in explaining contradictory and inconsistent findings. At least with regard to myocardial infarction, private sector employees have a three times higher risk compared to those within the public sector (Netterstrøm et al. 1999). It is thus possible that also the relationships between working conditions and behavioral risk factors are at least partly modified by the sector of employment. More specifically, in case the higher risk of myocardial infarction in private sector applies to behavioral risk factors as well, studying working conditions and these behaviors among public sector employees only is likely to produce more modest relationships than by being able to also include private sector employees.

Gaps in previous studies

To sum up, associations between working conditions and smoking have been studied for decades, but in varying settings and with different methods limiting the generalizability of the findings. Most of the studies have examined job strain or its dimensions, whereas information on other working conditions, work arrangements, and their relationships with smoking is much more limited. Thus, the associations of various working conditions and work-related factors with current smoking need further corroboration, which also applies to mixed evidence for the job strain model and its dimensions. Moreover, studies among women and international comparisons to test unique and common associations are sparse, as are studies assessing current work environment and several occupational groups and workplaces.

Previous data about drinking also derive from mostly cross-sectional studies that do not allow determining the causal relationships. Especially concerning drinking this might be problematic, as heavy drinking may affect perceptions of job strain or relate to exit from the workforce. Similar to research for smoking, most studies have

focused on work stress models, job demands, and job control, while the influence of other working conditions is mostly unnoticed or neglected. Thus, comprehensive understanding about the contribution of various working conditions to both moderate and heavy drinking behaviors is needed. Moreover, it needs to be established, whether job strain relates to heavier drinking across occupations or if other work-related factors are more likely to explain some of the observed associations. We also lack studies comparing employees from different countries, as well as gender-specific analyses focusing on female employees. The effects of strenuous working conditions and work-home interface might be of particular importance for women's drinking behaviors.

Due to various measures for physical activity, the comparisons between previous results are complicated. Further studies assessing the impact of working conditions for both physical activity as well as work-related determinants of inactivity among employees are needed. More specifically, the influence of job strain on physical activity needs to be corroborated and further evaluated, while the contribution of work schedule and working hours in particular to physical activity is unclear. Comparative research in these areas is also lacking. The significance of working hours as potential barriers to physical activity should also be further addressed to corroborate the previous, inconsistent findings. Overall, more information is needed about the effects of various working conditions on physical activity and inactivity behaviors, taking into account the confounding factors such as education.

Food habits have received the least attention, which is somewhat surprising as food habits are clearly associated with CVD (Kuller 2006) and the burden of food-related ill-health in terms of morbidity and mortality outcomes is similar to smoking (Rayner & Scarborough 2005). A potential explanation for the lack of studies might be that food habits are hard to measure and most questionnaires include none or only very proxy measures for food habits. Thus, the associations between food habits and working conditions need to be studied to establish the significance of both physical and psychosocial working conditions and work-related factors to healthy and adverse food habits. Also studies combining several aspects of work environment with potentially important factors outside work-life such as social support and work-home interface are needed. Since cultural differences are likely to play a major role, it is important to conduct international comparisons that help elucidate the common influence of working conditions on employees' food habits. Overall, it is evident that there is a need to comprehensively evaluate the significance of working conditions for food habits.

In addition to key health behaviors, some have focused on weight gain and obesity. Also in these areas, previous data are partly inconsistent, potentially mostly due to diverse measures for weight, i.e., some have used body mass index as a continuous variable (Hellerstedt & Jeffery 1997, Ball & Crawford 2006, Ostry et al. 2006), while others have examined obesity or weight gain using a dichotomous variable (Kivimäki et al. 2006, Brunner, Chandola & Marmot 2007). A broad approach taking mutually into account various working conditions, work-home interface and social support has not been applied. With regard to obesity, the role of working conditions needs to be studied across employee cohorts in different countries. As previous studies have been mostly focused on either job strain or work schedule and work arrangements, simultaneous analyses including both these aspects with other work-related factors are

warranted in order to produce comprehensive understanding about the contribution of work to weight gain and obesity. Studies should also include diverse occupations and occupational groups. Thus, based on the reviewed findings, the complexity and diversity of correlates relating to weight gain both at work and outside working life need further investigation. Overall, the information about other work-related factors is largely lacking, as are comparative studies and studies about mediating mechanisms. Finally, more research has been focused on BMI or obesity, while less is known about the contribution of working conditions to weight gain. Moreover, previous studies have produced inconsistent and weak results, which need further corroboration.

Previous evidence about working conditions and symptoms of angina pectoris is inconclusive as well. Most strikingly, information about the work-related determinants of women's angina symptoms is largely lacking since previous studies have included only a small number of women, or entered gender as only a covariate in the analyses (Netterstrøm et al. 1998, Head et al. 2002). Additionally, women and men have been examined combined, although stratified analyses should be conducted based on gender-specific differences in these symptoms. In other words, although the measure for angina symptoms is well-validated, it is not known to which extent the previous results can be applied to women. Previous studies have also primarily focused on work stress. Thus, the contribution of various working conditions should be assessed, in order to evaluate first the role of job demands and job control for these symptoms, and secondly to study whether other working conditions and work-related factors are associated with AP symptoms independent of the psychosocial work environment. Furthermore, as the prevalence of coronary disease among working-aged women is low, larger samples are needed to achieve enough power in the analyses and produce more valid results. Finally, it needs to be studied whether the associations of working conditions and AP symptoms remain after controlling for age, health behaviors, and other risk factors. More specifically, the extent to which AP symptoms among women are determined by working conditions needs to be examined.

4. SCOPE AND PURPOSE

This study was set to provide an overview of the associations between various working conditions, multiple behavioral risk factors, and symptoms of angina pectoris. The importance of simultaneously including a broader range of strenuous working conditions when assessing behavioral risk factors has recently been highlighted (Belkic & Nedic 2007). Previous studies applying a similar approach are, nevertheless, largely lacking. In order to provide a more comprehensive picture and add validity to the results about the associations between working conditions and behavioral risk factors, international comparisons are also included. More specifically, the study first aims to provide new evidence about the effects of current work environment on the behavioral risk factors among middle-aged employees of the City of Helsinki and secondly to examine the associations across countries, i.e., between comparable employee cohorts from Britain, Finland, and Japan. In other words, international comparison seeks to assess the extent to which findings from Helsinki can be extended to other settings. Although the focus is mostly on adverse behaviors and risk factors in order to gain information potentially relevant for disease prevention, some attention is paid to healthy behaviors that may bear importance for health promotion as well.

Based on previous literature, several unanswered questions are raised. First, what is the significance of various working conditions for all key health behaviors? It needs to be ascertained whether job strain is associated with health behaviors and whether these potential associations remain when other working conditions and confounding factors are taken into account. Secondly, are the associations similar or different by country among homogenous employee cohorts in terms of age-group and employment sector? Thirdly, what is the importance of various work-related factors concerning weight gain? Furthermore, what is the influence of work-home interface and social support in this aspect? A more specific question to be asked is whether working conditions predict weight gain independent of health behaviors. A broad approach including a variety of measures of the work environment will be applied. As weight gain and subsequent obesity are leading public health problems, it needs to be assessed whether part of the current epidemic can be explained by working conditions predisposing employees to weight gain. Fourthly, how do working conditions affect reported symptoms of angina pectoris (AP) among middle-aged women? Could working conditions help elucidate understanding of the known complexity of these symptoms? In particular, it needs to be examined if the effect of working conditions is independent of age, menopause, and health behaviors, which are known risk factors related to CVD. Furthermore, are job demands and job control associated with AP symptoms among middle-aged women thus corroborating the previously shown relationship between these working conditions, work stress, and CVD? Moreover, are the other working conditions and work-related factors more predictive of AP symptoms, independent of job demands and job control?

This study was set to examine these general questions by analyzing large, contemporary data among middle-aged public sector employees, within the City of Helsinki, as well in an international setting including comparable employee cohorts from Britain and Japan. The main aim was to study the contribution of various working conditions and work-related factors to health behaviors, and related weight

gain, obesity, and symptoms of angina pectoris. This aim was pursued by conducting four substudies on the following topics, referred in the text by Roman numerals:

(I) The first aim was to examine the associations of working conditions with healthy food habits, physical activity, moderate drinking, and current smoking.

(II) The second aim was to provide a more comprehensive view of the associations between job strain, working overtime, adverse health behaviors, and obesity using comparable public sector employee data from Britain, Finland and Japan.

(III) The third aim was to examine the associations of working conditions and work-related factors with weight gain.

(IV) The fourth aim was to study the associations between working conditions and symptoms of angina pectoris among women.

5. DATA AND METHODS

This study examines public sector employee survey data from Finland, Britain, and Japan. First, these data sources are presented, followed by a brief introduction to potential confounders and background variables. Then the key work-related determinants and outcomes are described. Information about missing values is gathered in a separate section of this chapter. Finally, an overview of the main statistical methods and ethical aspects are presented. More detailed description about the data and methods can be found in the attached substudies, I-IV.

5.1 Data sources

5.1.1 Finnish Helsinki Health Study cohort

Questionnaire survey data for the Helsinki Health Study (HHS) were collected among the middle-aged employees of the City of Helsinki in three consecutive years in 2000–2002. The City of Helsinki is the largest employer in Finland with around 40 000 employees and 100 different occupations covered within the social and health care system and education, for example. Each spring, postal questionnaires were sent to employees reaching 40, 45, 50, 55 and 60 during the years of the survey (Table 1). The cross-sectional data from all three survey years were pooled. Thus, the final sample consisted of 8960 employees, of whom 80% were women, corresponding to the gender distribution within the City of Helsinki in these age-groups. Other data sources for HHS include both the City of Helsinki register data and medical examinations of the study participants, carried out as part of the occupational health care. The data from these additional sources were not included in this study, except for some validation tests and occupational class.

Additionally, an informed consent form was requested from each participant to combine these internal data sources and to conduct linkages with external registers as well. Although internal and external data sources were not used in this study, asking for the consent has been shown to affect non-participation in questionnaire surveys, i.e., decrease the response rate (Korkeila et al. 2001). The overall response rate of 67% (Table 1) was, however, acceptable. Furthermore, based on the analyses of the effects of non-response bias in 2000, the data were broadly representative of the target population (Lallukka et al. 2002). Older employees, those in higher occupational classes, as well as those with higher income, permanent employees and those with no medically confirmed sickness absence were somewhat more likely to participate in the whole survey (Laaksonen et al. 2007). Moreover, survey non-response was not found to seriously distort examination of social inequalities in health status as indicated by long sickness absence spells (Martikainen et al. 2007).

For Substudy I, only data from first two HHS surveys, i.e., years 2000–2001 were available (n=6243). For further substudies all the data from three surveys were used, according to aims and scope of the substudies. For comparative Substudy (II), only white-collar employees aged 45-60 years were included (n=6070), in order to have homogenous sample comparable to that of the public sector employee cohorts from Britain and Japan (Table 2). For Substudy III, all surveys were available (n=8892). In Substudy IV, only women from Helsinki were included (n=7093). After conducting

the analyses for substudies III and IV, data were some what modified, i.e., some participants were excluded as they were not employees of the City of Helsinki. Thus, the final number of participants for the Helsinki Health Study was the above mentioned 8960. Finally, pregnant, possibly pregnant, and missing values for pregnancy status for women were excluded from the analyses relating to substudies III and IV (altogether less than 1%).

The Helsinki Health Study is a collaborative project with the City of Helsinki, the Whitehall Study, University College London, UK (Professor Sir Michael Marmot), and University of Toyama, Japan (Professor Sadanobu Kagamimori). The questionnaires used in all the cohorts comprised several similar measures such as SF-36, GHQ, self-rated health, health behaviors, sleep, BMI, Rose questionnaire, multiple socio-economic indicators, Karasek's job demands and job control, work arrangements etc. International collaboration was also the initial purpose of the projects and these homogenous measures enabled reliable cross-country comparisons.

The comparative analyses (II) were conducted by pooling Finnish public sector employee data with British and Japanese public sector employee data. Since Japan provides clear contrasts to Western European countries, and distant cultural aspects (Markus & Kitayama 2003, Kitayama et al. 2004), a more comprehensive picture of the associations between working conditions and behavioral risk factors can be presented. Furthermore, as Japan is the only non-Western, highly-industrialized and educationally-advantaged nation, its usefulness as a comparative country has been also previously noted and discussed (Inaba et al. 2005). Accordingly, Japan has already been included in several international comparisons (Martikainen et al. 2001, Chandola et al. 2004, Martikainen et al. 2004, Nasermoaddeli et al. 2005).

Table 1 Numbers of participants and response rates in Helsinki Health Study cross-sectional surveys 2000-2002

Year	Women	Men	Response rate
2000	2494	647	69.2%
2001	2460	589	68.1%
2002	2214	556	64.0%
Total	7168	1792	67.2%

5.1.2 British Whitehall II cohort

The Whitehall II study (WHII) is a follow-up study of civil servants aged 35–55 years at the time of recruitment, working in the London offices of twenty National Government Civil Service departments. The study currently includes data from seven postal surveys and four screening examinations conducted in 1985–2004. The fifth phase from 1997 was used for the analyses to have comparable data in terms of homogenous age-groups and complete, comparable data about working conditions. In later phases most participants have already retired or are out of the civil service. The earlier and later phases are, in turn, temporally distant from the other two cohorts. At baseline, 73% responded (N=10308), whereas the response rate for the fifth phase was 76% (n=7830) (Marmot & Brunner 2005). Participants included in the present study

were aged 45–60 years, while older participants were excluded (n=2036). The majority of the participants were men (72%), and all the participants were white-collar employees. By phase five, only about half of the respondents continued working in the civil service. As the focus of comparative Substudy (II) was set on psychosocial working conditions, retired participants (n=2214) and those out of work (n=605) had to be excluded from the sample. Participants who had changed their employer and were not working in civil service were also excluded (n=1467), in order to get comparable data in terms of employment sector. The number of eligible participants with these inclusion criteria was, therefore, 3397 (Table 2).

The phase five questionnaires included several items about working conditions, health behaviors and background factors, mostly repeating similar items from the earlier phases. However, information about food habits was limited to only three items providing a proxy measure of typical choices. More comprehensive data about food habits had been gathered in separate questionnaires, but these were not available for comparative Substudy II. Weights and heights were measured at clinical examinations.

5.1.3 Japanese cohort of civil servants

The Japanese data derived from a baseline postal survey (n=6431, response rate 88%) conducted among civil servants of a local government on the west coast of Japan in 1998–1999 (Kagamimori et al. 2002). The Whitehall questionnaire items were translated into Japanese and back-translated into English and the items used and reported in the comparisons are the back-translated ones. All employees were invited to the study. For the present study, only participants aged 45–60 years were included as in the other two cohorts. In contrast to the Whitehall study, the Japanese data included manual employees. However, for the purposes of comparative Substudy (II), these were excluded from the analyses (n=383). Thus, the number of eligible participants for comparisons amounted to 2213 (Table 2). As in London, the majority of the participants were men (71%).

Although the data were homogenized to the best comparability, there were some limitations in the use of the Japanese data. The prevalence of smoking and heavy drinking among women was rather low for statistical analyses. Additionally, the types and quantity for alcohol beverages differed largely from European drinking patterns and questionnaire items. Thus, heavy drinking may not measure the same phenomena in the Japanese cohort as in the European cohorts. As only the amount of absolute alcohol was measured, these different types of beverages are unlikely to distort the findings. Finally, the Japanese data did not include any information about food habits. Consequently, food habits could not be examined in Japan.

The data were collected on four separate occasions and combined afterwards. The questionnaires comprised items about job control and job demands similar in wordings to the Whitehall II study. Data about working time was also available, permitting multivariate comparative analyses and production of more comprehensive evidence about the associations and country-specific variation in the associations between psychosocial work environment and adverse health behaviors.

Table 2. Basic characteristics of participants in the British Whitehall II cohort, Finnish Helsinki Health Study and a Japanese civil servant study. Prevalence (%) of background variables and working conditions (II)

	London (%)		Helsinki (%)		A Japanese province (%)	
	Women	**Men**	**Women**	**Men**	**Women**	**Men**
Mean age (years)	52.4	51.7	51.6	52.4	50.9	51.3
Married or cohabiting	67	85	67	81	87	95
Occupational class						
Routine non-manuals, clericals	31	6	49	12	35	28
Professionals, semi-prof., executives	45	44	43	61	64	54
Managers, administrators	24	50	8	26	2	18
Job strain*						
Low job strain	32	29	28	25	27	34
Active work	27	27	23	26	28	25
Passive work	30	30	28	26	33	25
High job strain	11	14	21	23	13	16
Working overtime (over 40 hrs /wk)	43	60	14	21	55	49
N (total)	**967**	**2430**	**4984**	**1086**	**650**	**1563**

*(Karasek et al. 1981) and Figure 2.

5.2 Measures

5.2.1 Background variables and confounders

When focusing on behavioral risk factors, socio-demographic and socio-economic variation needs to be taken into account. First, gender, age, and marital status are key socio-demographic determinants of behavioral risk factors (Lahelma et al. 1997, Pomerleau et al. 2000, Emslie, Hunt & Macintyre 2002). Similarly, age, and marital status are also related to weight gain (Rosmond, Lapidus & Björntorp 1996, Lahti-Koski et al. 2000, Parkes 2003, Hannerz et al. 2004). Secondly, several indicators of socio-economic position such as occupational class, are potential confounders of the associations between working conditions and studied behavioral risk factors. While we lack comprehensive knowledge about the contribution of various working conditions to the behavioral risk factors of chronic diseases, socio-economic inequalities in both health behaviors (Prättälä, Berg & Puska 1992, Irala-Estévez et al. 2000, Roos, Prättälä & Koski 2001, Laaksonen, Prättälä & Lahelma 2003, Giskes et al. 2005, Huisman, Kunst & Mackenbach 2005), weight gain (Martikainen & Marmot 1999), body mass index (Wamala, Wolk & Orth-Gomér 1997, Molarius et al. 2000, Kouvonen et al. 2005a, Sarlio-Lähteenkorva 2007) and angina pectoris (Bartley et al. 2000, Richards, Reid & Watt 2002) are already well-established. Consequently, these factors need to be taken into account when assessing the influence of working conditions on employees' behaviors.

Although socio-economic inequalities in health and behavioral risk factors still pose major challenges and are even a worsening public health problem also in welfare states (Lahelma et al. 1993, Mackenbach 2006, Fritzell & Lundberg 2007), the indicators of socio-economic position are taken into account merely for the purposes of controlling for confounding effects (Virtanen & Notkola 2002). In other words, the emphasis is not on socio-economic determinants of behavioral risk factors. As socio-demographic and socio-economic factors shape health behaviors (Lahelma et al. 1997, Mackenbach 2006) this can, however, contribute to the weakening of the associations between working conditions and health behaviors while the these factors are adjusted for.

Information about occupational class was derived from the employer's personnel register for those who had given informed consent to perform such linkage (80%). Otherwise, self-reported occupational social class was used. Gender, age, marital status, and education were all based on self-reported data. Distributions of these background variables are shown in Table 2 concerning comparative Substudy II and in Table 3 for all of the Helsinki Health Study survey data analyzed in the other substudies (I, III, and IV).

5.2.2 Physically strenuous work

Physical working conditions were assessed using a single item enquiring how strenuous the respondent's work is physically (I, III, IV). The item comprised four response alternatives ranging from "very easy" to "very hard." In Substudy I, physically strenuous work was examined as a dichotomous variable categorizing responses to low and high physical strain at work. In further substudies, an intermediate category was also included. However, the generalizability and interpretation of the results are limited by the generic nature of the variable. As a large part of the employees report physical strain at work, the associations between physically strenuous work and behavioral risk factors were, nevertheless, reported when applicable. Physically strenuous work was examined in the substudies focusing on employees of the City of Helsinki only. Instead, information for physical working conditions was not available for comparisons (II).

5.2.3 Psychosocial working conditions

Karasek's job strain model

The main psychosocial working conditions were Karasek's (Karasek 1979, Karasek 1985) job demands and job control, examined in all the substudies I-IV. In Helsinki, the questionnaire included altogether 10 items about job demands and nine items about job control, each item comprised five response alternatives from "fully agree" to "fully disagree." Job demands comprise items such as having to work very fast or very hard, and experiencing controversial expectations and time pressures. Job control in turn was asked as agreement with statements such as work requires creativity, having a great deal of say concerning work, and having good learning opportunities. The mean sum score for 10 job demand items was 31.1 (SD 6.7) among women and

30.8 (SD 6.6) among men, whereas the corresponding scores for nine job control items were 33.2 (SD 5.4) among women and 32.7 (SD 5.9) among men.

For comparisons (II), four items about demands and eight about control were used within the Helsinki Health Study cohort, since the rest of the original items (see IV) were not included in the London and Japan questionnaires. The full list of items used in substudies I, III, and IV is shown in Appendix of Substudy IV, while the comparative items are reported in Substudy II. In London and Japan, items comprised four response alternatives from "often" to "never." Consequently, all the responses except 1 were divided by 1.25 in the HHS data to have corresponding scales in each cohort.

Due to the exclusion of some of the original items, correlations between short and longer versions were examined. The correlations between the short and longer versions of the job demands measures within the Helsinki data were high, 0.9 among both genders. The questionnaires in London and Japan included 15 control items. The correlations between eight and 15 job control items were also high. In London and Japan, the correlation between the short and longer measures was 0.9 among both women and men. In Helsinki, the correlation between the eight comparative and nine original items practically equaled to 1.0. Based on these correlations, it can be assumed that the use of shorter questionnaires is likely to produce valid results as well as capture similar aspects of the psychosocial work environment as the longer versions of these measures.

The internal consistency of the measures was also analyzed to assess the extent to which the items focus on similar aspects of the psychosocial work environment. Cronbach's alpha for the comparative four demand items was 0.7 and for the eight control items 0.8 in London as well as Helsinki among both genders, whereas these figures in Japan were 0.7 for demands and 0.6 for control among men, and 0.5 and 0.7 among women, respectively, despite the use of items with exactly similar wordings. Cronbach's alphas calculated for London and Helsinki are practically similar to a previous Danish study (Netterstrøm et al. 1998), while lower alphas have been also previously reported for Japanese employees (Tsutsumi et al. 2003). For 10 items for job demands within the Helsinki cohort, Cronbach's alphas were somewhat higher, i.e., 0.8 among both genders. Similar values (0.8) were obtained for nine available control items.

According to Karasek's model (Figure 2), four possible categories of job demands and job control exist (Karasek et al. 1981). A combination of low job demands and low job control is considered to be a passive work environment, while high job demands coupled with high control is an active situation related to learning motivation for instance. The low strain category combines low job demands and high control, whereas the last category of high job strain is the opposite situation with high job demands coupled with low job control. The diagonal from low strain work to high strain work represents a work-stress dimension and subsequent health risks, if the situation of high strain is prolonged (Karasek et al. 1981).

In substudies I and II, the interaction between job control and job demands was examined, while in the other substudies (III and IV), these dimensions were addressed separately and the interaction term was not included in the models. In the substudies

conducted within the HHS data (I, III, and IV), the responses to each item were first dichotomized to indicate the most frequent exposures, i.e., agreement with each statement yielded one point. In Substudy II, all responses to the items were summed and the sum was dichotomized into low and high job demands and job control separately by cohort and gender using the median values in the distribution of the sums as cut-off points, as has been done in previous studies (Kang et al. 2005). The sums of individual items in substudies III and IV were divided into quartiles of very low, low, high, and very high job demands and job control. The distribution of these variables is displayed in Table 3 alongside other working conditions examined within the HHS cohort. These distributions were calculated for the whole sample (n=8960). Instead, the distributions of comparative measures are shown in Table 2.

Although Substudy II showed results for job strain and working overtime only, initially the main effects of dimensions of the model, high job demands and job control were also examined. Responses to the items were dichotomized into low and high job demands and job control using the 75th percentile in the distribution of the sums as a cut-off point for high job demands and high job control, again separately by cohort and gender. Low job demands and high job control were the reference categories in the logistic regression analyses assessing the individual effects of these dimensions on adverse health behaviors and obesity. The results for these control analyses are reported in section 6.1.2.

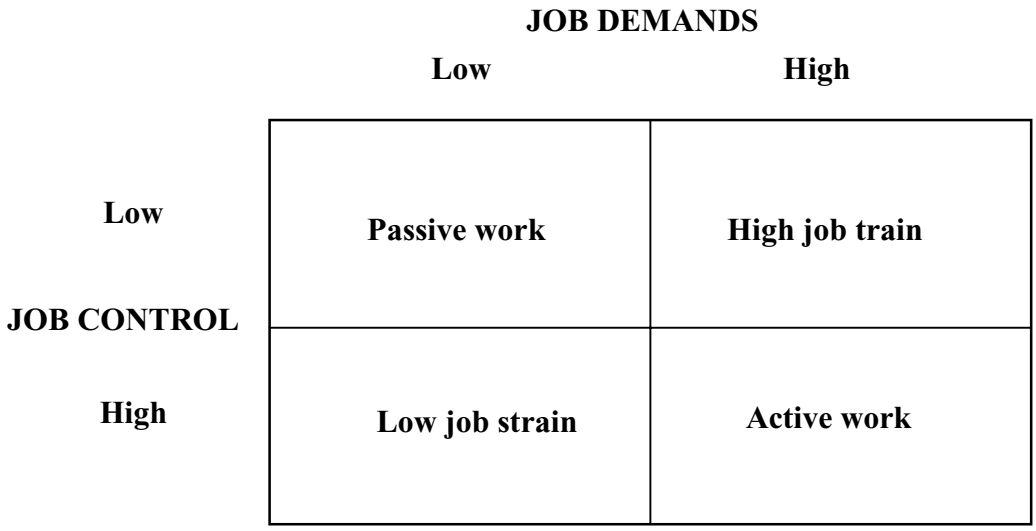

Figure 2 Job demand-job control model
Adapted from Karasek et al., Am J Public Health 1981;71:695.

Work fatigue

In addition to job demands and job control, work fatigue was examined. The measure of work fatigue is comprised of six items more explicitly described in Substudy IV. The items included are feeling used up at the end of the work day, feeling fatigued in the morning upon arising and having to face another day at work, having to work too hard, feeling totally exhausted or, worrying about work even during leisure-time, and

finding work too stressful. Each item had five response alternatives ranging from never or seldom to very often. The sum index values were calculated for those who had responded to each item or had missing values for two items out of six at most. Responding "often" or "very often" to an item yielded a point. The categories examined were high (4+ items), and intermediate (1-3 items) work fatigue, with those reporting no work fatigue (0 items) serving as a reference group. In Substudy I, the measure was dichotomized to high and low work fatigue using four positive responses as a cut-off point.

The measure is based on the first part or the exhaustion component of an extensive burn-out inventory, where exhaustion is followed by more severe states such as cynicism and loss of self-esteem at work and subsequent burnout (Maslach, Jackson & Leiter 1996). The Finnish version enquiring about exhaustive fatigue was developed at the Finnish Institute of Occupational Health (Kalimo, Olkkonen & Toppinen 1993). Work fatigue was examined in the studies conducted within the HHS data (I, III, IV), as the measure was not available in the international cohorts.

5.2.4 Work arrangements and work-related factors

Working overtime

Working overtime was defined as working over 40 hours a week. In London, the respondents were enquired about how many hours they worked per average week in their main job including work brought home. In Helsinki, the respondents reported how many hours a week they spent working in paid employment. It is possible that some employees may have reported the length of their work week by definition, while others reported the actual hours. Nonetheless, the responses were assumed to reflect the true length of the week, i.e., the hours actually used for work. In Japan, the questionnaire item about working time was formulated to correspond to an average length of one working day, including work brought home. Consequently, the length of a work week was calculated by multiplying the response by five. In general, Japanese civil servants work five days a week, but health professionals such as doctors and nurses may have irregular working days and working hours. However, information about the length of the work week was not available. The length of the working time calculated as mentioned above corresponds to the length of the average work week in Britain.

Although working overtime was much more prevalent in the British and Japanese cohorts than within the Helsinki Health Study cohort, the same cut-off point was applied in the international comparisons. This was justifiable since the working time was a categorical variable in the HHS questionnaire and use of a higher cut-off point was not applicable due to the distribution of responses. Additionally, similar cut-off points have been used in other studies, also within other Japanese employee cohorts (Nakamura et al. 1998). Working overtime was examined in all the substudies, I-IV.

Work-home interface

The work-home interface was measured based on a single item enquiring how satisfied the respondent had been in combining paid work and family life (I, III, IV). The response alternatives ranged from very dissatisfied to most satisfied (on a seven-point scale). In Substudy I, work-home interface was examined as a dichotomy comparing those who were satisfied in combining paid work and family life to those who were dissatisfied. In further substudies (III, IV), an intermediate category of "somewhat satisfied" was also included in the analyses. The questionnaires from 2001 and 2002 included more comprehensive measures for work-home and home-work conflicts, but as these items were not available in the 2000 survey, they were not examined in this study. The work-home interface was studied among employees of the City of Helsinki only, i.e., the single item was not available for comparative purposes.

Social support

Social support was a combined measure of support received at home from a spouse or friends and at work from colleagues and supervisors (III, IV). The items included are by and large similar to Sarason's social support questionnaire (Sarason et al. 1983, Sarason et al. 1987). The inventory included in the HHS questionnaire was comprised of four items relating to different situations when the respondent needs help and support from others. Each item had seven response alternatives, of which six were potential sources for support and the seventh alternative stood for no support or having no one to ask for support. As it was possible to list several sources of support for each item, all the responses were summed, the maximum score being therefore 24. Thus, the measure did not include any missing values, but every empty response was coded as zero and every response, i.e., source of support, scored one. The mean sum score calculated from the 24 items was 7.4 (SD 3.9) among women and 6.4 (SD 3.6) among men. Due to the formulations of the items and unequal distribution of responses, work-related social support could not be studied separately from other sources of support. Consequently, iso-strain, i.e., a combination of high job strain and low social support was not studied, but the independent effects of social support on behavioral risk factors were examined when applicable. The sum score for social support was divided into tertiles indicating low, intermediate, and high social support. As with the work-home interface, the British and Japanese data did not include comparable measures for social support.

Table 3 Helsinki Health Study data characteristics and distributions of key variables

		Women (n=7168)	Men (n=1792)
Age		%	%
40		21	18
45		22	19
50		22	21
55		24	27
60		11	15
	missing (n)	(0)	(0)
Married or cohabiting		67	78
	missing (n)	(40)	(16)
Education			
Low		43	41
Medium		32	28
High		24	32
	missing (n)	(69)	(10)
Occupational social class			
Manual		12	28
Routine non-manual		42	10
Semi-professionals		19	19
Professionals & managers		27	43
	missing (n)	(137)	(37)
Job demands			
Very low		31	33
Low		25	26
High		22	21
Very high		23	20
	missing (n)	(109)	(20)
Job control			
Very low		16	20
Low		21	17
High		30	28
Very high		33	35
	missing (n)	(73)	(18)
Work fatigue			
Low		49	52
Medium		36	35
High		15	13
	missing (n)	(69)	(18)
Working overtime (over 40 hours/wk)		13	21
	missing (n)	(147)	(31)
Mental strain			
Low		24	26
Medium		62	59
High		14	15
	missing (n)	(163)	(28)
Physical strain			
Low		17	32
Medium		42	52
High		40	16
	missing (n)	(121)	(23)
Work-home interface			
Dissatisfied		9	9
Somewhat satisfied		39	43
Satisfied		52	48
	missing (n)	(517)	(115)
Social Support			
Low		37	48
Medium		35	33
High		28	19
	missing (n)	(0)	(0)

5.2.5 Behavioral risk factors

Figures 3-6 display prevalence of behavioral risk factors that were examined in this study. In comparative Substudy (II) comprised of only while-collar employees over 45 years of age, the prevalence of health behaviors is somewhat different than in Substudy I examining all participants from survey years 2000 and 2001 (Table 1). Moreover, in comparative Substudy II, all outcomes reflected adverse behaviors in contrast to Substudy I.

Smoking

Smoking was examined as current smoking of cigarettes, cigars, or pipe (I-II). In Helsinki, a single item about smoking listed all the above types, while in London three separate items were included. Responses to each item were combined, i.e., smoking of any tobacco type was examined as current smoking. In Japan, only smoking of cigarettes was enquired, as smoking cigars or pipes is very rare. A non-smoking category comprised ex-smokers as well.
In substudies I and II smoking was one of the outcome variables, while in substudies III and IV, the models were only initially controlled for smoking. As smoking did not have an effect on the studied associations, it was excluded from the final models.

Drinking

Drinking was enquired with several items enquiring typical types and amounts of alcoholic beverages the respondent had consumed during an average week (Helsinki, I-II). In London and Japan (II), the consumption during a previous week was asked. Based on responses, moderate and heavy drinking patterns were defined and examined. Reported units of beer, wine and spirits were summed, and the units were treated as grams of pure alcohol per week, i.e., multiplying the reported units by 12. In Substudy I, moderate alcohol consumption was defined based on Finnish dietary recommendations (National Nutrition Council 1998). Among women, cut-off point for moderate drinking was 105 grams per week, and for men 140 grams, corresponding approximately to the recommendation for energy provided by alcohol, i.e., maximum 5% of the daily energy intake.

Moderate drinking was also examined in comparative Substudy (II), but as the focus was on adverse health behaviors, these results were not displayed in the tables. Instead, heavy drinking was examined, defined as consuming more than 280 grams of absolute alcohol per week for men and 140 grams per week for women. This cut-off is based on Finnish Current Care guidelines (Working group appointed by the Finnish Society of Addiction Medicine 2005; see also www.kaypahoito.fi) as well as on other previous literature (Marmot et al. 1993, Aalto et al. 1999). In Japan, the types of alcohol beverages differed from Britain and Finland, but this is unlikely to cause any bias, as only the actual intake of alcohol in grams was examined based on the alcoholic content of each reported alcohol beverage. The initial models in Substudy III were also controlled for moderate drinking, but all the health behaviors were removed from the final models as the focus was on associations between working conditions and weight gain.

Binge drinking was defined in the questionnaire as drinking at least six units of beer, wine or spirits on one occasion. This was rarely reported among women. Thus, the cut-off point used was binge drinking at least once month (7% of women). In Substudy IV, binge drinking was initially examined in order to assess whether it had associations with AP symptoms that need to be taken into account in the multivariate models. As no associations were found (IV), and binge drinking did not affect the associations between working conditions and AP symptoms either, it was excluded from the final models and only descriptive statistics were reported.

Physical activity

Physical activity was assessed as leisure-time physical activity (I-II). It was examined based on a metabolic equivalent task (MET) calculated from the responses of the frequency and intensity of activities. More specifically, the Helsinki questionnaire included four items about mild, moderate, and vigorous activities including time spent on each form of activity per week. In Substudy I, the cut-off point for the recommended level of leisure-time physical activity was 30 MET per week, which corresponds to about 2100 kcal per week for a person weighing 70 kilograms, or a recommendation of approximately 30 minutes of moderate-intensity physical activity each day (Pate et al. 1995). One MET corresponds to the metabolic activity at rest. More information about the calculation of MET values has been reported earlier (Kujala et al. 1998).

In Substudy II, physical inactivity was used as outcome, as the items in the actual activity patterns were not fully comparable between cohorts. Additionally, the outcomes in Substudy II all reflected adverse behaviors. Since the items were not fully similar, and the outcome was composed somewhat differently in the cohorts, the prevalence rates as such are not comparable between countries. However, the idea was to look at the associations between inactive behaviors and working conditions in each country. Thus, the distribution of physical inactivity is displayed in Figure 4 alongside other adverse behaviors, but as the cut-off point was somewhat arbitrary, these distributions merely show the proportion of participants in the inactive category. More specifically, physical inactivity was defined based on the reported amount of leisure time physical activity in each country classifying those in the lowest quintile to be physically inactive. In London, reported hours for mild, moderate, and vigorous activities per week were summed up, and those who reported being physically active one hour per week or less were defined as physically inactive. This corresponded to the lowest active quintile as well. In Helsinki and Japan, the amounts and intensity of leisure-time activities were asked, and those in the lowest quintile of reported activities were classified as physically inactive. Calculating hours separately was not applicable in Helsinki and Japan due to somewhat different formulations of the questionnaire items and distribution of responses. Nonetheless, examining the associations between physical inactivity and working conditions is unlikely to be affected. In substudies III and IV, the focus was not on physical activity. The initial models were, however, controlled for physical activity. As the measure had no effects on the associations, and is a proxy measure for overall physical activities, it was excluded from the final analyses.

Food habits

Food habits were measured in substudies I and II using a food frequency questionnaire (FFQ), which has been suggested to be a useful tool for epidemiological studies (Paalanen et al. 2006). The food frequency questionnaire consisted of selected food items, and the questions were formulated to ask how often a respondent had consumed these foods during a certain time period. The Helsinki Health Study inventory was comprised of 22 food items, enquiring consumption frequency during the previous month. In addition, typically used fat for cooking and on bread were requested in separate items. For Substudy I, six items were chosen to indicate healthy food habits, based on national dietary recommendations (National Nutrition Council 1998). The items consisted of daily consumptions of rye bread, fresh vegetables, fruit and berries, and fish consumption at least twice a week, as well as choosing vegetable-based soft margarine on bread, and vegetable oil in cooking.

For Substudy II, three items that were comparable between Finnish and British participants were used. The outcome in Substudy II was treated as indicating unhealthy food habits, i.e., the participants not reporting any of the recommended food habits were examined. Items included were consumptions of fruit and vegetables, low-fat milk, and whole-grain bread.

Food habits were not addressed in substudies III and IV. However, they were initially controlled for in the analyses for Substudy III. Like physical activity, food habits did not affect the studied associations. Since they also were proxy indicators of dietary factors contributing to weight gain, they were excluded from the final paper.

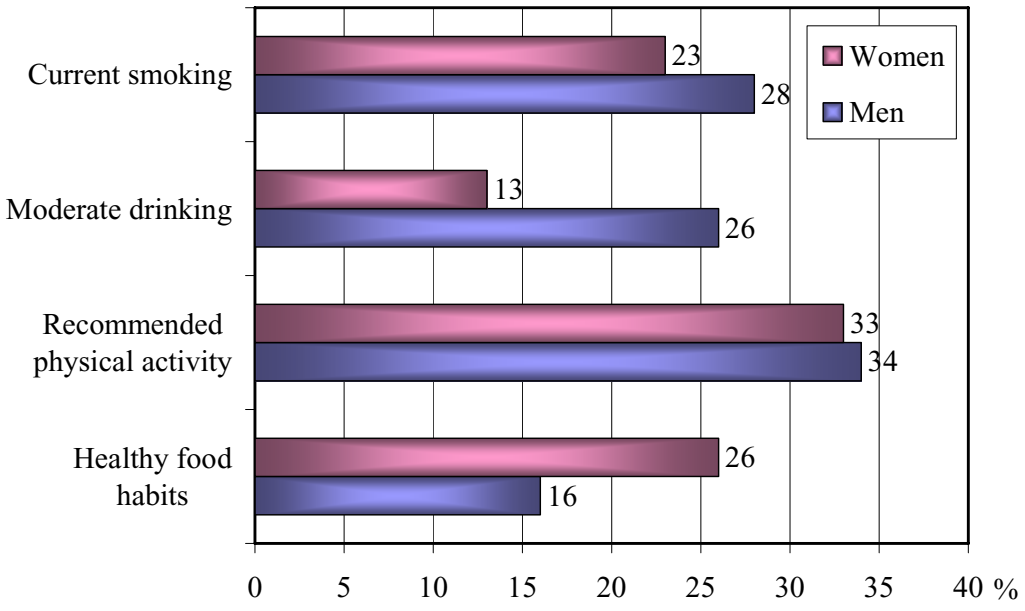

Figure 3 Prevalence (%) of health behaviors in the Helsinki Health Study cohort (I)

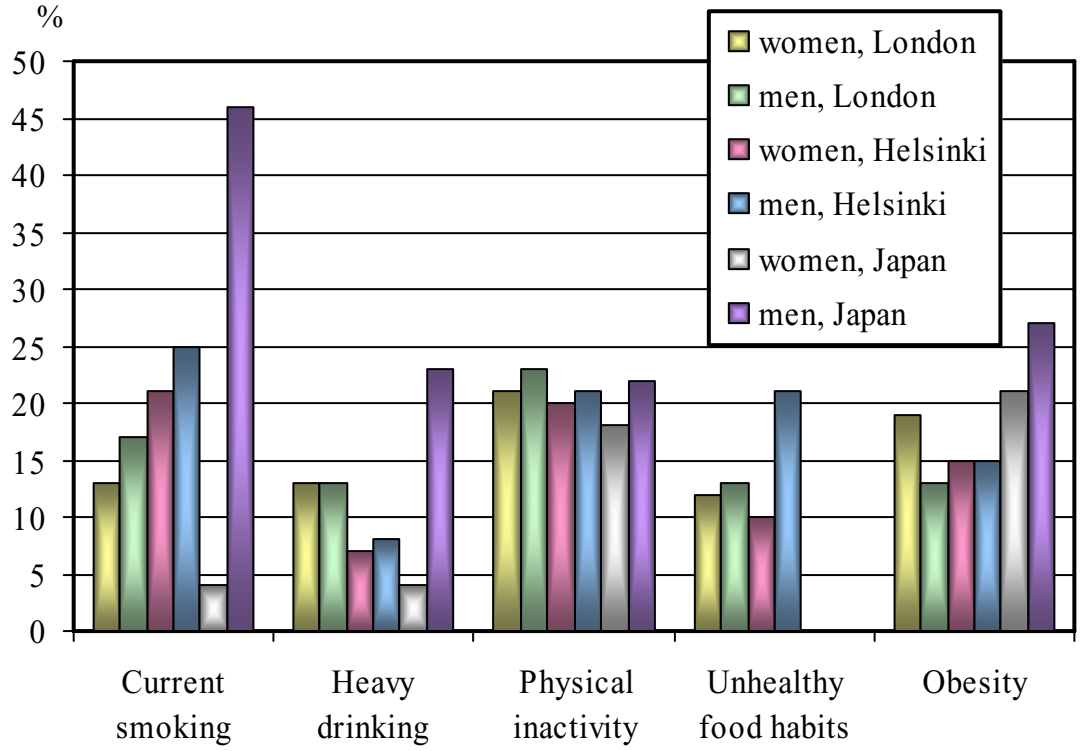

Figure 4 Prevalence (%) of adverse health behaviors and obesity in Britain, Finland, and Japan (II)

Weight gain and obesity

The participants within the Helsinki Health Study cohort were asked to report whether they had gained any weight during a year preceding the data collection (Figure 5; III). Also the amount gained was enquired, but as the responses were not comprehensive for kilograms, only general weight gain was analyzed. Additional analyses for major weight gain (five kilograms or more) produced, however, by and large similar results (data not shown). Altogether 11% of women and 8% of men reported to have gained over five kilograms during the year preceding data collection. Weight gain was examined in Substudy III only, as the corresponding information about weight changes was not available from the other cohorts.

Obesity was, in turn, examined in Substudy II. It was calculated based on self-reported weights and heights in Helsinki, while measured data were available for the international cohorts, presented in more detail in the following paragraphs. Additionally, BMI was initially taken into account when examining the associations between working conditions and AP symptoms among women in Helsinki (IV).

In London, body mass index was calculated from measured height and weight, excluding a few outliers, i.e., those with BMI more than 57.5. As information was derived from medical examination, it was available for only 77% of the sample, i.e., among those with these data combined with their questionnaire responses. As measured, it provides more accurate information than the self-reported data in Helsinki. Furthermore, direct comparisons between countries are limited by the

methodological differences. In general, as western countries, it is probable that both the prevalence and correlates of obesity are similar and comparable in both Britain and Finland.

The cut-off point for defining obesity has been lower in Japan than the internationally used cut-off point of 30.0 suggested by the World Health Organization (WHO). In the examined cohort of middle-aged civil servants, the prevalence of obesity judged by these criteria was very low. Subsequently, use of a similar cut-off point was not applicable. The Japan Society for the Study of Obesity suggests 25.0 as the cut-off point for measuring obesity among Japanese people (Examination Committee of Criteria for 'Obesity Disease' in Japan, Japan Society for the Study of Obesity 2002), and this definition has been applied in recent Japanese studies (Nakamura et al. 2007, Yang et al. 2007). Thus, for the purposes of the comparative analyses, employees with a BMI over 25.0 were classified as obese. The prevalence of obesity is not, therefore, fully comparable between countries as such. However, this does not imply that the associations between working conditions and high BMI need to be affected or biased.

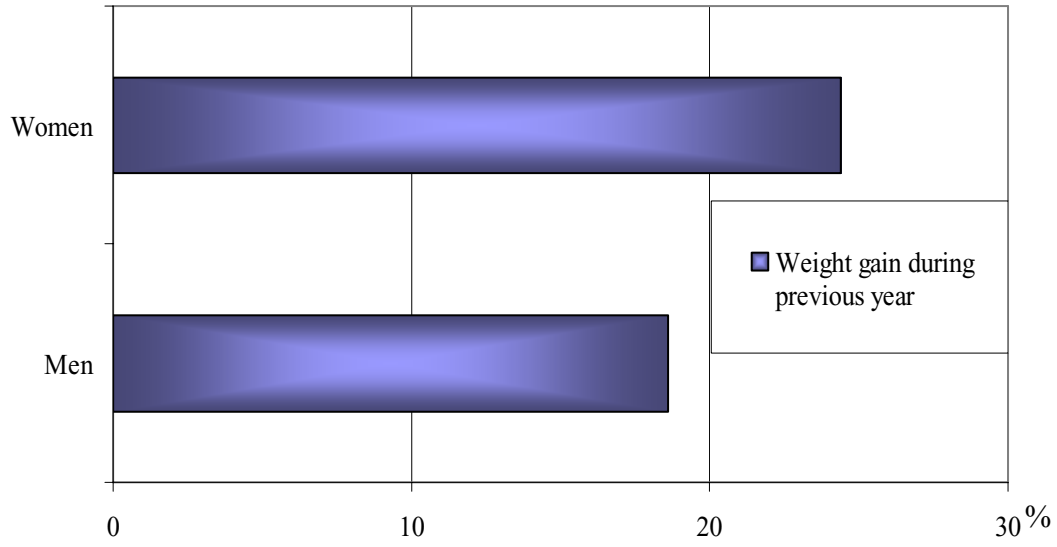

Figure 5 Prevalence (%) of weight gain during previous year among women (n=7011) and men (n=1774) in the Helsinki Health Study cohort (III)

5.2.6 Symptoms of angina pectoris

In this study (IV), symptoms of angina pectoris were measured by a self-administered angina pectoris questionnaire (Rose 1965). The WHO Rose Questionnaire, London School of Hygiene Cardiovascular Questionnaire, (Rose 1962, Rose 1965) is a standardized and objective tool for measuring angina pectoris. The questionnaire has been widely utilized for several decades and is suggested to be a valid tool for epidemiological studies (Sorlie et al. 1996).

Symptoms of angina pectoris are defined by reporting any chest pain or discomfort experienced while walking or hurrying, which forces one to stop or slow down, relieves within 10 minutes when resting, and is situated over the upper or lower sternum *or* lower sternum or left anterior chest and left arm. Only the respondents fulfilling all of the above original criteria were classified as having symptoms of angina pectoris. The severity of symptoms is defined based on response whether the chest pain occurs while hurrying/walking uphill (Grade I) or while walking at an ordinary pace on the level (Grade II). However, in the younger age groups, separating these grades was not applicable. Thus, the analyses were conducted by combining the two grades, whereas only control analyses were conducted for Grade II angina.

The prevalence of AP symptoms by grade is displayed in Figure 6. Furthermore, only 'definite' angina (6.0%) was examined, as 'possible' angina (4.6%) based on positive responses to the first two items only is likely to include a large variety of false positive cases in this age-group. In older, post-menopausal women, a shortened version focusing on exertional chest pain has also been suggested to be adequate and perform even better than the full version of the questionnaire (Lawlor, Adamson & Ebrahim 2003).

In this study focus was on elucidating understanding in these areas among women in Helsinki only. In addition, the number of men reporting AP symptoms was too low for statistical analyses. All the items were reported in Appendix I of Substudy IV. In other substudies, AP symptoms were not addressed.

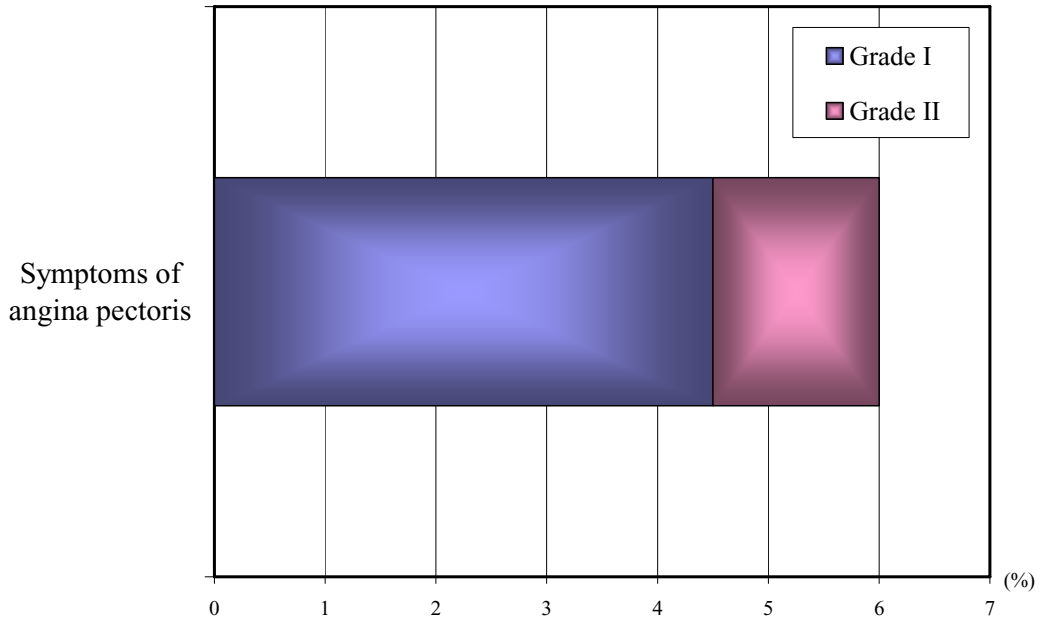

Figure 6 Prevalence (%) of symptoms of angina pectoris among women in Helsinki (N=7093; IV)

5.2.7 Missing values

The number of missing values was generally low, i.e., around 2% within the Helsinki Health Study data (see Table 3). The only exception was the item enquiring about satisfaction in combining paid work and family life, where about 7% of responses were missing. With regard to outcome variables, missing values were excluded, while a more conservative approach was applied with background and independent variables. In most cases, missing values were either included in the reference category, or excluded. For work-home interface, missing responses were included in the intermediate category. Concerning the measures of work fatigue, job demands and job control, which consist of several items, missing values were included in the analyses and coded as 0 (I) or replaced by mode (II) if the percentage of missing items in the measure was around 25–30%. For these working conditions, missing one out of four items for job demands, or two out of eight job control items at the most, missing values were replaced by mode (II). In other substudies (III, IV) missing values were coded as 0, if 25% of the items at the most were left empty. These replacements were conducted to avoid excess loss of data in the multivariate logistic regression analyses. These methods were applied for a small percentage of participants only suggesting that the selected imputation method is unlikely to bias the findings. If more items or the whole inventory were left unanswered, the respondent was excluded from the analyses.

Although the response rates were acceptable in each country the item missing was a larger problem in international cohorts than within the Helsinki data. This was especially true for the Japanese data. Numbers missing for alcohol items may, however, be partly accounted for by the high prevalence of abstinence among Japanese women (Nasermoaddeli, Sekine & Kagamimori 2006, Tsutsumi et al. 2006). As measured weights and heights were derived for only those who had participated in a medical examination, this also resulted in a higher number of missing values for BMI than for other variables in London and presumably Japan as well.

Due to data collection on four separate questionnaires in Japan, the item missing was higher when analyzing the associations between working conditions and health behaviors enquired in different questionnaires. In other words, although the response rates were high and the item missing per questionnaire was acceptable, a high number for missing values was produced when information from separate questionnaires was combined. Thus, due to somewhat varying respondents during the data collection, the combined data did not include comprehensive responses to working conditions and health behaviors for every otherwise eligible participant.

In London, numbers missing were also quite notable, i.e., about 10% of the responses were missing per each questionnaire item. Thus, in multivariate analyses carried out only among those with data for all the working conditions, the accumulation effect is substantial resulting in a reduced number of participants in the models. However, information about gender and age was available for every participant in all the countries.

To better control the effects of item missing in comparative Substudy (II), analyses were also conducted including missing values as separate categories in job demands, job control, and working overtime measures. The main results were unaffected

suggesting that the item missing does not seriously distort the finding in comparative Substudy (data not shown).

5.3 Statistical analyses

The main method for calculation of age-adjusted prevalence rates was general linear regression analysis. Multivariate analyses were conducted with the logistic regression procedure most suitable for the dichotomous outcomes of this study. In each substudy, logistic regression models were fitted using a stepwise method, i.e., including the variables in the models in an assumed temporal order. Age was adjusted for in all the substudies (I, II, III, IV). Results derived from bivariate models including only age and one working condition or work-related factor at a time are shown first in substudies I, II, and IV. Marital status was taken into account in the second step (I, II, III) alongside socio-economic indicators of education (I, III) and occupational class (I,II). In Substudy related to weight gain (III), also physically strenuous at work and body mass index were taken into account, while the prevalence estimates of weight gain by working conditions reflect the age-adjusted effects. In Substudy IV background variables did not affect the studied associations. Thus, they were excluded from the final models and only age was adjusted for in the analyses. Finally, in all the substudies, working conditions, background factors and potential confounders were mutually adjusted for. However, when all the working conditions are mutually adjusted for in the model, separating their individual effects is not easy. Simultaneous adjustments, nevertheless, show which associations remain statistically significant even after adjusting for the other working conditions.

Correlations and multicollinearity between education, occupational class, and working conditions were also tested (Table 4). As the confounders and working conditions were comprised of categorical variables, correlations were calculated by the nonparametric Spearman correlation, i.e., assumption about the normal distribution of the values was not applied. Education and occupational class were strongly correlated (0.76). Instead, the correlations between working conditions were mostly weak, and varied between 0.02-0.45. The highest correlations amongst working conditions were found between work fatigue and job demands (0.45), between work fatigue and mental strain (0.39), and between mental strain and job demands (0.39). Additionally, correlations between education and working conditions were mostly weak (0.09-0.36), except between education and job control the correlation was 0.36, while a similar inverse correlation existed between education and physically strenuous work (-0.35). Correlations between occupational class and working conditions showed similar, weak patterns (0.05-0.43), with the strongest correlations found between occupation and job control (0.43) and between occupational class and physically strenuous work (-0.40). The correlations were very similar between genders. Thus, the correlations are displayed for the whole cohort only. These mostly weak correlations suggest that over-adjustment of the models is not likely to bias the results. The stepwise modeling strategy of examining the age-adjusted effects first also aims to rule out the over-adjustment by looking at the effects of stepwise adjustments on the parameter estimates and derived odds ratios. The effects of the adjustments are also reported in the result section. However, to further examine the potential issue of adjusting the models with too many, partly correlated variables, multicollinearity was also tested.

Multicollinearity refers to negative or positive linear relationships or high correlations amongst independent variables in the regression models potentially affecting two or more of the variables (Morrow-Howell 1994). In other words, multicollinearity occurs if at least two independent variables measure the same thing. However, multicollinearity may also occur even if variables are not highly correlated, but can be mathematically derived by knowing other variables for instance (Tu, Clerehugh & Gilthorpe 2004). Thus, it may not be enough to only conduct basic tests for correlations, but it is also necessary to examine multicollinearity caused by other characteristics of variables in the regression models. In case of multicollinearity, the estimate of one independent variable's impact on the outcome while adjusting for the other variables tends to be less precise than if the variables show no correlations (Morrow-Howell 1994).

Multicollinearity was tested by looking at variation inflation factor (VIF) values, i.e., fitting a regression model including all the working conditions simultaneously and producing the multicollinearity diagnostics. Alternatively, tolerance values can be calculated, which contain the same information (tolerance= 1/VIF). In general, VIF-values incorporate information about how much of the variation of one covariate can be explained by other covariates in the multivariate regression model. If the VIF-values produced are large, the multiple regression model is threatened by multicollinearity and the results derived may be questionable. However, no generally accepted cut-offs for VIF-values for defining multicollinearity exist (Morrow-Howell 1994). Nonetheless, VIF values greater than 10 have been suggested to indicate problems with multicollinearity.

No suggestion for multicollinearity was observed in these data based on low VIF values varying between 1.05-1.49 for working conditions and between 2.44-2.80 for confounding factors (Table 4). Thus, applying the approach of including various working conditions in the models simultaneously is unlikely to produce biased, such as reduced or opposite results. Moreover, none of these variables should be conceptualized as being proxy for one another, redundant in the models, or reflecting over-fitting of the models with highly correlating variables (Morrow-Howell 1994). Thus, adjusting for various working conditions can be assumed to provide comprehensive, reliable knowledge about the studied associations. All the statistical analyses were carried out using SAS-programs for Windows (current version 8.2).

Table 4 Correlations and multicollinearity between education, occupational class, and working conditions*

n=8960	Education	Occupation-al class	Job demands	Job control	Work fatigue	Working overtime	Mental strain	Physical strain	Work-home interface	Social support	Variance inflation (VIF)
Education	1.00										2.44
Occupation-al class	0.76	1.00									2.80
Job demands	0.20	0.23	1.00								1.41
Job control	0.36	0.43	0.11	1.00							1.32
Work fatigue	0.11	0.11	0.45	-0.06	1.00						1.49
Working overtime	0.14	0.13	0.15	0.10	0.09	1.00					1.05
Mental strain	0.21	0.25	0.39	0.14	0.39	0.11	1.00				1.37
Physical strain	-0.35	-0.40	-0.03	-0.15	0.05	-0.06	0.07	1.00			1.24
Work-home interface	0.09	0.05	0.23	-0.13	0.33	0.09	0.22	0.02 ns	1.00		1.20
Social support	0.17	0.17	0.03	0.16	-0.05	0.03 p=0.001	0.05	-0.06	-0.08	1.00	1.05

*p-values <0.001 except for those marked in the table

5.4 Ethical considerations

The Helsinki Health Study is conducted following the data protection laws and ethical regulations of the University of Helsinki and the City of Helsinki. The study has been approved by the Ethics Committee of the Department of Public Health, University of Helsinki, and by the Ethics Committee of the health authorities of the City of Helsinki. Participation is voluntary, and the respondents are allowed to decline participation at any phase of the study. Individuals cannot be identified in the data analyses, and all personal identification numbers were replaced by unidentifiable codes, i.e., consecutive numbers in the data when conducting the current analyses.
The register document describing the study data is available at the project's website (http://www.kttl.helsinki.fi/hhs). The data Protection Ombudsman has received and approved the document as well.

With regard to international cohorts, the University College London ethics committee approved the Whitehall II study, whereas at the time of the collection of Japanese data, institutional ethical approval was not required for observational study. Instead, a civil service committee checked the contents and ethical aspects of the Japanese civil servant study.

6. RESULTS

The following results section will present and summarize the main results observed in all the substudies (I, II, III, and IV). First, results from the Helsinki Health Study are reviewed and compared with comparative findings when applicable, i.e., concerning health behaviors and obesity examined in substudies I and II. Secondly, results derived from substudies about weight gain (III) and symptoms of angina pectoris (IV) will be reviewed. Tables 5–12 gather and display the main results of each substudy. The focus in reporting the key findings is to show the most notable results, as well as present the observed trends that are similar or differ between genders and countries. Also the effects of controlling for confounding factors as well mutual adjustments for working conditions will be pointed out. When applicable, odds ratios (ORs) and their 95% confidence intervals (CI 95%) from the age-adjusted models will be reported in the text, whereas Tables 5–10 display the corresponding results from the mutually adjusted models. Another approach to these results is to address the aims and review the results in accordance with the main and the specific aims (see Chapter 3) set up to conduct this study. Since the emphasis of the present study is on the psychosocial working conditions and on the Karasek job demand-job control model (Figure 2) in particular, the focus in reporting and discussing the results is on job demands, job control, job strain, related work fatigue as well as on working overtime.

6.1 Working conditions and health behaviors

6.1.1 Helsinki Health Study

Health behaviors varied by gender except for physical activity, as about one-third of both women and men reported recommended levels of physical activity within employees of the City of Helsinki (Substudy I). While 26% of women reported healthy food habits, only 16% of men fulfilled at least five out of six recommended food habits. Men in turn were more often moderate alcohol drinkers, as 26% of men exceeded the cut-off point of moderate drinking compared to 13% women. Additionally, the cut-off point was lower among women further contributing to the gender difference in reported drinking behaviors. Smoking was also somewhat more prevalent among men. In 2000-2001, 28% of men were current smokers, while the corresponding figure was 23% among women.

Judging by descriptive statistics, i.e., cross-tabulations between the outcomes and working conditions (p-values, chi-squared distribution), most of the working conditions related to health behaviors among women (Table 5). Instead, among men, differences in the observed and expected frequencies did not reach statistical significance except for working overtime and a couple of other measures (Table 6).

Associations between working conditions and health behaviors more thoroughly examined in the logistic regression analyses were, in turn, mostly modest. Active work was inversely associated with current smoking among women in the age-adjusted model (OR 0.61; CI 95% 0.49-0.75). While this association was mostly explained by covariates and working conditions, a similar association for low strain work remained (Table 5). Additionally, women in physically strenuous work reported

more smoking (OR 1.41; CI 95% 1.23-1.62). This association was, however, explained by socio-economic factors. Among men, the only association was found between working overtime and smoking, i.e., men with overtime hours were less likely to smoke (OR 0.62; CI 95% 0.44-0.86). The association remained strong even after adjusting for education, occupational class, marital status and other working conditions (Table 6).

Concerning moderate drinking behaviors, work fatigue was of equal importance among both women (OR 1.41; CI 95% 1.13-1.75) and men (OR 1.45; CI 95% 1.01-2.07). Among women, however, the association attenuated after mutual adjustments, whereas among men the association was even slightly strengthened in the final model (Tables 5-6). Additionally, women with high mental strain at work were more likely to report moderate drinking (OR 1.35; CI 95% 1.10-1.67), while satisfaction with work-home interface was inversely associated with drinking (OR 0.85; CI 95% 0.72-1.00). These associations, however, disappeared after adjustments, i.e., were mostly explained by socio-demographic and socio-economic factors.

With regard to physical activity, working conditions had both beneficial and adverse effects. First, women reporting work fatigue were less likely to engage in leisure-time physical activities at the recommended level (OR 0.72; CI 95% 0.60-0.86). This association only slightly attenuated when mutually adjusted for (Table 5). Instead, women having physically strenuous work were somewhat more likely to be physically active also at leisure time (OR 1.14; CI 95% 1.01-1.28). The association remained when mutually adjusted for. Additionally, satisfaction with the work-home interface showed a beneficial influence on physical activity (OR 1.32; CI 95% 1.17-1.48) that remained in all steps of the modeling. Among men, only working overtime was associated with physical activity. This association reduced when mutually adjusted for (Table 6). However, the patterns of associations for work fatigue were similar to women, although the statistical significance was not reached.

Finally, the main findings for healthy food habits relate to high job control and high mental strain. More specifically, healthy food habits were associated with both active work (OR 1.46; CI 95% 1.18-1.80) and low job strain (OR 1.41; CI 95% 1.15-1.73) in the age-adjusted models, but among women only. The association for mental strain was of similar strength (1.42; CI 95% 1.22-1.66). All these associations remained, although attenuated when mutually adjusted for covariates and other working conditions (Table 5). Among men, healthy food habits were moderately associated with working overtime (OR 1.47; CI 95% 1.03-2.08), but this association reduced after adjustments (Table 6).

Thus, overall, physical and psychosocial working conditions bore some, albeit inconsistent, significance for health behaviors of employees. Moreover, the associations varied by gender, and outcome in question, i.e., working conditions did not produce universally negative or positive effects on health behaviors. Instead, partially beneficial and adverse influences were observed. Another noteworthy additional finding concerning working conditions suggests that simultaneous adjustments for several working conditions produces by and large similar estimates as compared to models assessing one working condition at a time, controlled for age, education, occupational social class, and marital status.

To summarize, as displayed in Tables 5-6, low job strain was related with recommended behaviors, i.e., healthier food habits and non-smoking among women, while high work fatigue was associated with adverse behaviors, such as less physical activity among women and drinking among men (I). Additionally, physically strenuous work and satisfaction with work-home interface remained associated with physical activity among women in the mutually adjusted models, whereas working overtime was associated with non-smoking among men in these final models.

Table 5. Associations between various working conditions and health behaviors among women (Odds ratios, OR and 95% confidence intervals, CI 95%, from logistic regression analyses*, I)

Women (n=4991)	**%**	**Current smoking**			**%**	**Moderate drinking**			**%**	**Physical activity**			**%**	**Healthy food habits**		
		OR	**CI 95%** lower	upper		**OR**	**CI 95%** lower	upper		**OR**	**CI 95%** lower	upper		**OR**	**CI 95%** lower	upper
Job strain																
High job strain	27	1.00	(ref)		13	1.00	(ref)		31	1.00	(ref)		23	1.00	(ref)	
Passive	26	0.81	0.64	1.03	10	0.87	0.63	1.19	29	0.82	0.65	1.02	20	1.03	0.80	1.31
Low job strain	20	0.71	0.57	0.90	12	0.86	0.64	1.15	36	1.11	0.90	1.36	29	1.32	1.06	1.66
Active	20	0.84	0.67	1.07	15	0.93	0.70	1.24	33	1.05	0.85	1.30	30	1.24	0.99	1.55
p-value	.00				.00				.00				.00			
Work fatigue																
Low	23	1.00	(ref)		12	1.00	(ref)		34	1.00	(ref)		28	1.00	(ref)	
High	21	0.96	0.77	1.20	16	1.25	0.97	1.60	27	0.77	0.63	0.93	30	1.01	0.83	1.23
p-value	.47				.01				.00				.42			
Working overtime																
No	23	1.00	(ref)		13	1.00	(ref)		33	1.00	(ref)		28	1.00	(ref)	
Yes	21	1.13	0.91	1.41	13	0.80	0.62	1.05	33	1.08	0.89	1.30	29	0.91	0.71	1.11
p-value	.42				.92				.99				.43			
Physical strain																
Low	20	1.00	(ref)		15	1.00	(ref)		32	1.00	(ref)		30	1.00	(ref)	
High	26	0.97	0.82	1.13	10	0.84	0.68	1.04	35	1.18	1.02	1.35	26	1.05	0.90	1.22
p-value	.00				.00				.05				.00			
Mental strain																
Low	26	1.00	(ref)		10	1.00	(ref)		34	1.00	(ref)		23	1.00	(ref)	
High	21	0.92	0.77	1.10	14	1.10	0.87	1.40	33	0.96	0.82	1.13	30	1.24	1.04	1.45
p-value	.00				.00				.37				.00			
Work-home interface																
Not satisfied	21	1.00	(ref)		14	1.00	(ref)		30	1.00	(ref)		28	1.00	(ref)	
Satisfied	23	1.03	0.89	1.20	12	0.97	0.81	1.17	36	1.27	1.11	1.44	29	1.11	0.96	1.27
p-value	.13				.05				.00				.37			

*Adjusted for age, marital status, education, occupational class, and mutually for all working conditions. P-values for descriptive statistics (prevalence of outcome by working conditions) are from chi-squared distribution.

Table 6. Associations between various working conditions and health behaviors among men (Odds ratios, OR and 95% confidence intervals, CI 95%, from logistic regression analyses*, I)

Men (n=1252)	%	Current smoking			%	Moderate drinking			%	Physical activity			%	Healthy food habits		
		OR	CI 95% lower	upper		OR	CI 95% lower	upper		OR	CI 95% lower	upper		OR	CI 95% lower	upper
Job strain																
High job strain	25	1.00	(ref)		23	1.00	(ref)		31	1.00	(ref)		18	1.00	(ref)	
Passive	29	0.95	0.59	1.55	24	1.38	0.84	2.25	30	0.96	0.61	1.51	14	0.75	0.43	1.31
Low job strain	30	1.32	0.82	2.13	27	1.37	0.85	2.21	36	1.20	0.77	1.86	15	0.68	0.39	1.16
Active	27	1.56	0.97	2.53	28	1.10	0.68	1.76	36	1.21	0.78	1.87	19	0.85	0.50	1.43
p-value	.69				.43				.27				.28			
Work fatigue																
Low	30	1.00	(ref)		25	1.00	(ref)		36	1.00	(ref)		19	1.00	(ref)	
High	23	0.73	0.47	1.13	33	1.59	1.06	2.39	30	0.77	0.52	1.15	25	0.88	0.54	1.43
p-value	.07				.05				.14				.08			
Working overtime																
No	30	1.00	(ref)		25	1.00	(ref)		32	1.00	(ref)		18	1.00	(ref)	
Yes	21	0.64	0.45	0.91	29	1.11	0.80	1.55	40	1.31	0.96	1.78	24	1.33	0.92	1.94
p-value	.01				.30				.02				.03			
Physical strain																
Low	27	1.00	(ref)		27	1.00	(ref)		34	1.00	(ref)		19	1.00	(ref)	
High	35	1.14	0.79	1.65	21	0.82	0.55	1.23	33	0.93	0.65	1.33	19	1.01	0.63	1.62
p-value	.04				.08				.78				.84			
Mental strain																
Low	32	1.00	(ref)		23	1.00	(ref)		34	1.00	(ref)		16	1.00	(ref)	
High	27	0.79	0.57	1.10	27	1.32	0.93	1.86	34	0.94	0.69	1.29	21	1.05	0.69	1.58
p-value	.11				.16				.98				.06			
Work-home interface																
Not satisfied	30	1.00	(ref)		25	1.00	(ref)		33	1.00	(ref)		19	1.00	(ref)	
Satisfied	26	0.77	0.58	1.02	27	1.18	0.89	1.57	34	1.08	0.83	1.39	19	1.07	0.77	1.49
p-value	.10				.53				.67				.83			

*Adjusted for age, marital status, education, occupational class, and mutually for all working conditions. P-values for descriptive statistics (prevalence of outcome by working conditions) are from chi-squared distribution.

6.1.2 Comparative analyses

Comparative analyses (II) among public sector employees from Britain, Finland and Japan by and large repeat and corroborate the results derived in Substudy I. As within the HHS cohort, the comparative associations between examined psychosocial working conditions and health behaviors were overall few and inconsistent, varying

by behavior (Tables 7-8). However, as the pooled dataset only comprised white-collar employees aged 45-60 years, the results are not fully comparable with Substudy I. Moreover, the focus in the international comparison was set on adverse behaviors, while Substudy I aimed to focus on both recommended behaviors such as healthy food habits and physical activity as well as examine smoking and moderate drinking. Since these behaviors are patterned by socio-economic factors, variation between employees is not as large as in Substudy I that also examined manual workers. However, information across countries is more valid with homogenous samples comprised of employees of similar age groups and within a public sector.

As in Substudy I, a large variation by gender was observed in the prevalence of health behaviors in each country (Figure 4). Notable differences by country were also observed. Since the outcomes used are not comprised of fully overlapping items, the comparison between countries concerning levels of behaviors is not, however, as applicable as is the focus on the associations between working conditions and adverse behaviors.

With regard to background and confounding factors, men had a higher occupational position than women in each country, and also more men than women were married. Consequently, all the analyses also in Substudy II were conducted stratified by gender. Furthermore, as one of the overall aims of the study was set to gain more information about the effects of psychosocial working conditions on women's behaviors, combined analyses were not preferred. However, within the Japanese cohort, the small number of women participants may have limited the power in statistical analyses. Also the questionnaire data were more limited than in the other cohorts, as was the prevalence for adverse behaviors, in particular for heavy drinking and smoking.

Some differences were observed in the distributions of the outcome variables by the categories of the examined independent variables (Tables 7-8). However, p-values (chi^2) were mostly statistically nonsignificant.

One overall finding agreeing with Substudy I was that more and stronger associations were usually observed in the age-adjusted bivariate models, at least with respect to the HHS cohort. When occupational class and marital status were added to the models, the associations mostly attenuated. However, adjusting mutually for all the confounding factors and psychosocial working conditions produced practically negligible effect on the estimates. Some exceptions exist, and these are reported by behavior in the following paragraphs. In contrast, in Britain and Japan adjustments strengthened some of the associations.

Despite the use of homogenous employee cohorts in terms of age, and employment status, as well as largely similar questionnaire items, the results were only partly similar between countries. Psychosocial working conditions had a somewhat more pronounced effect on the British employees as well women in Helsinki, while most of the associations between working conditions and health behaviors did not reach statistical significance within the Japanese cohort or among men in Helsinki.

Concerning smoking, some associations were found for both job strain and working overtime. First, women reporting passive work were less likely to be smokers in

London. This association was weak and not statistically significant in the age-adjusted model, but strengthened when adjusted for occupational class and marital status (OR 0.53; CI 95% 0.29-0.96). Further adjustment for working overtime did not attenuate this association (Table 7). Additionally, high job strain was found to be associated with smoking among men in Japan. The association was even strengthened by the mutual adjustments for covariates and working overtime (Table 8). Working overtime, in turn, related to non-smoking among Japanese men (OR 0.72; CI 95% 0.54-0.95), and this effect also remained in the mutual adjustments (Table 8). Similarly, working overtime was associated with non-smoking among men in Helsinki (OR 0.68; CI 95% 0.47-0.99), but the adjustments for covariates and job strain reduced the association among men in Helsinki (Table 8). Furthermore, women reporting low job control (OR 1.34; CI 95% 1.13-1.59) were more likely to be smokers, while among men high job demands were inversely related to smoking (OR 0.61; CI 95% 0.40-0.93) in Helsinki. However, also these associations disappeared with further adjustments among women in particular, while among men the attenuation was more modest.

Unexpectedly, heavy drinking behaviors were mostly unaffected by psychosocial working conditions. The only result observed for the job strain model was the strong and inverse association between passive work and heavy drinking among women in London (OR 0.25; CI 95% 0.13-0.49). This age-adjusted association remained moderately strong after mutual adjustments as well (Table 7). Only low job control was observed to be inversely related to heavy drinking among women in London (OR 0.46; CI 95% 0.30-0.72), but the association was explained by occupational class and marital status.

Nevertheless, moderate drinking as assessed in Substudy I was also examined, which showed some associations with working conditions (data not shown). Passive work was inversely associated with moderate drinking. The patterns were broadly similar in each cohort and among both genders. However, the associations were statistically significant only among women (OR 0.37; CI 95% 0.23-0.61) and men (OR 0.79; CI 95% 0.62-0.99) in London, and among women in Helsinki (OR 0.75; CI 95% 0.60-0.94). However, these age-adjusted associations reduced when adjusted for covariates and simultaneously for working overtime, except among women in London the association remained moderately strong in the mutually adjusted models as well (OR 0.54; CI 95% 0.32-0.92). This association between moderate drinking and passive work in London is also very similar to the one shown for heavy drinking (Table 7). In Helsinki, men with high job strain were less likely to report moderate drinking (OR 0.62; CI 95% 0.41-0.92). This association remained also in the mutually adjusted models, i.e., when covariates and working overtime were taken into account (OR 0.59; CI 95% 0.39-0.88). Additionally, varying, country-specific effects were shown for working time. Men who worked overtime reported more moderate drinking in both London (OR 1.28; CI 95% 1.07-1.53) and Helsinki (OR 1.54; CI 95% 1.12-2.11), while the influence of working hours was the opposite among Japanese men (OR 0.72; CI 95% 0.54-0.96). The association among men in London reduced when adjusted for covariates. Instead, the associations even slightly strengthened in Helsinki and Japan in further phases of the modeling. The heavier cut-off point was, nevertheless, chosen as it is more profoundly and unanimously linked with health risks. The associations with moderate drinking and working conditions are, in turn, likely to reflect different phenomena.

Several associations were observed between physical inactivity and working conditions as well. With regard to the job strain model, passive work (OR 1.82; CI 95% 1.34-2.48) and high job strain (OR 1.97; CI 95% 1.36-2.83) showed strong associations with physical inactivity among men in London. Similar associations were found for passive work (OR 1.29; CI 95% 1.05-1.58) and for high job strain (OR 1.25; CI 95% 1.00-1.56) among women in Helsinki as well. These age-adjusted associations remained even after simultaneously controlling for covariates and working overtime (Tables 7-8). Additionally, working overtime was strongly and inversely related to physical inactivity among women in London (OR 0.59; CI 95% 0.36-0.95). This association was, however, explained by occupational class and marital status. Low job control related to physical inactivity among men in London (OR 1.41; CI 95% 1.00-2.00), whereas among Japanese women, low job control was associated with a reduced likelihood of being inactive (OR 0.52; CI 95% 0.27-1.02). The association for Japanese women even slightly strengthened, when adjusted for occupational class and marital status (OR 0.48; CI 95% 0.24-0.98). The opposing associations for London and Japanese women disappeared when mutually adjusted for other working conditions. High job demands, in turn, remained strongly associated with physical inactivity among women in London in the mutually adjusted model (OR 2.03; CI 95% 1.10-3.75).

In contrast to physical activity, unhealthy food habits were unassociated with job strain and working overtime in the mutually adjusted models. However, when looking at the individual age-adjusted effects, a couple of findings were observed among men in London. Passive work was associated with unhealthy food habits (OR 1.67; CI 95% 1.20-2.33), whereas those working overtime were less likely to report unhealthy food habits (OR 0.65; CI 95% 0.51-0.84). With regard to the dimensions of psychosocial working conditions, unhealthy food habits were inversely related to high job demands (OR 0.62 CI 95% 0.44-0.86) in men in London. This association, however, attenuated when confounding factors and working conditions had been taken into account. Otherwise, no associations were observed between working conditions and food habits. The results are not fully comparable to Substudy I, as the unhealthy food habits examined in Substudy II were comprised of only three items, while Substudy I focused on six recommended choices.

Also interaction analyses were conducted to confirm whether the association between the studied behavioral risk factors and working conditions differed by cohort (data not shown). These analyses were conducted by comparing the models including and not including the interaction term cohort*independent variable, i.e., the nested models both contained the same terms and the interaction model one additional term as well. The statistical significance was examined using -2 log likelihood values (intercept and covariates), and the difference between degrees of freedom of these two models. P-values were derived from chi-distribution.

Interactions were mostly statistically non-significant suggesting that the overall pattern of non-existent associations is similar in each cohort. Only two statistically significant interactions were found among men. The first found interaction for cohort*working overtime concerning smoking had already been shown in the stratified analyses, i.e., working overtime related to smoking only among Japanese men in the fully adjusted model. The second interaction suggested that the association

between working overtime and food habits may differ between British and Finnish men.

Table 7. Associations between job strain, working overtime, and adverse health behaviors in Britain, Finland and Japan among women (Odds ratios, OR and 95% confidence intervals, CI 95%, from logistic regression analyses*, II)

	%	Current smoking			%	Heavy drinking			%	Physical inactivity			%	Unhealthy food habits		
		OR	CI 95% lower	upper		OR	CI 95% lower	upper		OR	CI 95% lower	upper		OR	CI 95% lower	upper
LONDON		n=780				n=766				n=782				n=777		
Job strain																
Low strain	16	1.00	(ref)		18	1.00	(ref)		11	1.00	(ref)		13	1.00	(ref)	
Active	12	0.92	0.52	1.64	18	0.74	0.45	1.22	9	1.33	0.67	2.64	9	0.90	0.48	1.68
Passive	11	0.53	0.29	0.96	5	0.38	0.19	0.78	16	0.83	0.45	1.53	13	0.73	0.40	1.34
High strain	13	0.72	0.35	1.46	13	0.86	0.42	1.75	8	0.57	0.23	1.42	12	0.70	0.31	1.56
p-value	.45				.00				.06				.56			
Working overtime																
No	12	1.00	(ref)		12	1.00	(ref)		15	1.00	(ref)		13	1.00	(ref)	
Yes	13	1.29	0.81	2.04	16	0.95	0.61	1.50	9	0.81	0.47	1.38	11	1.00	0.61	1.64
p-value	.55				.07				.02				.51			
HELSINKI		n=4685				n=4698				n=4089				n=4724		
Job strain																
Low strain	20	1.00	(ref)		8	1.00	(ref)		18	1.00	(ref)		8	1.00	(ref)	
Active	19	0.98	0.79	1.22	7	0.77	0.56	1.06	18	0.96	0.76	1.20	9	1.02	0.76	1.37
Passive	23	0.96	0.78	1.17	6	0.93	0.68	1.28	22	1.31	1.05	1.62	11	1.17	0.89	1.54
High strain	23	1.04	0.85	1.29	6	0.85	0.61	1.19	21	1.25	1.00	1.57	11	1.18	0.89	1.57
p-value	.02				.34				.01				.11			
Working overtime																
No	21	1.00	(ref)		7	1.00	(ref)		20	1.00	(ref)		10	1.00	(ref)	
Yes	20	1.03	0.84	1.28	7	0.98	0.70	1.35	20	1.05	0.83	1.31	9	1.03	0.78	1.38
p-value	.44				.63				.80				.60			
JAPANESE PROVINCE		n=301				n=298				n=302						
Job strain																
Low strain	5	1.00	(ref)		4	1.00	(ref)		14	1.00	(ref)			N/A		
Active	2	0.18	0.02	1.77	6	1.04	0.25	4.29	21	1.83	0.78	4.28				
Passive	2	0.20	0.02	2.05	3	0.33	0.06	1.84	14	0.87	0.35	2.16				
High strain	9	2.08	0.45	9.57	2	0.37	0.04	3.58	22	1.09	0.36	3.29				
p-value	.10				.66				.32							
Working overtime																
No	3	1.00	(ref)		4	1.00	(ref)		19	1.00	(ref)					
Yes	5	1.47	0.34	6.33	5	0.77	0.23	2.64	18	0.95	0.49	1.84				
p-value	.33				.63				.81							

*Age, occupational class, marital status, and all working conditions mutually adjusted for; N/A not applicable. P-values for descriptive statistics (prevalence of outcome by working conditions) are from chi-squared distribution.

Table 8. Associations between job strain, working overtime, and adverse health behaviors in Britain, Finland and Japan among men (Odds ratios, OR and 95% confidence intervals, CI 95%, from logistic regression analyses*, II)

		Current smoking				Heavy drinking				Physical inactivity				Unhealthy food habits		
	%	OR	CI 95% lower	upper	%	OR	CI 95% lower	upper	%	OR	CI 95% lower	upper	%	OR	CI 95% lower	upper
LONDON		n=2130				n=2115				n=2135				n=2130		
Job strain																
Low strain	17	1.00	(ref)		14	1.00	(ref)		13	1.00	(ref)		11	1.00	(ref)	
Active	17	1.07	0.78	1.46	13	0.90	0.63	1.27	14	1.20	0.85	1.69	12	1.26	0.87	1.83
Passive	17	0.77	0.56	1.06	11	0.87	0.61	1.25	20	1.64	1.18	2.27	17	1.25	0.88	1.78
High strain	18	0.93	0.64	1.34	14	0.97	0.64	1.46	21	1.88	1.30	2.72	11	0.96	0.61	1.49
p-value	.93				.59				.00				.01			
Working overtime																
No	18	1.00	(ref)		12	1.00	(ref)		19	1.00	(ref)		16	1.00	(ref)	
Yes	17	1.10	0.86	1.41	13	1.15	0.86	1.53	16	0.97	0.75	1.24	11	0.78	0.59	1.04
p-value	.87				.33				.13				.00			
HELSINKI		n=1023				n=1022				n=857				n=1025		
Job strain																
Low strain	25	1.00	(ref)		9	1.00	(ref)		18	1.00	(ref)		21	1.00	(ref)	
Active	26	1.09	0.72	1.65	7	0.60	0.31	1.16	20	1.11	0.67	1.81	26	1.22	0.80	1.86
Passive	25	0.84	0.55	1.26	9	1.08	0.59	1.98	21	1.18	0.73	1.93	22	1.08	0.70	1.66
High strain	24	0.83	0.54	1.27	5	0.56	0.27	1.15	24	1.44	0.89	2.35	17	0.76	0.48	1.21
p-value	.95				.29				.48				.13			
Working overtime																
No	26	1.00	(ref)		7	1.00	(ref)		20	1.00	(ref)		20	1.00	(ref)	
Yes	20	0.73	0.49	1.09	10	1.64	0.94	2.86	23	1.14	0.75	1.74	26	1.30	0.89	1.89
p-value	.08				.14				.36				.05			
JAPANESE PROVINCE		n=790				n=778				n=785						
Job strain																
Low strain	44	1.00	(ref)		26	1.00	(ref)		20	1.00	(ref)			N/A		
Active	46	1.25	0.86	1.84	22	0.96	0.62	1.49	21	1.08	0.67	1.74				
Passive	43	1.06	0.72	1.55	23	0.79	0.50	1.24	24	1.34	0.85	2.12				
High strain	53	1.56	1.01	2.41	20	0.74	0.43	1.28	27	1.17	0.69	1.98				
p-value	.23				.57				.26							
Working overtime																
No	49	1.00	(ref)		25	1.00	(ref)		21	1.00	(ref)					
Yes	40	0.67	0.49	0.90	21	0.83	0.59	1.19	21	0.98	0.68	1.41				
p-value	.01				.10				.89							

*Age, occupational class, marital status, and all working conditions mutually adjusted for; N/A not applicable. P-values for descriptive statistics (prevalence of outcome by working conditions) are from chi-squared distribution.

6.2 Working conditions and weight

6.2.1 Results from Helsinki Health Study on weight gain

Weight gain was prevalent among employees of the City of Helsinki during a year preceding the data collection, based on self-reported information (III). Altogether 24% of women and 19% of men reported having gained weight during the previous year. However, neither age nor any other potential confounder of an association between working conditions and weight gain was related to weight gain. Instead, several working conditions were of importance concerning weight gain (Table 9). Particularly, differences between the lowest and highest categories of work-related exposures were observed among women, while the intermediate group differed from the reference group among men in the mutually-adjusted models.

The prevalence of weight gain did not differ by physical strain at work (Table 9). However, when looking at job strain, women reporting high or very high job demands were more likely to have gained weight during the previous year as compared to those with very low job demands. Among men, the pattern was similar for high job demands as compared to the very low job demands, but the 95% confidence intervals partly overlapped. Additionally, differences were observed for work fatigue among both genders. Women and men reporting high work fatigue were more likely to have gained weight than their counterparts with no work fatigue. Similarly, those reporting high mental strain and those working overtime were more likely to have gained weight. Among men, the pattern was similar, but statistically not significant. Dissatisfaction in combining paid work and family life was also more common among those who had gained weight among both women and men.

In the base models, the strongest associations were observed between high work fatigue and weight gain (OR 1.56; CI 95% 1.33-1.83) and dissatisfaction with work-home interface and weight gain (OR 1.49; CI 95% 1.22-1.82) among women. Also intermediate categories were related to weight gain, but the association was more moderate for both medium work fatigue (OR 1.19; CI 95% 1.05-1.35) and work-home interface (OR 1.19; CI 95% 1.06-1.34) Additionally, high (OR 1.24; CI 95% 1.06-1.46) and very high job demands (OR 1.27; CI 95% 1.09-1.49), high mental strain (OR 1.29; CI 95% 1.06-1.55), working overtime (OR 1.26; CI 95% 1.07-1.49), and low social support (OR 1.17; CI 95% 1.01-1.35) were associated with gain among women in the models adjusted for age, education, marital status, physical strain at work and body mass index. The results for men were similar, except social support was unassociated with weight gain. In agreement with findings among women, strong associations were found between work fatigue and weight gain (OR 1.86; CI 95% 1.30-2.68) and dissatisfaction with work-home interface and weight gain (OR 1.83; CI 95% 1.20-2.79) among men as well. Additionally, medium (OR 1.51; CI 95% 1.10-2.07) and high mental strain (OR 1.93; CI 95% 1.29-2.87) as well as working overtime (OR 1.49; CI 95% 1.12-1.99) showed strong associations with weight gain among men.

When age, education, marital status, and all working conditions were mutually adjusted for, the associations attenuated. However, high work fatigue, working overtime, and dissatisfaction with work-home interface remained associated with weight gain among women (Table 9). In line with the results among women, work

fatigue, working overtime, and work-home interface showed associations with weight gain among men as well. Additionally, men with low demands were less likely to have gained weight. While the statistically significant differences among men mostly remained only for the intermediate category, the associations, however, were somewhat stronger than among women. Simultaneous adjustments for confounding factors and working conditions produced estimates that were weaker than the estimates derived from the base models. Thus, adjusting for working conditions had a more notable impact on the associations as in substudies I and II, at least concerning the HHS data.

Separate analyses for minor (1-4 kg) and major (≥ 5 kg) weight gain were also conducted for the purposes of controlling whether the amount of the weight gain influences the observed associations. Unexpectedly, the results were unaffected, i.e., not stronger for major weight gain as compared to minor weight gain.

Table 9. Associations between psychosocial working conditions and weight gain (Odds ratios, OR and 95% confidence intervals, CI 95%, from logistic regression analyses). Prevalence (%) and results from logistic regression analyses stratified by gender (III)

	Women (n=7011[1])				**Men (n=1774[1])**			
	Age-adjusted prevalence of weight gain	Fully adjusted logistic regression model [2]			Age-adjusted prevalence of weight gain	Fully adjusted logistic regression model [2]		
	%	OR	CI 95%		%	OR	CI 95%	
Job demands			lower	upper			lower	upper
Very low	22	1.00	(ref)		18	1.00	(ref)	
Low	24	1.11	0.95	1.30	16	0.69	0.49	0.98
High	26*	1.12	0.94	1.32	19	0.70	0.48	1.03
Very high	27*	1.02	0.85	1.23	24	0.85	0.57	1.28
Job control								
Very high	24	1.00	(ref)		20	1.00	(ref)	
Very low	24	0.96	0.80	1.16	17	0.95	0.63	1.42
Low	25	1.07	0.90	1.26	20	1.07	0.74	1.55
High	25	1.03	0.89	1.19	18	0.92	0.67	1.28
Work fatigue								
No	22	1.00	(ref)		15	1.00	(ref)	
Medium	26*	1.13	0.99	1.29	23*	1.49	1.11	2.00
High	32*	1.41	1.16	1.71	26*	1.48	0.95	2.32
Mental strain								
Low	22	1.00	(ref)		13	1.00	(ref)	
Medium	25	1.01	0.88	1.18	20*	1.35	0.95	1.90
High	28*	1.02	0.83	1.27	24*	1.45	0.90	2.33
Working overtime								
No	24	1.00	(ref)		18	1.00	(ref)	
Yes	28*	1.21	1.02	1.43	24	1.36	1.00	1.83
Work-home interface								
Satisfied	22	1.00	(ref)		15	1.00	(ref)	
Somewhat satisfied	26*	1.11	0.98	1.26	21*	1.32	1.00	1.74
Dissatisfied	31*	1.24	1.00	1.54	24	1.37	0.86	2.17
Social Support								
High	26	1.00	(ref)		18	1.00	(ref)	
Medium	24	1.02	0.88	1.18	19	0.94	0.66	1.34
Low	24	1.13	0.98	1.31	20	0.89	0.63	1.25

[1] Pregnant women and those with missing data for weight gain excluded.
[2] Adjusted for age, education, marital status, physical strain at work, body mass index, and mutually for all working conditions.
* Statistically significant age-adjusted prevalence rates are marked with an asterisk (i.e., 95% confidence intervals between categories do not overlap)

6.2.2 Comparative analyses on obesity

Obesity was somewhat more prevalent among women in London than men, with about 19% of women and 13% men being obese (II). However, the prevalence of obesity was equally distributed in Helsinki by gender, as a sixth of participants within the Helsinki Health Study cohort were currently obese. In contrast to London, more

men than women were obese in the Japanese cohort, as judged by the lower cut-off point of BMI 25. Almost one third of Japanese men were obese, while the percentage obese was 21 among Japanese women. Prevalence of obesity did not differ statistically significantly by job strain or working overtime in any of the examined cohorts, except for working overtime among women in London (Table 10).

In London and in Helsinki, job strain and working overtime were not associated with obesity among men (II). Instead, women reporting working overtime were more likely to be obese in London. This association was weaker in the age-adjusted model, but strengthened, when occupational class and marital status were adjusted for (OR 1.68; CI 95% 1.09-2.59). When working overtime was taken into account, the association also slightly strengthened (Table 10). In Japan, obesity was unrelated to working conditions in either gender. However, some of the estimates among Japanese women were strong, but did not reach statistical significance possibly due to the small size of the sample. Thus, it is possible that working conditions relate to obesity among Japanese women, but these associations cannot be ascertained in this study. Otherwise, in London, Helsinki and among Japanese men, even the estimates were mostly weak, and working conditions were unrelated to obesity.

Additional analyses for separate dimensions of the job strain model showed that women with low job control were less likely to be obese. This was, however, observed among women in Helsinki only. The association was strengthened when adjusted for occupational class and marital status (OR 0.74; CI 95% 0.61-0.91), but remained practically similar after mutual adjustment for job demands and working overtime (OR 0.75; CI 95% 0.61-0.91). Model estimates were similar among Japanese men, but statistical significance was not reached.

Table 10. Associations between job strain, working overtime, and obesity in Britain, Finland and Japan (Odds ratios, OR and 95% confidence intervals, CI 95%, from logistic regression analyses*, II)

	%	Women			%	Men		
		OR	CI 95% lower	upper		OR	CI 95% lower	upper
LONDON		n=640				n=1747		
Job strain								
Low strain	17	1.00	(ref)		12	1.00	(ref)	
Active	17	0.96	0.54	1.70	12	0.96	0.65	1.44
Passive	22	1.37	0.78	2.40	14	1.12	0.76	1.65
High strain	24	1.33	0.68	2.61	16	1.33	0.85	2.07
p-value	.35				.34			
Working overtime								
No	16	1.00	(ref)		13	1.00	(ref)	
Yes (over 40 hr/ wk)	23	1.71	1.11	2.65	13	1.11	0.81	1.52
p-value	.01				.87			
HELSINKI		n=4667				n=1015		
Job strain								
Low strain	15	1.00	(ref)		16	1.00	(ref)	
Active	14	1.01	0.80	1.28	13	0.85	0.51	1.42
Passive	16	0.92	0.74	1.16	14	0.85	0.52	1.41
High strain	13	0.84	0.66	1.07	18	1.18	0.72	1.94
p-value	.42				.51			
Working overtime								
No	14	1.00	(ref)		15	1.00	(ref)	
Yes (over 40 hr/ wk)	15	1.08	0.85	1.36	16	1.28	0.82	1.99
p-value	.53				.64			
JAPANESE PROVINCE		n=307				n=804		
Job strain								
Low strain	20	1.00	(ref)		24	1.00	(ref)	
Active	23	1.71	0.79	3.70	26	1.07	0.69	1.64
Passive	18	0.95	0.42	2.16	28	1.08	0.70	1.68
High strain	29	1.82	0.71	4.63	23	0.85	0.51	1.42
p-value	.38				.59			
Working overtime								
No	22	1.00	(ref)		27	1.00	(ref)	
Yes (over 40 hr/ wk)	20	0.64	0.35	1.17	25	0.86	0.61	1.21
p-value	.51				.40			

*Age, occupational class, marital status, and all working conditions mutually adjusted for. The cut-off point for BMI was 30.0 in London and Helsinki, and 25.0 in the Japanese province. P-values for descriptive statistics (prevalence of outcome by working conditions) are from chi-squared distribution.

6.3 Working conditions and symptoms of angina pectoris

Symptoms of angina pectoris were examined among the women within the Helsinki Health Study cohort only (IV). These symptoms were reported by 422 (6%) of eligible participants, i.e., those not pregnant and fulfilling all of the original criteria for AP symptoms reported in Appendix I in Substudy IV. Of those reporting angina, 316 had grade I AP symptoms, while the more severe, grade II symptoms were reported by 106 women.

Before fitting the logistic regression models, the associations of several background factors with AP symptoms were examined. Older women reported more symptoms than their younger counterparts, as these symptoms were found in 9% of 60-year olds as compared to 4% of 40-year-old employees. Those with low education also had a higher prevalence of AP symptoms (8%) compared to highly educated women (4%). Additionally, women in manual work were more likely to report AP symptoms (8%) than their counterparts occupied in higher occupational classes (4%). Thus, these factors were initially controlled for in the analyses.

The importance of health behaviors, BMI, menopause as well as self-reported use of medication for high blood pressure or high cholesterol was also assessed (IV). The prevalence of AP symptoms was 11% among obese employees, while the corresponding figure for normal weight employees was 4%. Menopausal women also reported these symptoms more often (8%) than their pre-menopausal counterparts (6%). Additionally, those with self-reported use of medication to lower high blood pressure were more likely to report AP symptoms (10%) than women without this risk factor (5%). The difference appeared to be even larger for self-reported use of cholesterol lowering medication. The prevalence of AP symptoms for women using this medication was 14%, while the corresponding figure for those without the medication was 6%. Nevertheless, these descriptive statistics somewhat add to the validity of the measure, i.e., relate the symptoms to the risk factors of CHD. The prevalence of AP symptoms also differed by the studied working conditions based on the descriptive statistics (Table 11).

Finally, logistic regression analyses were conducted in order to first study the age-adjusted effects of various working conditions on AP symptoms. Secondly, the mutually adjusted models were carried out. Only age was adjusted for as a confounder in these multivariate models, in contrast to previous substudies, as the other initially checked potentially confounding factors did not affect the studied associations between working conditions, work-related factors and AP symptoms. Thus, the models were fitted to include only the variables that were of particular interest in this study, subject to the fourth aim of this study.

In the bivariate models including only one working conditions at a time adjusted for age, low job control, high work fatigue, high mental strain, high physical strain, dissatisfaction with work-home interface, and low social support were all associated with AP symptoms (Table 11). The associations were strong for low job control and high work fatigue, whereas other working conditions showed weak or moderate associations with AP symptoms.

When all the working conditions were mutually adjusted for, the associations concerning working conditions mostly remained. However, for work-home interface and social support, the associations weakened. The mutual adjustments did not, however, notably attenuate the associations for job control and work fatigue.

The findings for more severe, grade II angina that occurred when walking at an ordinary pace were of similar direction (Table 12). The strong associations for low job control and work fatigue were repeated in this small group of women. The association for low job control was of similar strength, but the association between high work fatigue and Grade II AP was emphasized (OR 4.51; CI 95% 2.34-8.64). As Grade I angina was more common than Grade II angina, the separate results for Grade I angina by and large repeat what was displayed in Table 11.

Biological risk factors among those reporting and not reporting AP symptoms were also examined for validation (data not shown). Measured waist circumference and body mass index were higher among women with AP symptoms as compared to their counterparts without these symptoms. Also systolic blood pressure was higher, whereas HDL-cholesterol values were lower among those with AP symptoms, but these figures could not take into account use of medication. Furthermore, information about fasting values was not available. Nonetheless, these data from health-check ups for a sub-sample of participants (n=3101) provided some validity for the AP measure linking the reported symptoms to coronary heart disease risk factors.

Table 11. Associations between symptoms of angina pectoris and working conditions among women (n=7093). (Odds ratios, OR and 95% confidence intervals, CI 95%, from logistic regression analyses[1], IV)

	%	Age adjusted			Fully adjusted[2]		
		OR	CI 95%		OR	CI 95%	
Job demands			lower	upper		lower	upper
Very low	5.3	1.00	(ref)		1.00	(ref)	
Low	5.3	1.04	0.78	1.38	0.90	0.67	1.21
High	6.6	1.27	0.96	1.68	0.93	0.69	1.26
Very high	6.7	1.31	1.00	1.72	0.79	0.57	1.09
p-value	.12						
Job control							
Very high	4.5	1.00	(ref)		1.00	(ref)	
Very low	9.7	2.26	1.71	2.99	2.04	1.51	2.75
Low	7.1	1.65	1.24	2.18	1.50	1.12	2.01
High	4.4	1.00	0.75	1.33	0.93	0.70	1.25
p-value	.00						
Work fatigue							
No	3.7	1.00	(ref)		1.00	(ref)	
Medium	6.8	1.90	1.50	2.41	1.85	1.43	2.39
High	11.0	3.09	2.37	4.03	2.80	2.02	3.89
p-value	.00						
Mental strain							
Low	4.8	1.00	(ref)		1.00	(ref)	
Medium	6.0	1.30	1.00	1.68	1.19	0.91	1.58
High	8.0	1.82	1.32	2.50	1.27	0.87	1.84
p-value	.00						
Physical strain							
Low	4.4	1.00	(ref)		1.00	(ref)	
Medium	5.4	1.32	0.96	1.82	1.38	1.00	1.91
High	7.3	1.85	1.35	2.54	1.66	1.21	2.29
p-value	.00						
Working overtime							
No	5.8	1.00	(ref)		1.00	(ref)	
Yes	7.2	1.29	0.98	1.70	1.41	1.06	1.89
p-value	.08						
Work-home interface							
Satisfied	4.8	1.00	(ref)		1.00	(ref)	
Somewhat satisfied	7.0	1.53	1.23	1.89	1.11	0.88	1.39
Dissatisfied	7.2	1.76	1.24	2.50	1.00	0.68	1.47
p-value	.00						
Social Support							
High	4.5	1.00	(ref)		1.00	(ref)	
Medium	6.5	1.44	1.10	1.89	1.27	0.96	1.68
Low	6.6	1.36	1.03	1.78	1.11	0.83	1.46
p-value	.01						

1 Pregnant women excluded.
2 Adjusted for age and mutually for all working conditions. P-values for descriptive statistics (prevalence of outcome by working conditions) are from chi-squared distribution.

Table 12. Associations of grade I and grade II angina pectoris with working conditions among women. (Odds ratios, OR and 95% confidence intervals, CI 95%, from logistic regression analyses[1], IV)

	Grade I (n=6854)			Grade II (n=6648)		
	OR	CI 95%		OR	CI 95%	
Job demands		lower	upper		lower	upper
Very low	1.00	(ref)		1.00	(ref)	
Low	0.97	0.70	1.35	0.68	0.37	1.25
High	0.87	0.62	1.24	1.06	0.60	1.89
Very high	0.80	0.55	1.15	0.75	0.40	1.42
Job control						
Very high	1.00	(ref)		1.00	(ref)	
Very low	2.04	1.46	2.87	1.98	1.06	3.70
Low	1.46	1.05	2.04	1.61	0.89	2.91
High	0.78	0.55	1.11	1.49	0.86	2.59
Work fatigue						
No	1.00	(ref)		1.00	(ref)	
Medium	1.65	1.24	2.21	2.61	1.54	4.43
High	2.41	1.66	3.51	4.51	2.36	8.64
Mental strain						
Low	1.00	(ref)		1.00	(ref)	
Medium	1.29	0.94	1.78	0.94	0.55	1.61
High	1.33	0.86	2.05	1.13	0.57	2.26
Physical strain						
Low	1.00	(ref)		1.00	(ref)	
Medium	1.44	0.98	2.11	1.23	0.67	2.25
High	1.82	1.25	2.65	1.27	0.70	2.31
Working overtime						
No	1.00	(ref)		1.00	(ref)	
Yes	1.58	1.15	2.18	0.94	0.50	1.76
Work-home interface						
Satisfied	1.00	(ref)		1.00	(ref)	
Somewhat satisfied	1.17	0.90	1.53	0.92	0.59	1.42
Dissatisfied	1.12	0.72	1.74	0.71	0.34	1.52
Social Support						
High	1.00	(ref)		1.00	(ref)	
Medium	1.57	1.13	2.17	0.69	0.41	1.17
Low	1.21	0.86	1.69	0.91	0.55	1.49

1 Pregnant women excluded. The models were adjusted for age and mutually for all working conditions (fully adjusted model).

7. DISCUSSION

This study sought to examine whether working conditions and other work-related factors are associated with health behaviors, weight, and symptoms of angina pectoris among middle-aged public sector employees. All the substudies included female employees in order to produce new evidence about the associations of strenuous working conditions with women's health-related outcomes in particular. Moreover, international comparisons aimed to show both country-specific and common associations between working conditions, adverse behaviors, and obesity.

7.1 Main findings

Overall, the studied physical and psychosocial working conditions were mostly unassociated with the behavioral risk factors among both women and men in all the studied cohorts, while the observed relationships were weak and inconsistent. Thus, no general patterns were identified with respect to any of the working conditions or outcomes. In other words, psychosocially strenuous and other working conditions bore only minor significance for middle-aged public sector employees' health behaviors, weight, and symptoms of angina pectoris within the studied cross-sectional settings. However, some associations were found which may be of potential importance for the health of employees and warrant further examination.

First, although job strain and its dimensions were not associated with the behavioral risk factors in any consistent way, high job strain and passive work quadrants of the job strain model showed some gender- and country-specific associations with the studied behaviors. Women with low job strain were less likely to be current smokers in Helsinki, while high job strain related to current smoking in Japan for instance. Additionally, high job strain and passive work had some associations with physical inactivity among women in Helsinki and among men in London. Men reporting low job demands were less likely to have gained weight, while low job control was, in turn, associated with symptoms of angina pectoris among women in Helsinki.

Secondly, work fatigue was related to drinking among men, physical inactivity among women, weight gain among both genders, and strongly linked to the symptoms of angina pectoris among women. These associations remained after taking into account the effects of job strain, its dimensions and other work-related factors. Furthermore, all the found associations were in an adverse direction, i.e., work fatigue may detrimentally influence these behavioral risk factors and symptoms of angina pectoris.

Thirdly, working overtime also had some associations with the examined outcomes in each substudy, but findings were partly bidirectional, i.e., working overtime contributed both detrimentally and beneficially to behavioral risk factors. On one hand, men working overtime were less likely to be smokers both in Helsinki and Japan, while on the other hand, working overtime was also associated with weight gain in Helsinki among both genders, and with obesity among women in London. Additionally, women working overtime were more likely to report symptoms of angina pectoris in Helsinki.

Fourthly, associations of work-related factors such as work-home interface and social support with the behavioral outcomes and the symptoms of angina pectoris were mostly explained by job strain and other examined working conditions.

Finally, gender differences, data characteristics, methodological issues, and cultural contexts may also have contributed to the findings or the lack of associations. These will be discussed as potential explanations for the weak and non-existent associations.

7.2 Comparison to previous studies

7.2.1 Working conditions and behavioral risk factors: why only weak associations?

Although job strain and its two dimensions are the most widely used measures of psychosocial working conditions and are linked with health outcomes (Belkic et al. 2004, Kivimäki et al. 2006, Sekine et al. 2006), they were not consistently associated with the key health behaviors or other risk factors in this study. The observed associations also varied by outcome, gender, and country. The overall weak contribution of job strain and other psychosocial working conditions to health behaviors and weight mostly agrees with the recent literature review focusing on smoking, drinking, and BMI (Hellerstedt & Jeffery 1997, Siegrist & Rödel 2006), and with other evidence about physical activity (Kouvonen et al. 2005, Schneider & Becker 2005) and food habits as well (Kawakami et al. 2006). These previous studies have, however, focused on one or a few outcomes at a time and have found either no or only weak associations. Thus, comparing the current study with broader approach to the previous evidence needs to mostly rely on one behavioral risk factor at a time. This also applies to working conditions. Weak associations and lack of general patterns in the associations suggest that the previously established health effects of job strain and other strenuous working conditions can only partly be accounted for work-related modification of behavioral risk factors. However, pathways between working conditions, behavioral risk factors, and morbidity need to be examined in prospective studies with data about actual health outcomes.

It could be argued that the lack of associations partly relates to the cross-sectional design of this study, i.e., data about both the outcomes and explanatory variables are based on evaluation of point exposures only. Nonetheless, previous studies with a longitudinal design have also provided mixed and mostly weak results (Shields 1999, Kouvonen et al. 2007, Lallukka et al. 2007). Moreover, an extensive study reviewing results only from high-quality longitudinal studies did not find stronger support for the job demand-job control model than previous reviews on mostly cross-sectional studies (de Lange et al. 2003). This suggests that the current results showing modest and inconsistent associations between working conditions and behavioral risk factors among employees might reflect the real situation. However, with repeated measurements concerning both working conditions and the outcomes, and by utilizing prospective data, the contribution of working conditions to behavioral risk factors could be more straightforwardly ruled out. Additionally, the causal order could be ascertained. Based on other measures of the psychosocial work environment, such as organizational justice, baseline heavy drinking does not predict perceptions of

organizational justice, i.e., reverse causality does not explain the observed associations (Kouvonen et al. 2007). Overall, reverse causality needs, however, to be pointed out as a potential explanation for cross-sectional relationships (Kalimo 2005). For example, if women with AP symptoms change their work, this might cause bias in the results. Also the relationships between behavioral risk factors are likely to exist in both directions. Even though these causal pathways were not examined in this study, multiple, complex relations between studied variables still may exist and somewhat bias the actual findings. In other words, with the point exposures, the possibility that current adverse behaviors affected reporting of the perceived working conditions cannot be excluded. Thus, the detrimental and beneficial influence of working conditions to behavioral risk factors merely refers to the assumed relationships based on reported odds ratios, whereas the causal direction of the relationships cannot be judged.

It is also possible that the inconsistent findings for different behaviors are explained by the nature of the outcomes, i.e., some of the studied behaviors may be more stable, while other habits may be more easily modified by the influence of the strenuous working conditions. In particular, smoking appears to remain relatively stable, while behaviors such as food habits and physical activity patterns may change over time (Mulder et al. 1998). Only age was related to the behavior changes, while, unexpectedly, socio-economic status was only related to the prevalence of adverse behaviors, not to the changes in the behaviors in the previous Dutch study (Mulder et al. 1998). Since the study did not include data about working conditions, it is unclear whether strenuous work or time constraints might have explained the findings during the four-year follow-up. Nonetheless, as the study population in this present study consisted of middle-aged employees only, they probably have already adopted their health behaviors elsewhere or earlier.

Furthermore, in addition to risks related to chronic work-related exposures, changes in the work environment might also partly explain the discrepant evidence. In this study, only current working conditions were examined, while the changes in working conditions or the time period of exposure were not asked and therefore could not be taken into account. Based on some previous studies, changes in particular may be of importance with respect to smoking and drinking (Shields 1999) as well as weight gain (Shields 1999, Lallukka et al. 2007). The behavioral risk factors might have also reflected habits that have emerged already in early adulthood. This is again likely to be especially true for smoking, an addictive habit which may have been started already in adolescence (Paavola, Vartiainen & Haukkala 2004). Smoking cessation or smoking intensity could, nevertheless, be influenced by strenuous working conditions, while these effects could not be studied in this cross-sectional survey focusing on the prevalence of smoking only. Chronic work stress or changes in working conditions may also impact other health behaviors and subsequent weight and physical health or symptoms as well. These causal relationships and mechanisms need further examination in longitudinal studies. It is also noteworthy that behaviors are under biological influence as well as affected by social and psychological contexts (The Committee on Health and Behavior 2001), i.e., adverse behaviors are likely to be only partly a consequence of strenuous working conditions. These underlying explanations may also have contributed to the non-existent and inconsistent associations between working conditions and behavioral risk factors in this cross-sectional study.

A further explanation for the lack of associations is the effect of socio-economic factors. In other words, socio-economic position appeared to be a more important determinant of both healthy and unhealthy behaviors, independent of working conditions and explain a large part of the studied associations. In contrast to findings within the Helsinki Health Study cohort, demographic variables strengthened the association between job strain and smoking behavior in a previous study among U.S. employees (Green & Johnson 1990). The associations between job strain and smoking among Japanese men and an inverse relationship between passive work and smoking among women in London were also slightly stronger when socio-economic position was taken into account. These differences may be explained by varying cultural influences and some underlying workplace or country-specific factors that were not measured in this study.

Non-existent associations might also be attributable to methodological issues. These will be further discussed in section 7.3. As cut-off points used for job demands and job control in previous studies have varied, comparisons between studies need to take into account these differences in methodology (Corrao et al. 2000, Rehm et al. 2003, Britton & Marmot 2004, van Loon et al. 2004). In other words, findings are potentially dependent upon the cut-off points for job demands and job control dimensions, at least with respect to coronary outcomes (Hallqvist et al. 1998). It is not known to what extent this applies to behavioral risk factors and thus explains the discrepancy in the overall weak findings. Since these behaviors are patterned by socio-economic factors e.g., (Irala-Estévez et al. 2000, Laaksonen, Prättälä & Lahelma 2003, Giskes et al. 2005, Huisman, Kunst & Mackenbach 2005), working conditions as such may be less important.

Additionally, different gender distributions might have contributed to the lack of consistent associations. Within Helsinki, healthy behaviors, such as recommended food habits and physical activity showed some associations with working conditions among women, while among men these behaviors were mostly unassociated with working conditions in the mutually-adjusted models. Although most findings were observed among women only, this does not necessarily imply that working conditions are less important for men's behaviors. Accordingly, the patterns in the associations among men suggest that with a larger sample, results between genders might have been more similar for women and men. Gender-specific results might also be partly explained by differences in occupational structure between women and men, potentially leading to varying perceptions about the psychosocial working conditions as well.

With regard to international comparisons in general, some common influence was observed, for instance with respect to associations between non-smoking and working overtime and between physical inactivity, job strain, and passive work. Lack of more overall common associations between working conditions, adverse behaviors and obesity is, however, also an expected finding. Behaviors of Finnish and British employees might vary because of differences between these two western countries concerning labor markets, welfare, income, and social and family structures (Esping-Andersen 1990, Smeeding & Gottschalk 1999). These factors may show stronger contribution to behaviors than the studied working conditions. In Japan, career prospects have been more tied to age, potentially affecting the perceived psychosocial working conditions and subsequent health behaviors as well. Varying social, cultural,

and worksite contexts may, therefore, partly contribute to the complexity of the observed associations (Hellerstedt & Jeffery 1997). In other words, cultural variation over and above the effects of the psychosocial working conditions is likely to have affected behaviors, as Japanese people may be influenced by worry of rejection by others, while western contexts encourage a view of the self as independent (Kitayama et al. 2004). This may affect smoking and drinking habits, for example. A few unique results among the Japanese employees could also reflect the social patterning of risk factors, which seems to be partly opposite to the western countries (Martikainen et al. 2001). Societal and cultural differences and variations are, nevertheless, potential sources of confusion and can even bias the results. However, international comparisons also provided a unique opportunity to test assumptions across several populations, and enabled to produce a more comprehensive picture on the associations between psychosocial working conditions and behavioral risk factors. Since the associations were found to vary in working populations of similar age-groups, the employment sector and despite the use of highly similar questionnaire items, this highlights the importance of the social structure and culture for the behaviors as well. Nonetheless, it is also possible that the lack of associations in each cohort should be interpreted as reflecting the real situation, i.e., working conditions contribute only slightly to adverse behaviors and obesity among employees despite cultural surroundings.

7.2.2 Job strain and behavioral risk factors

Previous research is mostly based on evidence for the job strain and effort-reward imbalance models, while other features of the psychosocial working environment have received much less attention. Also studies using similar measures for work-related factors such as work-home interface or social support are practically lacking. Consequently, comparison to previous research is limited to studies about work stress, although other aspects of psychosocial working conditions and work-related factors bear some additional significance for behavioral risk factors and AP symptoms over and above the reported associations for job strain, effort-reward imbalance, and their components. In other words, it is possible that some of the findings for job strain in previous studies might be explained by other working conditions that were not addressed. These differences in the simultaneous inclusion of working conditions to the study designs might be, therefore, partially contribute to discrepant evidence about the associations between job strain and behavioral risk factors. Since the previous literature about psychosocial working conditions and behavioral risk factors is limited, at least with respect to some of the risk factors and AP symptoms, findings relating to both work stress models are discussed.

Job strain and its two dimensions, job demands and job control, were not found to have any consistent associations with health behaviors, weight or symptoms of angina in any of the substudies. Job strain and its dimensions may even be less important than other conditions such as work fatigue and working overtime with respect to health behaviors and weight gain at least. Furthermore, the associations were not consistent for healthy or adverse behaviors, i.e., job strain is not likely to have a similar effect on all behaviors. Some of the effects could also be explained by gender (Emslie, Hunt & Macintyre 2002) or by cultural differences, or variation by work-site.

Few associations were, however, observed, but as these findings could not be repeated among both women and men and in all the countries, they need to be interpreted with caution. On one hand, it is possible that the findings are explained by chance, while on the other hand, dichotomizing the outcome variables might has been a source of non-differential misclassification, which could have led to a bias towards null. These arguments may apply to all behavioral risk factors except for AP symptoms, which were measured based on a widely-used questionnaire (Rose 1965).

In line with several previous studies reporting no associations between smoking and psychosocial working conditions (Otten, Bosma & Swinkels 1999, van Loon et al. 2000, John et al. 2006b), smoking was mostly unrelated to working conditions in all the studied cohorts and among both genders in this study as well. The associations between job strain and smoking in Helsinki and Japan are in line with previous evidence (Hellerstedt & Jeffery 1997, Bastian et al. 2001, Lindström 2004). Additionally, in London, women reporting passive work were less likely to be smokers. Although the emphasis has been in findings relating to job strain and smoking, somewhat lower prevalence of smoking among passive employees as compared to the high job strain category has also previously been observed (Lindström 2004, Kouvonen et al. 2005). The mechanisms explaining this association are unclear. However, passive work may not provoke smoking behaviors or urge to smoke as a means to sedate oneself if one is occupied in an undemanding job, as compared to a high job strain situation.

Heavier drinking was mostly unrelated to job strain model, except for the inverse association between passive work and heavy drinking among women in London. As this association was observed only in the comparative analyses restricted to white-collar employees of 45-60 years, it is possible that it relates to drinking patterns by socio-economic position and age. Also a previous Finnish public sector employee study reported varying association by occupational class (Kouvonen et al. 2005b). A lack of overall associations between working conditions and heavy drinking is somewhat unexpected based on other earlier findings that link job strain (Tsutsumi et al. 2003) and work arrangements (Trinkoff & Storr 1998) with heavy drinking, but inconsistent and non-existent associations have been reported in many previous studies as well (Greenlund et al. 1995, Ragland et al. 1995, Kouvonen et al. 2005b). Mixed evidence could also account for varying beliefs among employees about whether alcohol is an effective means to reduce work-related stress (Grunberg, Moore & Greenberg 1998, Grunberg et al. 1999).

Job strain had only minor associations with physical activity as well. Instead, work fatigue seemed to explain the observed association between low job strain and physical activity among women in Helsinki. With respect to job strain and physical inactivity, and concerning men in London and women in Helsinki, both passive work and high job strain were, however, related to inactivity behaviors, which is in line with findings from earlier studies (Kouvonen et al. 2005, Ali & Lindström 2006). The weak and mixed evidence may also be partly explained by recent findings suggesting that job demands affect only the perceptions of behavioral control over exercise patterns, not the actual exercise intentions or behavior (Payne, Jones & Harris 2005).

In this study, job strain was unassociated with food habits as well, except for an association between low job strain and healthy food habits observed among women in

Helsinki only. A general pattern of non-existent associations applies both to a more extensive measure of recommended food habits and a shorter measure for adverse food habits. Although fully comparable studies were not found, job strain has previously been connected with low vegetable consumption (Tsutsumi et al. 2003) or otherwise adverse eating behaviors (Nishitani & Sakakibara 2006). However, several other studies have also failed to find associations between working conditions and food habits (van Loon et al. 2000, Devine et al. 2007). Concerning intake of key nutrients, job strain also has only a minor influence (Kawakami et al. 2006). As a measure of healthy food habits comprised of key dietary recommendations, it may serve as a proxy for overall healthy eating and subsequent nutrient intake as well. Thus, weak or non-existent associations based on both measured nutrient intakes or food habits suggest that working conditions do not have much impact on employees' eating behaviors. This is somewhat unexpected, as strenuous working conditions and time constraints could act as barriers for healthy eating or lead to increased consumption of foods low in nutrients and high in energy, sugar, and fat. Accordingly, some evidence supports the hypothesized connection between high job demands and fat intake (Hellerstedt & Jeffery 1997). Also a more recent study suggests that job strain or its quadrants may only influence the consumption of high density foods, while the intake of fruit and vegetables is unaffected (Payne, Jones & Harris 2005). Since consumption of fat and sugar was not examined in this study, the previous results are not comparable to the current ones about reporting or not following some recommended food habits. Nonetheless, these results together with previous evidence suggest that job strain and other working conditions may be more likely to relate to consumption of unhealthy foods, while weak or no associations are found for recommended food habits.

While some studies have not found associations between job demands, job control, and BMI (Kang et al. 2005, Nishitani & Sakakibara 2006), high and low control, have, nevertheless, been linked with higher BMI by others (Niedhammer et al. 1998, Steptoe et al. 1999, Kivimäki et al. 2002). Thus, a lack of an association between job control and weight gain partly agrees with previous evidence, but the discrepancy in previous studies warrants further examination of the role of job control in the weight gain and subsequent development of obesity.

Contrary to prospective evidence (Brunner, Chandola & Marmot 2007), job strain was unrelated to obesity. Conclusions of recent reviews support the mostly weak associations between job strain and weight (Overgaard, Gyntelberg & Heitmann 2004, Siegrist & Rödel 2006). Thus, based on these analyses, modification of the psychosocial working environment is unlikely to have a strong impact on employees' weight. Job strain and job demands have, nevertheless, shown differential effects on weight gain depending on baseline body mass index (Hannerz et al. 2004, Kivimäki et al. 2006). As this study was cross-sectional, studying the differential effects was not applicable as in the previous longitudinal studies. Instead, the employees were asked to report weight gain during the previous year, while the information about BMI was current. Nonetheless, the lack of associations between the job strain model and obesity might partly be due to the lack of information of the baseline body weight and health behaviors among the participants of this study. A recent prospective study, however, suggests that the effect of work stress on obesity is only modestly attenuated after excluding obese employees at baseline and after adjusting for health behaviors (Brunner, Chandola & Marmot 2007).

Finally, associations between symptoms of angina pectoris were examined. Although the outcome is clearly different from health behaviors and weight, all these outcomes are related and are associated with the risk of future chronic disease morbidity and mortality. Furthermore, working conditions have been linked with health behaviors, weight, and AP symptoms, although the approach in this study is broader than in previous studies, i.e., it includes all these outcomes simultaneously. Since AP symptoms were examined only among women in Helsinki in a cross-sectional design, both comparability to the previous studies and generalizability of the results are limited. The findings were in line with the known relationship between strenuous working conditions and coronary health (Kivimäki et al. 2006). However, due to the relatively young age of participants with respect to actual CHD morbidity, the reported symptoms may also reflect psychological health or be confounded by physical health status.

Nevertheless, the findings linking psychosocially strenuous working conditions to the AP symptoms partly agree with the few previous studies available. First, low control has also previously been shown to relate to AP symptoms in a study among male civil servants in London (Head et al. 2002). Additionally, high job strain (Netterstrøm et al. 1998) and effort-reward imbalance (Chandola, Siegrist & Marmot 2005) are connected with angina. As high job strain is a combination of low job control and high job demands, these results at least partly support the adverse consequences of low job control to the AP symptoms. Nevertheless, angina has been measured somewhat differently in these studies, which limits the comparability. While this study could not fully rule out the potential confounding effects of biological risk factors and health behaviors, a previous Danish study, has however, showed that the relation of job strain with AP symptoms is independent of biological, conventional risk factors (Harris & Weissfeld 1991). Prospective studies are, however, needed to examine the role of health behaviors and obesity in explaining the associations between working conditions and AP symptoms, as well as ruling out the possibility that women with AP symptoms merely perceive their work differently due to their physical symptoms.

7.2.3 Work fatigue and behavioral risk factors

Somewhat in contrast to inconsistent findings between working conditions and health behaviors, psychosocial working conditions and work-related factors showed several associations with weight gain. Furthermore, the associations were quite similar among both women and men. Particularly work fatigue and working overtime may be risk factors for weight gain. These findings will be further discussed in the next two sections.

As compared to job strain, work fatigue appeared as a potentially more important factor associated with the examined outcomes. Since work fatigue is a pre-stage for burnout, it possibly reflects a more severe or more chronic exposure to work-related stress. Work fatigue had associations with moderate drinking among men in Helsinki, physical inactivity among women in Helsinki, and weight gain and symptoms of angina pectoris, whereas previous studies examining the associations between work

fatigue and these behavioral risk factors are practically lacking. Instead, most of the earlier research has been focused on burnout or exhaustive fatigue and their relations to alcohol dependence, for example (Cunradi et al. 2003, Ahola et al. 2006). However, a study among Finnish veterinarians comprised data about health behaviors and work fatigue, but did not report associations between the two (Reijula et al. 2003). Nonetheless, those with lower scores, i.e., a lower risk for burnout, have been reported to have healthier behaviors with regard to physical activity, alcohol consumption, and food habits than their counterparts with a high burnout risk in a study among Dutch dentists (Gorter, Eijkman & Hoogstraten 2000). Since the scores for emotional exhaustion or work fatigue subscales were not separated from further stages of burnout, it is hard to compare these findings with the current ones more specifically. Furthermore, a current review suggests that the associations between exhaustion or burnout and health behaviors, and in particular potential synergistic effects, are an auspicious area for studies about risk of CVD morbidity at least (Melamed et al. 2006).

Although the evidence is not consistent for all the outcomes and both genders, some associations between work fatigue and behavioral risk factors were observed that are of potential importance with respect to subsequent health, well-being and work ability of employees, warranting further examinations. Within Helsinki men only, high work fatigue related to moderate drinking, but fully corresponding results from previous studies were not found. Nevertheless, among French general practitioners, emotional exhaustion has also been related to drinking (Cathébras et al. 2004). As emotional exhaustion refers to work fatigue, this French result partly agrees with the current result. Also partly in accordance with the finding, previous studies have shown associations between alcohol dependence and emotional exhaustion (Cunradi et al. 2003) and between alcohol dependence and burnout (Ahola et al. 2006). However, burnout was not related to heavy drinking (Ahola et al. 2006). These findings suggest that already the milder symptoms preceding the actual burnout need to be taken seriously with respect to alcohol-related problems at least. Furthermore, the effects of work fatigue on the consumption levels needs to be ascertained, as only alcohol dependence is more consistently linked with burnout. Also other features of the psychosocial work environment and work stress may be more strongly related to alcohol dependence, i.e., less likely to reflect levels of drinking (Head, Stansfeld & Siegrist 2004). These discrepancies might be related to different nature of the measures: alcohol dependence (CAGE) reflects problems that have occurred over the life-course, while heavy drinking refers to current alcohol consumption. It is also possible that chronic exposure to psychosocially strenuous work and subsequent work fatigue predispose some vulnerable employees to alcohol dependency, whereas general consumption is affected by other biological, social, seasonal, and cultural factors, for example. Evidently, alcohol dependence may, however, modify perceptions of the work environment.

While the women in Helsinki reporting a high level of work fatigue were less likely to engage in leisure-time physical activities, a prospective study has in turn demonstrated a protective effect of strenuous physical activity in the prevention of emotional exhaustion (Bernaards et al. 2006). Thus, it is possible that while high work fatigue is a plausible barrier to physical activities, moderate physical activity may have a beneficial influence on the prevention of work-related exhaustion. Furthermore, the findings were observed for only those in sedentary work further

highlighting the importance of promoting leisure-time activities among those in sedentary positions.

The association between work fatigue and weight gain is, in turn, understandable although previous evidence is lacking. High work fatigue as an early stage of burnout could increase fast food consumption, which as a frequent behavior is likely to cause excess energy intake and subsequent weight gain (Bowman & Vinyard 2004). As those reporting work fatigue were also observed as less physically active than their counterparts with low work fatigue, part of the effects of work fatigue on weight gain could be explained by lack of physical activity contributing to weight gain (Jeffery et al. 2000). The association between work fatigue and weight gain is also partly in line with a previous Japanese study observing that moving from an 8-hour shift to a 12-hour shift resulted in fatigue and unhealthy weight gain (Yamada et al. 2001). Although work-related physical and psychological fatigue are not fully similar to the emotional exhaustion, the consistency of a relationship between perceived work-related, psychological fatigue, and weight gain suggest that employees with fatigue may be at risk of gaining weight. The mechanisms for causality need to be further examined in order to assess the extent to which the observed association might be explained by adverse behaviors. However, weight gain could also lead to work fatigue by causing sleep problems for example.

As work fatigue is linked with workload (Maslach, Schaufeli & Leiter 2001), the strong association between work fatigue and symptoms of angina pectoris is partially in line with previous evidence connecting work stress with AP symptoms (Netterstrøm et al. 1998, Chandola, Siegrist & Marmot 2005). However, since the causal order between the work-related exposure and emergence of the symptoms could not be assessed, the observed finding may also reflect reverse causality. More specifically, prospective studies are needed to establish the role of these factors for the AP symptoms, as well as more evidence about potential confounding factors. Especially the strong associations between work fatigue and AP symptoms show a need to exclude reporting tendency or negative affectivity as alternative explanations for the finding. Furthermore, while work fatigue measures the current situation, the AP symptoms refer to symptoms during the life-course. Nonetheless, partly in agreement with the current strong association between work fatigue and AP symptoms, a Dutch study reported higher prevalence for pain in the chest region among those with high risk for burnout, as compared to those with a lower risk (Gorter, Eijkman & Hoogstraten 2000). Since only the risk of burnout was included, it is not known to what extent the difference in the prevalence of the chest pain is due to the facet of emotional exhaustion. Chest pain may also be other than angina pectoris, since it was based on one item only, i.e., the Rose questionnaire (Rose 1965) was not included.

7.2.4 Working overtime and behavioral risk factors

In addition to job strain as a measure of psychosocial work environment, working overtime has been quite extensively studied. However, the focus has mostly been on shift work, extended shifts or on extremely long hours worked (Spurgeon, Harrington & Cooper 1997, Caruso et al. 2004). As compared to perceived job strain, working

overtime is, however, a more direct measure of work-related exposures. It is also likely to be easier to report the actual hours spent at work than the perceived job demands and job control. By being able to simultaneously examine the effects of both psychosocial working conditions and working overtime, this study aimed to widen the current understanding about the associations of working hours with behavioral risk factors. However, the overall pattern of associations suggest that working overtime shows mostly weak relationships with health behaviors, differently by outcome and gender. Modest associations were, however, found for weight gain and AP symptoms, which may partly explain the previously observed adverse health consequences related to overtime hours (Caruso et al. 2004, Härmä 2006). However, as working overtime also related to non-smoking, the evidence is mixed and needs further corroboration and examination.

The relationship of working overtime with non-smoking is partly in contrast to previous studies showing an increase in smoking with working overtime (Shields 1999, Mizoue et al. 2006). Nonetheless, this study examined only current working hours, not changes in working time (Shields 1999) or potentially varying effects of low, moderate, and high working hours on smoking (Mizoue et al. 2006). The effect of changes in working conditions and smoking behaviors is likely to reflect different phenomena than the current association between long working hours and prevalence of smoking as such. Moreover, it is possible that the effect of change in working hours will level off over time, i.e., increase in smoking is potentially a temporary phase. An association between working overtime and non-smoking might also be explained by the effect of socio-economic status. Those working overtime are more likely to be professionals (Johnson & Lipscomb 2006), who smoke less than other employee groups. An increase in smoking also applies to current smokers only. Thus, the effect of working hours on non-smoking cannot be concluded from the results (Shields 1999, Mizoue et al. 2006). However, it is unlikely that those working overtime in the current study would have quit smoking due to excess working hours. Since smoking cessation was not examined, this association cannot be confirmed. Therefore, based on these and previous results, the effects of working hours on smoking are likely to be different for consumption patterns and the actual prevalence. While working overtime might modify smoking intensity, it is less likely to be related to the prevalence or initiation of smoking, at least among older employees.

Similar to smoking, working overtime related only to men's drinking, albeit the associations were weak and inconsistent. An association between working overtime and moderate drinking was observed only for men in London and Helsinki, while a discrepant finding for Japanese men may reflect cultural variation in drinking behaviors. The positive association between working hours and drinking is, nevertheless, partly in line with a finding from Canada showing that a shift from normal hours to working overtime is related to an increase in drinking for women (Shields 1999). However, as no association was found between working time and drinking for women in this study, and also the change in working time was not assessed, these findings may not reflect similar phenomena.

The weak association between working overtime and weight gain observed both among women and men is, in turn, in line with previous prospective studies (Nakamura et al. 1998, Lallukka et al. 2007). Additionally, going from standard to long hours has predicted weight gain (Shields 1999). Working long hours has also

been observed to predict higher BMI among men in Australia (Ostry et al. 2006) and Canada (Shields 1999), whereas among women these association were not found. This is in contrast to the present finding about the relationship between working overtime and obesity that was shown only among women in London.

With respect to the potential mechanisms or explanations for the findings, working overtime may act as a barrier to healthy behaviors that help prevent obesity. More specifically, lack of free time is an understandable cause for reduced physical activities for example, and plausibly for healthy food habits as well. Since these behaviors are major contributors for weight gain and obesity (Popkin & Gordon-Larsen 2004), work-related barriers for maintaining and adopting such behaviors should be addressed and modified accordingly. Based on the previous and current evidence about the associations between working overtime, weight gain and obesity, promoting normal working hours may help prevent unhealthy weight gain and thereby obesity.

7.2.5 Further remarks

The associations of physically strenuous work with behavioral risk factors were mostly non-existent. However, the focus was on psychosocial working conditions. Thus, the effects of physically strenuous work are mostly neglected. Although physically strenuous working conditions are generally connected with adverse behaviors (Prättälä 1998), these effects could not be observed in this study. Instead, women reporting physically strenuous work were also more active during leisure-time, i.e., physical strain was associated with a recommended behavior. Nonetheless, women with physical strain also reported more AP symptoms.

Similarly to physical strain, mentally strenuous work was assessed using a single item only. Moderate associations for mental strain mostly disappeared when other working conditions were taken into account. The association between high mental strain and healthy food habits among women is in turn partly in contrast with a recent study showing that high mental strain is related to less likelihood of having lunch at the staff canteen (Raulio et al. 2007). Since eating in workplace canteens has been shown to be related to an increased vegetable consumption (Lallukka, Lahti-Koski & Ovaskainen 2001) and following healthy food habits (Roos, Sarlio-Lähteenkorva & Lallukka 2004), the somewhat mixed effects of mental strain on eating behaviors need further corroboration and examination.

In addition to the above discussed findings, the examined work-related factors also had only a few associations with the outcomes in this study. For instance, when adjusted for working conditions, the work-home interface and social support were unassociated with health behaviors, except for satisfaction with the work-home interface being weakly related to leisure-time physical activity among women. Dissatisfaction with the work-home interface related, in turn, to weight gain. With respect to symptoms of angina pectoris, the moderately strong associations between dissatisfaction with work-home interface, low social support, and AP symptoms reduced when mutually adjusted for other working conditions. Previous studies linking social support with health behaviors are, therefore, not comparable to the

present one, as the simultaneous effects of working conditions have mostly been neglected. Nevertheless, the effects of social support on health behaviors can be modest as such (Callaghan 1998).

Although this present study included a wide variety of working conditions as determinants of behavioral risk factors, some novel aspects of the psychosocial work environment such as effort-reward imbalance (Siegrist 1996) and organizational justice (Elovainio, Kivimäki & Vahtera 2002) were, nevertheless, excluded. Since the job demand-job control and effort-reward imbalance models identify different aspects of psychosocially strenuous working environment (Tsutsumi et al. 2001), the results derived using different models may not be directly comparable. In other words, different aspects captured by these separate models might partly contribute to discrepant and weak findings between work stress and behavioral risk factors.

Organizational justice, in turn, is associated with job control (Elovainio et al. 2004), and has shown some weak relationships with smoking (Kouvonen et al. 2007) and drinking (Kouvonen et al. 2007) for example. Since organizational justice has been linked with the risk of CHD as well (Kivimäki et al. 2005), these associations with the risk factors might be of importance alongside effects of other psychosocially strenuous working conditions. Finally, although shift work was not examined in this study, its effects might underlie some associations, since part of the study population worked in shifts.

7.3 Methodological considerations

In addition to the above-discussed limitations of the study, some further consideration relating to the validity of the variables and measures used need to be acknowledged. As this study applied a broad approach with respect to both working conditions and behavioral risk factors, several methodological issues about the dependent and independent variables are discussed next. While limitations in the variety of measures may have affected the results, a comprehensive, broad approach is simultaneously also a major strength of this study. Although widely used measures were used to examine the key psychosocial working conditions (Karasek 1979, Kalimo, Olkkonen & Toppinen 1993, Maslach, Jackson & Leiter 1996), several single item measures were also included. Since the reliability and correlation of single items with scale measures are not very high (Wanous, Reichers & Hudy 1997), the results for these items were only cautiously interpreted and were not extensively discussed. However, since all these working conditions were simultaneously examined, they cover together a wide variety of working conditions and work-related factors.

7.3.1 Working conditions

Physically strenuous work examined within the HHS was measured using an item similar to other previous studies (Nishitani & Sakakibara 2006, Ostry et al. 2006). Since only a single item was used to measure physical exposure at work in this study, it should be considered to be a proxy indicator of physically strenuous work.

However, as the focus was not set on physical working conditions, the information provided indicates a general level of physical strain and can be used to categorize employees or for the purposes of adjustment, while the main focus is on the psychosocial working conditions. Nonetheless, especially with a measure of generic nature, both formulation of the questionnaire item and the respondent's cognitive abilities to conceptualize physical demands may distort validity of the measure (Stock et al. 2005).

Although information for physical working conditions was not available for international comparisons, this is not considered to bias the results. This is due to occupational class linkage of physical working conditions, i.e., blue-collar employees are the most exposed to physical workload (Hemström 2001). Instead, the employees included in the comparisons were all white-collar employees occupied mostly in more homogenous, sedentary positions, at least compared with the blue-collar workers. Moreover, the aim was not to provide comprehensive data on physical exposures.

Because this study relied on self-reported information about job demands and job control, social pressures by colleagues or supervisors, predisposal to negative affectivity or varying cognitive abilities may have affected reporting of both the adverse as well as beneficial working conditions, i.e., may have distorted the description of the actual work environment (Theorell 2000). Additionally, similar 'global' items were used across occupations, countries, and genders, i.e., occupation-specific job demands and job control remain overlooked or neglected. This may have underestimated the effects of job strain and its dimensions on the studied behavioral risk factors and symptoms. A similar critique for the use of global, simple measures has been previously presented as well (de Lange et al. 2003, Bakker & Demerouti 2007).

One of the most fundamental theoretical questions in the field has been proposed to establish whether job demands interact with job control and thus generate an increased risk, i.e., act as more than additive for one another (Kasl 1996). Some support for the hypothesis already exists (Hallqvist et al. 1998). However, job control may be more important and easier to conceptualize than job demands (Theorell 2000), but nonlinear relationships between the dimensions may cause spurious interaction effects for the two dimensions (Jones & Fletcher 1996). Nonetheless, it has also been suggested that studies using both of the dimensions have produced better predictions than studies utilizing only a single dimension of the psychosocial work environment (Theorell 2000). It is not known to what extent these matters apply to behavioral risk factors. A further limitation of this current measure relates to the cross-sectional design, i.e., the model actually describes the content of the work and not the actual long-term outcome of exposure to job demands or job control. Thus, it is not known whether high demand-low control situation is causing strain and subsequent health risks. Finally, the iso-strain model could not be studied, which might have produced stronger or more consistent associations. Limited data available suggest, however, no evidence for the relationship between iso-strain and health behaviours (Kawakami, Haratani & Araki 1998, van Loon et al. 2000).

Although the job demand-job control model has been widely used in epidemiological studies for decades, its theoretical starting points have received much criticism (Jonge & Kompier 1997, Taris et al. 2003, Bakker & Demerouti 2007). Major issues from a

work psychology perspective were extensively reviewed about a decade ago (Jonge & Kompier 1997). The review included a social support dimension, but similar criticism is likely to apply to the original model as well. In particular, difficulties in conceptualizing job demands and job control is challenging in different settings and workplaces. Additionally, most of the previous studies have focused on job strain, while the effects of active and passive work are less clear. The review also pointed out methodological aspects such as the above-mentioned curvilinearity and interactive effects as possible theoretical problems relating to use of the job strain model. The simplicity of the model was, in turn, addressed by Bakker & Demerouti (2007), who recently presented job demands-resources model as an extension of both job demand-job control model and the effort-reward imbalance model (Bakker & Demerouti 2007). The model encompasses elements of previous work stress models, but also aims to capture occupation-specific demands and resources that are mostly neglected by the previous work stress models. Based on the model it is suggested that job demands and job resources should be better envisaged as inducing separate processes relating to strain and motivation, respectively. Despite all its limitations, the job strain model still appears as a useful tool in assessing employees' exposure to job strain and subsequent health-related outcomes.

The work fatigue measure was a modified version of the emotional exhaustion facet of the widely-used burnout inventory (Maslach, Jackson & Leiter 1996). While the inventory was originally developed for employees working in the human relations field, items about customer service and frustration were omitted from the current version (Kalimo, Olkkonen & Toppinen 1993). Because the emotional exhaustion is of particular importance with respect to psychosocial work environment (Maslach, Schaufeli & Leiter 2001), this measure is considered well suitable for the purposes of this study. Since the measure for mental strain was, in turn, based on a single item only, it is only a proxy indicator of overall perceived mental workload.

As the measure for work-home interface was also based on a single item only, this study may not be fully comparable to other reports including more extensive measures for work-home conflicts (Roos, Lahelma & Rahkonen 2006, Roos et al. 2007). Finally, since the measure of social support captured and combined simultaneously support received at home from spouse or friends and at work from colleagues and supervisors, it is hard to compare findings for studies examining only support from home or work-related support, which are likely to have differential meaning and influence on behaviors (Lindorff 2005).

7.3.2 Behavioral risk factors and symptoms of angina pectoris

Contrary to working conditions, behavioral risk factors were generally not measured with any generally accepted, international scales. Instead, mostly proxy measures were included. However, AP symptoms were measured with a well-validated questionnaire (Rose 1965, Sorlie et al. 1996). Concerning current smoking, comparisons to previous studies are easier than for other behaviors with respect to measurement factors at least, i.e., using a single item is likely to separate smokers from non-smokers at least. However, time trends and cultural variation is likely to make interpretation of the results more difficult. Moreover, including ex-smokers to

the non-smoking category is another methodological issue potentially hindering direct comparisons between studies. When looking at current smoking only, the influence of psychosocial working conditions to smoking cessation, smoking intensity, or nicotine dependence is potentially neglected or may even bias the results for these middle-aged and aging employees. Additionally, by excluding manual workers, the comparability of the comparative results to other previous studies with larger socio-demographic and socio-economic variation is limited.

Measuring the drinking behaviors is also challenging. Drinking behaviors may be under-reported more than smoking, at least considering heavy or problem drinking and social desirability or cultural norms that are likely to be followed (Cockerham, Hinote & Abbott 2006).

Complete, accurate data about physical activities are hard to obtain as well, since it is difficult to collect complete information about all activities during a specified time period. Consequently, physical activity is a proxy measure of activities in this study. Furthermore, work-related and commuting physical activities were not assessed, i.e., physical activity was solely conceptualized as a leisure-time related behavior. Misinterpretation of instructions, deliberate misreporting, and inaccurate recall of intensity and time of physical activity may, nevertheless, have biased the results (Keim, Blanton & Kretsch 2004). Differences in methodology and incomplete data are a concern in comparative research, but the associations studied or the correlates of inactive behaviors need not be affected.

Although only a proxy measure of food habits was included, reported food frequencies have proven sufficient to measure socio-economic variation in food habits, or healthy food habits more specifically (Dynesen et al. 2003). Gender, age and other personal characteristics may, however, affect the validity of FFQ derived estimates of food habits (Marks, Hughes & van der Pols 2006). Reporting bias, i.e., potential over-reporting of healthy food habits, may have also caused bias on the measurement of food habits.

The information about heights and weights within the HHS were self-reports, as was the information about weight gain. Thus, these are likely to be somewhat under-reported (Jeffery 1996, Boström & Diderichsen 1997). Nonetheless, self-reported weight has been suggested to approximate well with actual weight across population subgroups (Jeffery 1996). Obesity was calculated based on self-reported weights and heights in Helsinki. Based on validity analyses for a sub-sample of Helsinki participants with laboratory data and measured heights and weights, the self-reported values were somewhat under-reported (data not shown). This finding also agrees with the previous literature (John et al. 2006a, Visscher et al. 2006). Nonetheless, these under-reports in BMI do not imply that the associations between working conditions and weight need to be biased.

With respect to weight gain referring only to one year weight change, the variability in the responses and the effect of actual kilograms is not as significant as in the long follow-ups (Lallukka et al. 2007). Thus, weight gain was analyzed without taking into account the amount of weight gained. A shortcoming of this study is that current heights and weights were used to calculate BMI, whereas weight gain was retrospectively enquired, i.e., reflected weight changes during the previous year. In

other words, information about weight gain could not be adjusted for BMI corresponding to the time before reported changes.

Although AP symptoms were measured with a widely-used questionnaire (Rose 1965), the diagnostics of angina pectoris have proven difficult. More specifically, the origin of chest pain can be other than coronary heart disease, i.e., physical, functional, or psychosocial (Nicholson et al. 1999, Macleod et al. 2002). Some previous results suggest, however, that psychosocial factors are related to chest pain, rather than being a cause of the reported pain (Zachariae et al. 2001). Age is also an important modifier of the questionnaire assessed symptoms of angina pectoris, and among middle-aged women in particular, the diagnostic and predictive power of these symptoms is complicated (Harris & Weissfeld 1991, Garber, Carleton & Heller 1992). Moreover, questionnaire data are likely to reflect current symptoms with a considerable variability in symptom reporting, i.e., prevalence may remain the same, but somewhat different people are classified as having symptoms of angina pectoris in repeated measurements (Lampe et al. 2001). Nevertheless, a single report also appears to be valid and is associated with both coronary risk factors and disease (Sorlie et al. 1996).

7.3.3 Limitations and strengths of the data and the study design

Helsinki Health Study

In addition to the limitations acknowledged for the measures used, some further issues related to data need to be considered and summed up. First, a major limitation of this baseline study is its cross-sectional design, which does not allow examining any causal relationships, i.e., temporal order between working conditions and studied outcomes cannot be ascertained. Thus, working conditions may influence health behaviors or health behaviors may affect perceptions about working conditions, or show more complex relationships with some other factors that were not measured in this study. Furthermore, while assessing cross-sectional data, it is not possible to determine whether exposure to strenuous working conditions or working overtime had occurred prior to emergence of health behaviors, or has the behavior in question been adopted already in young adulthood or should be explained by other determinants than work-related factors. Furthermore, duration of time periods under psychosocially strenuous working conditions or overtime hours was not available, i.e., reflected current situation or previous four weeks only.

Secondly, because all the participants are employed, the known beneficial, protective effects of employment on health and effects of health on selection into employment, the 'healthy worker effect', is likely to have affected the results (Wilcosky & Wing 1987, Ross & Mirowski 1995). Moreover, the cohort comprises a relatively homogenous sample in terms of age, area of residence, employment sector, and health status. This may have further diluted the findings. Nonetheless, a previous study comparing longitudinal high-quality homogenous and heterogenous samples did not find differences between such samples in the evidence produced for the support of the strain hypothesis in predicting various health outcomes (de Lange et al. 2003). This was mentioned to suggest that homogenous study populations are as useful as

heterogenous samples in examining job strain model, i.e., provide enough true individual and within-occupation variation in these work characteristics.

Due to inclusion of only middle-aged employees, this study may be particularly vulnerable to survivor bias. More specifically, in the age group of 40 to 60 years, employees with the most adverse behaviors could have already selected out of the workforce and succumbed to illness. Therefore, it is possible that the associations between strenuous working conditions and adverse health behaviors might have been stronger for younger employee groups. With the exception of smoking among the Japanese men, the relatively low prevalence of adverse behaviors among the participating employees supports these speculations. In other words, the inclusion of only a narrow age group is another likely explanation for some of the discrepant findings and lack of consistent associations in this study. Nonetheless, job strain had only weak and partly contradictory associations with risk factors such as smoking and drinking in a previous study among young adults (Greenlund et al. 1995). Furthermore, selection by health is likely to reflect more severe phenomena than selection by the examined behavioral risk factors.

Thirdly, a further limitation of this study is that all the findings rely on self-reported data, which are prone to bias due to both under-reporting of adverse behaviors or over-reporting some other, healthy habits and some personal reporting disposition (Nielsen et al. 2006). The overall response rate of 67% can be considered as moderate and typical in epidemiological studies nowadays, since non-response as phenomena cannot be fully avoided (Barriball & While 1999). As about third of the target population were, however, non-respondents this is likely to have somewhat reduced the differences between groups. Since those who participated had a higher occupational class and their health status was slightly better as judged by the lower number of sickness absence spells, larger differences in adverse behaviors and physical symptoms might have been observed with the fully representative sample. Accordingly, previous evidence suggests that those with adverse health behaviors are less likely to participate in health surveys (Chinn et al. 2006, Larsen et al. 2006). However, information about the health behaviors of the non-respondents was not available, i.e., the actual differences in health behaviors between respondents and non-respondents are not known. Also both physical and psychosocial working conditions of those with lower socio-economic position tend to be poorer, which may have further reduced the estimates towards null.

Finally, although the City of Helsinki is a large employer covering a variety of occupations, these results may not apply to other employee groups, or to the private sector. All the participants were employees of the City of Helsinki and lived in the capital area. Furthermore, most of the participants were women and the age-group was limited to middle-aged employees, who might differ from younger employees with respect to stability of behaviors, tendency to gain weight as well as symptom reporting. Working conditions might also be perceived or reported differently in different working environments such as in the private sector.

International comparisons

Although British and Japanese cohorts comprise follow-up data, these could not be analyzed in this study. Thus, the causality remains to be confirmed in further studies. Additionally, while the international cohorts had higher response rates than that of the Helsinki Health Study, the numbers of missing items were higher in the WHII and Japanese cohorts compared with the HHS data. Thus, these large numbers of missing values may have diluted some findings, or reduced the power in the statistical analyses, as only those with complete data about all the independent variables were included in the multivariate logistic regression analyses. As the WHII cohort only comprised white-collar employees, manual workers had to be excluded from the Japanese and HHS cohorts for comparative purposes. Thus, comparisons to previous studies including manual workers are somewhat convoluted, as larger variation is expected when a more complete social spectrum is analyzed. Furthermore, the age-group was also limited to 45–60-year olds, which further contributes to the difficulties in comparing these results with other studies that also included younger employees. This is of importance, as age is strongly related to health-related and behavioral outcomes (Mulder et al. 1998, Laaksonen, Prättälä & Lahelma 2003). Age may relate to working conditions and perceptions of psychosocial work environment as well. Furthermore, in contrast to the HHS cohort, the WHII cohort and Japanese cohort of civil servants were male-dominated. Thus, the number of eligible women was quite small. Subsequently, the confidence intervals were large particularly concerning findings for Japanese women. Although statistical significance was not reached, patterns in some of the associations indicated some similar associations among Japanese women as in the other cohorts. Moreover, some of the odds ratios were strong, suggesting that with a larger sample, statistical significance of these psychosocial working conditions for adverse behaviors could have been observed.

Study strengths

A main strength of this study was that a wide range of physical and psychosocial working conditions, work-related factors, health behaviors, weight and AP symptoms as potential indicator of future morbidity and CVD mortality could be simultaneously included and examined. Furthermore, all the associations could be examined among female employees, elucidating understanding about the significance of various working conditions to women's behavioral risk factors and subsequent health. Additionally, the previous results for men could be further studied and corroborated having information about several dimensions of the work environment. The data were large and contemporary and thereby provided up-to-date evidence about the contribution of current physical and psychosocial working conditions and work-related factors on the behavioral risk factors and AP symptoms.

The measures used were also well-validated, such as the Rose questionnaire (Rose et al. 1982, Sorlie et al. 1996, Cosin et al. 1999) and Karasek's job demands and job control for examining psychosocial work exposures (Karasek 1979, Karasek et al. 1981). Thus, these homogenous measures enable more valid conclusions and comparison to previous studies.

The opportunity to also include international comparisons to this study is of particular importance, as very few studies have compared the associations between working conditions and adverse behaviors and obesity using highly similar questionnaires and homogenous cohorts in terms of age, employment sector and contemporary data.
The main advantage of international comparisons is the potential to move beyond cohort- or country-specific examination and study variation in the associations across social contexts. Thus, both the common influence of working conditions to adverse behaviors and obesity can be identified, as well as unique associations by country and gender. Generalization of the results is also improved, as results are derived from three different study populations instead of settings focusing on one worksite or groups of employees within a single country.

8. CONCLUSIONS AND IMPLICATIONS OF THE RESULTS

In general, based on this cross-sectional study among public sector employees of the City of Helsinki as well as international comparisons in three countries, working conditions were mostly weakly and inconsistently associated with health behaviors. Thus, no clear general patterns could be identified.

Nonetheless, strenuous working conditions, work fatigue, and working overtime in particular may be more important with respect to weight and symptoms of angina pectoris than for health behaviors. Also low control is a potential risk factor for angina pectoris. Although working overtime had some associations with weight gain, obesity, and symptoms of angina pectoris, it was also related to non-smoking. Thus, its effect on health of the employees is somewhat unclear.

The main conclusions based on the aims of the study are as follows:

I) Working conditions showed weak and inconsistent associations with health behaviors;
II) Job strain and working overtime had only modest and mostly insignificant associations with adverse health behaviors and obesity within middle-aged public sector employees from Finland, Britain, and Japan;
III) Work fatigue, working overtime, and dissatisfaction with work-home interface were associated with weight gain, but most of the working conditions and work-related factors were unrelated to weight gain, and
IV) Work fatigue and job control had strong associations with the symptoms of angina pectoris among middle-aged women, but the associations for the other working conditions and work-related factors were modest.

Based on the key findings and these overall conclusions, working conditions are likely to provide only minor explanations about middle-aged employees' health behaviors. Accordingly, adverse health behaviors are likely to only partly explain the health consequences of strenuous working conditions. Instead, psychosocial working conditions have some, albeit limited associations with weight gain and symptoms of angina pectoris. In particular, work fatigue and working overtime are potential risk factors for weight gain. Attention could be paid to these working conditions in occupational health care to prevent weight gain. Future studies are expected to further elucidate the relationships between psychosocial working conditions and weight gain as well as mediating mechanisms.

Also the correlates and consequences of women's symptoms of angina pectoris need further examination. In other words, longitudinal studies should confirm the causal order between work fatigue and weight gain and corroborate the associations between work fatigue, low job control, and AP symptoms as well. Although the cross-sectional design did not allow the assessment of causal relations in this study, the mechanisms for the associations between psychosocial working conditions, weight gain, and symptoms of angina pectoris are likely to be other than a work-related modification of health behaviors.

As judged by the lack of general patterns in the associations, working conditions are not likely to have a similar contribution to the behavioral risk factors for all employees. In other words, since the associations for health behaviors were modest and inconsistent, any specific working condition is unlikely to produce beneficial or detrimental influence on employees' behaviors in general. Instead, gender differences as well as socio-economic position need to be taken into account. Furthermore, the associations may also be bidirectional and vary by country, worksite, or occupation.

Nevertheless, working conditions are important, as are health behaviors as determinants of major chronic diseases. Because some detrimental trends in the development of both areas have occurred, it is necessary to consider the consequences of these changes on the health of employees in the future. More specifically, it is important to aim to improve health behaviors among employees and identify optimal ways for these health promotion needs. Although job redesign is unlikely to largely contribute to the level of adverse behaviors, a major part of the adult population is within the occupational health care system that may be exploited to help increase healthy behaviors and subsequent work ability, well-being, and health. Addressing and improving physical and mental working conditions is, in turn, a relevant focus of health promotion in the workforce at least for other reasons than with respect to behavioral risk factors, i.e., in order to further promote work ability and prevent chronic diseases for example.

The evidence produced is of potential use both for the perspective of employees and employers. As both working conditions and behavioral risk factors are at least partly modifiable and thus preventable, it is possible to achieve some health benefits by modifying working time and preventing work fatigue, for example. Moreover, maintaining and improving health and health behaviors of employees and finding the optimal workload and exposures are likely to produce financial gains in terms of reduced sickness absence rates (Vahtera et al. 2002, Laaksonen, Piha & Sarlio-Lähteenkorva 2007, Rauhala et al. 2007), lower health care expenses, better productivity, efficacy of employees, and improved well-being and quality of life at the individual level. Accordingly, evidence on health-related factors contributing to maintenance of work ability and extending working life are essential, since work ability has been noted as the most important asset of employees in work-life (Ylikoski et al. 2006). Additionally, the workplace provides a valuable setting for reaching a substantial part of middle-aged adults in order to successfully promote healthier behaviors and thus help the employees maintain healthy weight, well-being, and work ability and continue in their work until their normal retirement age.

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APPENDICES: Previous studies reporting associations between working conditions and behavioral risk factors

1. Working conditions and smoking

Reference	Outcome(s)	Working condition(s)	Covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Reed et al. 1989)	cigarettes per day	job demands, job control, job strain	age (number of years worked at the jobs)	8006, W 0%, RR not reported	men of Japanese ancestry in Hawaii	prospective (18 year follow-up)	1965-1983	cross-tabulation analysis, Cox proportional hazards model	no significant associations
(Pieper, LaCroix & Karasek 1989)	current smoking	job demands, job control, job strain	age, education, BMI, type A behavior	12555, W 0%, RR not reported	men in five investigations	prospective/ cross-sectional	1959-1980	meta-analysis	low job control was related to smoking
(Green & Johnson 1990)	smoking prevalence and intensity	physical demands, job strain, job insecurity, social support	age, race, marital status, education, occupation, income	389, W 0%, RR 60%	U.S. employees of a chemical plant	cross-sectional	not reported	logistic regression analysis	high job strain was related to smoking, and co-worker support to smoking cessation
(Johansson, Johnson & Hall 1991)	daily smoking	job demands, work resources	age, education	7201, W 49%, RR 81%	Sweden, random sample	cross-sectional	1977	logistic regression analysis	job demands and physical workload were related to smoking
(Greenlund et al. 1995)	current smoking, smoking intensity	job demands, job control, job strain	age, education, physical activity, BMI, personality score	2665, W 50%, RR not reported	multi-centre study of working young adults	prospective/ cross-sectional	1987-1988	multiple linear and logistic regression analyses	no significant associations

Reference	Outcome(s)	Working condition(s)	Covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Hellerstedt & Jeffery 1997)	daily smoking, smoking intensity	job demands, job control, job strain	age, marital status, race, education, occupation, income, working hours, time with company, chemical and physical hazards	3843, W 51%, RR 60%	U.S , randomly selected employees of 32 worksites in Minnesota	cross-sectional	1989	mixed model and logistic regression analysis	job demands and job strain were related to smoking and smoking intensity, but differently by gender
(Callaghan 1998)	current smoking	social support	none (reported)	114, W 82%, RR 57%	UK nurses	cross-sectional	not reported	Spearman's and Pearson's correlation tests	social support was not related to smoking
(Kawakami, Haratani & Araki 1998)	current smoking, smoking intensity	job demands, job control, social support (single items)	age, education, occupation, shift work, obesity, physical activity, drinking	3862, W 0%, RR 92%	Japan, an electrical factory	cross-sectional	1984	logistic regression analysis	low work-site social support may affect smoking
(Niedhammer et al. 1998)	daily smoking	job demands, job control, work-related social support	age, marital status, children, education, occupation, physical strain at work	13226, W 27%, RR 45% (at baseline 1989)	French GAZEL cohort	prospective/ cross-sectional	1995	logistic regression analysis	high demands were related to smoking in women
(Trinkoff & Storr 1998)	smoking >10 cigarettes a day	work schedules, i.e., shifts, shift lengths, weekends, working overtime	age, gender, race	3917, W 95%, RR 78%	U.S., Nurses' Worklife and Health Study	cross-sectional	1994	logistic regression analysis	night shifts combined with overtime hours were related to smoking

Reference	Outcome(s)	Working condition(s)	Covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Otten, Bosma & Swinkels 1999)	current smoking, smoking intensity, ex-smoking	job demands, job control, job strain	age, education, occupation	3701, W 36%, RR 52.5%.	The Netherlands, random sample	cross-sectional	1994-1995	multinomial logit analysis	low job control was related to smoking in men
(Shields 1999)	current smoking, smoking intensity	working overtime (41 hours or more)	age, marital status, education, income, occupation, shift work, self-employment, job strain, supervisor support	3830, W 43%, RR 89%	Canadian employees	prospective (two years)	1994-1995 & 1996-1997	multiple logistic regression	change from standard hours to working overtime was related to increase in smoking
(van Loon et al. 2000)	current smoking	job demands, job control, job strain, iso-strain, social support	age, education	3309, W 50% RR 44%	The Netherlands, sex-stratified random sample	cross-sectional	1993, 1996	multiple logistic regression	non-existent associations for job strain, few inconsistent associations for the iso-strain model
(Bastian et al. 2001)	current smoking (cigarettes)	job strain, home strain (multiple roles)	age, marital status, education, income, ethnicity, drinking, physical activity, obesity	275, W 100%, RR 71%	U.S., women veterans, North Carolina	cross-sectional	1997-1999	logistic regression analysis	high job strain was related to smoking
(Tsutsumi et al. 2003)	smoking prevalence and intensity	job demands, job control, job strain	gender, age, marital status, education, occupation	6759, W 52%, RR 65%	Japan, rural workers	cross-sectional	1992-1995	logistic regression analysis	job demands were related to heavy smoking, low job control to less consumption of cigarettes, and job strain to low prevalence of smoking

Reference	Outcome(s)	Working condition(s)	Covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Lindström 2004)	daily smoking	job strain, social participation	age, country of origin, education, economic stress	5180, W 44%, RR 59%	Sweden, public health survey	cross-sectional	1999-2000	logistic regression analysis	high job strain was related to smoking among both genders
(Kang et al. 2005)	current smoking	job demands, job control, job strain	age, marital status, BMI	160, W 0%, RR not reported	Korea, study of 20 worksites	cross-sectional	not reported	logistic and linear regression analysis	job demands were related to smoking
(Kouvonen et al. 2005)	current smoking, smoking intensity	job strain, effort-reward imbalance (ERI)	age, marital status, education, occupation, employment type	46188, W 81%, RR 67%	Finland, public sector employee cohort	cross-sectional	2000-2002	logistic regression analysis	work stress (ERI and job strain) was related to smoking prevalence and smoking intensity
(John et al. 2006b)	smoking (nicotine dependence)	job strain	gender, age, occupation, drinking	2549, W % not reported, RR 70%	German, community sample	cross-sectional	not reported	logistic regression analysis	high job strain was related to nicotine dependence
(Mizoue et al. 2006)	heaviness of smoking	working overtime	age, workplace smoking restriction, occupation, work stress	571,W 0%, RR 84%	Japanese municipal employees	cross-sectional	2001	analysis of covariance, pairwise comparisons (Tukey method)	working overtime had a U-shaped relationship with overall cigarette consumption
(Kouvonen et al. 2007)	current smoking, smoking intensity	organizational justice	gender, age, marital status, education, occupation, job contract, trait anxiety, job strain, ERI	34021, W 80%, RR 68%	Finland, public sector employee cohort	cross-sectional	2000-2002	logistic regression analysis with generalized estimating equations	low procedural justice and low levels of justice in interpersonal treatment were related to heavy smoking

*the number of eligible participants reported, .i.e., those examined in the analyses. Response rates usually refer to all the respondents.

2. Working conditions and drinking

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Reed et al. 1989)	alcohol intake/ month	job demands, job control, job strain	age (number of years worked at the jobs)	8006, W 0%, RR not reported	men of Japanese ancestry in Hawaii	prospective (18 year follow-up)	1965-1983	cross-tabulation analysis, Cox proportional hazards model	no significant associations
(Romelsjö et al. 1992)	drinking, hospitalization and mortality (alcohol-related diagnosis)	stressful working conditions (15 measures)	age, occupation	2838, W 53%, RR 65%	Sweden, Stockholm Health of the Population Study, aged 25-64 years	cross-sectional with a longitudinal component	1984	logistic regression analysis	stressful working conditions were related to severe alcohol problems
(Crum et al. 1995)	drinking (alcohol abuse and dependence)	job demands (physical & psychological) , job control, job strain, job insecurity, social support (imputed data)	gender, race, marital status, employment status, education, age at first intoxication with alcohol	507, W 49%, RR 76% at baseline (not reported for selected cases)	U.S. adults from five metropolitan areas, only incident cases and matched non-cases included	prospective (one year follow-up)	1980-1984	conditional logistic regression model	high job strain was related to alcohol abuse-dependence, but early problem drinking at baseline could not be excluded
(Greenberg & Grunberg 1995)	heavy drinking, negative consequences of drinking	low job control (related measures)	gender, age, marital status, parental drinking problem, race, education	1429,W 10%, RR 68%	U.S. employees of wood products industry	cross-sectional	1992	regression models	low use of capacities, low job autonomy, participation in decision making were minimally related to heavy drinking or drinking problems

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Greenlund et al. 1995)	current drinking, amount consumed per day	job demands, job control, job strain	age, education, physical activity, BMI, personality score	2665, W 50%, RR not reported	multi-centre study of working young adults	prospective/ cross-sectional	1987-1988	multiple linear and logistic regression analyses	low job strain and high job control had some associations with drinking
(Ragland et al. 1995)	heavy and average weekly consumption	job demands, job control, job strain, some other job stressors	gender, age, race	1820, W 9%, RR 78%	U.S., employees of the municipal railway in San Francisco	cross-sectional	1983-1985	logistic regression model, general linear model	heavy and average consumption were related to occupational and non-occupational factors and job stressors (but not to job strain or its components)
(Callaghan 1998)	regular alcohol use	social support	none (reported)	114, W 82%, RR 57%	UK nurses	cross-sectional	not reported	Spearman's and Pearson's correlation tests	social support was not related to drinking
(Niedhammer et al. 1998)	light, moderate, and heavy drinking	job demands, job control, work-related social support	age, marital status, children, education, occupation, physical strain at work	13226, W 27%, RR 45% (at baseline 1989)	French GAZEL cohort	prospective/ cross-sectional	1995	logistic regression analysis	low job control was related to drinking in men, low social support was related to drinking in women
(Trinkoff & Storr 1998)	consumption of five or more drinks on one occasion	work schedules, i.e., shifts, shift lengths, weekends, working overtime	gender, age, race	3917, W 95%, RR 78%	U.S., Nurses' Worklife and Health Study	cross-sectional	1994	logistic regression analysis	night and rotating shifts combined with overtime hours were related to drinking

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Roxburgh 1998)	alcohol consumption	job demands (including hours worked per week), job control, job noxiousness	age, income, marital status, working hours, family history of alcohol abuse	719, W 48%, RR 73%	Canadian adults	cross-sectional	not reported	linear regression analysis	high job complexity was related to low alcohol consumption, high job demands and job noxiousness to heavy drinking
(Shields 1999)	number of drinks per day in the week before the survey	working overtime (41 hours or more)	age, marital status, education, income, occupation, shift work, self-employment, job strain, supervisor support	3830, W 43%, RR 89%	Canadian employees	prospective (two years)	1994-1995 & 1996-1997	multiple logistic regression	change from standard hours to working overtime was related to increase in drinking in women
(Mitchell & Williamson 2000)	drinking (as sleep aid)	shift-work, change in shifts	none (reported)	27, W 0%, 100% (all working in shifts in the company)	male employees of a power station	prospective (one year)	not reported	independent group measures	half of employees used alcohol between successive nights as sleep aid
(Ragland et al. 2000)	six alcohol-related outcomes e.g. quantity and frequency of drinking	job stressors	gender, age, race, years of working at the company	1386, W 17%, RR 74%	U.S., employees of the municipal railway in San Francisco	cross-sectional	1993-1995	linear regression analysis	job stressor measures were positively related to the studied outcomes
(San Jose et al. 2000)	drinking (abstinence, light-moderate, heavy, and binge drinking)	physical working conditions, job demands, job control, social support	age, marital status, religion, place of residence, education	7533, W 35%, RR 70%	The Netherlands, those working in 1991, 40% of the original sample	cross-sectional	1991	multivariate logistic regression analysis	adverse working conditions such as hazardous physical working conditions and job demands were related to heavier drinking

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(van Loon et al. 2000)	weakly alcohol consumption	job demands, job control, job strain, iso-strain, social support	age, education	3309, W 50% RR 44%	The Netherlands, sex-stratified random sample	cross-sectional	1993, 1996	multiple logistic regression	non-existent associations for job strain, few inconsistent associations for the iso-strain model
(Head et al. 2002, Head, Stansfeld & Siegrist 2004)	drinking level, binge drinking, alcohol dependence	job demands, job control, job strain, social support, effort-reward imbalance (ERI)	age, socio-demographic and socio-economic data	10308, W 33%, RR 73%	UK, male and female civil servants of the Whitehall II study	prospective (5.3 years on average, phase 1-phase 3)	1985-1999	linear regression analysis, logistic regression analysis etc.	low job control and effort-reward imbalance were related to alcohol dependence
(Tsutsumi et al. 2003)	current drinking (average total amount)	job demands, job control, job strain	gender, age, marital status, education, occupation	6759, W 52%, RR 65%	Japan, rural workers	cross-sectional	1992-1995	logistic regression analysis	job demands and job strain were related to prevalence of drinking
(van Loon et al. 2004)	heavy drinking	job demands, job control, job strain, stress related to relatives, money etc.	gender, age, household composition, education, smoking, subjective health	4131, W 54%, RR 45% (baseline)	The Netherlands, cohort study	cross-sectional	1993-1997	logistic regression analysis	heavy drinking was only marginally related to stress-related factors
(Bobak et al. 2005)	annual alcohol intake, annual number of drinking sessions, the mean dose of alcohol per drinking session, binge drinking, problem drinking, negative social consequences of drinking	job control, effort-reward-imbalance	age and center of the study, depressive symptoms, education, material deprivation	694, W 0%, RR 65-71%	three Eastern European urban populations, men in full-time employment	cross-sectional	1999-2000	logistic regression analysis	effort-reward imbalance was related to increased drinking and problem drinking

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Dawson, Grant & Ruan 2005)	six measures of drinking pattern and volume	health-related stress, social stress, job stress, legal stress	gender, age, race, marital status, education, poverty, mood/anxiety	26946, W 52%, RR 81%	U.S. adults, past-year drinkers	cross-sectional	2000-2001	multiple linear regression analysis	stress was related to increased consumption of alcohol when drinking, not to the increased frequency of drinking
(Kouvonen et al. 2005b)	heavy drinking (weekly intake of different alcohol beverages)	job strain, effort-reward imbalance, and their components	age, marital status, education, occupation, job contract, negative affectivity	40851, W 79%, RR 67%	Finland, public sector employee cohort	cross-sectional	2000-2002	logistic regression analysis	some components of the work stress models were related to heavy drinking, partly in unexpected direction
(Roos, Lahelma & Rahkonen 2006)	heavy drinking, weekly binge drinking, problem drinking	work-family conflicts	age, family structure, education, income, occupation	5271, W 80%, RR 66%	Finland, public sector employees (Helsinki Health Study)	cross-sectional	2001-2002	logistic regression analysis	work-family conflicts were related to problem drinking among both genders and to heavy drinking among women

*the number of eligible participants reported, .i.e., those examined in the analyses. Response rates usually refer to all the respondents.

3. Working conditions and physical activity

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W%), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Reed et al. 1989)	physical activity index	job demands, job control, job strain	age (number of years worked at the jobs)	8006, W 0%, RR not reported	men of Japanese ancestry in Hawaii	prospective (18 year follow-up)	1965-1983	cross-tabulation analysis, Cox proportional hazards model	no significant associations
(Johansson, Johnson & Hall 1991)	leisure-time physical activity	job demands, work resources	age, education	7201, W 49%, RR 81%	Sweden, random sample	cross-sectional	1977	logistic regression analysis	job demands were related to sedentary behavior, job control was related to physical activity
(Hellerstedt & Jeffery 1997)	summary of weekly frequency of physical activities	job demands, job control, job strain	age, marital status, race, education, occupation, income, working hours, time with company, chemical and physical hazards	3843, W 51%, RR 60%	U.S , randomly selected employees of 32 worksites in Minnesota	cross-sectional	1989	mixed model and logistic regression analysis	job control was related to higher physical activity among both genders
(Callaghan 1998)	regular exercise	social support	none (reported)	114, W 82%, RR 57%	UK nurses	cross-sectional	not reported	Spearman's and Pearson's correlation tests	social support did not relate to exercise

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Nakamura et al. 1998)	physical activity (as an indicator of kinetic energy)	working overtime	age, marital status, education, drinking, eating habits	269, W 0%, RR 92%	Japan, non-management white-collar employees	prospective (three year follow-up)/ part of the data cross-sectional	1990-1993	multiple linear regression analysis	no significant associations
(Shields 1999)	leisure-time physical activity	working overtime (41 hours or more)	age, marital status, education, income, occupation, shift work, self-employment, job strain, supervisor support	3830, W 43%, RR 89%	Canadian employees	prospective (two years)	1994-1995 & 1996-1997	multiple logistic regression	no associations
(Burton & Turrell 2000)	leisure-time physical activity	working hours (eight levels), occupation	age, living arrangement, smoking status, body mass index, self-reported health	24454, W 45%, RR 91.5%	Australian Health Survey	cross-sectional	1995	logistic regression analysis	a suggested relationship between working hours and physical activity, but working time did not explain occupational class variability in physical activity
(van Loon et al. 2000)	lack of physical activity	job demands, job control, job strain, iso-strain, social support	age, education	3309, W 50%, RR 44%	The Netherlands, sex-stratified random sample	cross-sectional	1993, 1996	multiple logistic regression	non-existent associations for both job strain and iso-strain model

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Mizoue, Reijula & Andersson 2001)	physical inactivity	working overtime	gender, perceived work overload	1281, W % not reported, RR 89%	Japanese municipal employees	cross-sectional	1998	logistic regression analysis	working overtime was related to physical inactivity
(Ståhl et al. 2001)	physical activity	social support	gender, age, education etc.	3342, W 57%, RR 53.5%	public survey among adults from six countries	cross-sectional	1997-1998	logistic regression analysis	low social support (from e.g. family and workplace) was related to sedentary behavior
(Tsutsumi et al. 2003)	physical activity at work and at leisure time	job demands, job control, job strain	gender, age, marital status, education, occupation, working hours	6759, W 52%, RR 65%	Japan, rural workers	cross-sectional	1992-1995	logistic regression analysis	high demands were related to high work-related physical activity, and low control to low work-related physical activity
(Kouvonen et al. 2005)	physical activity (MET-index)	job demands, job control, job strain	age, marital status, socio-economic position, job contract type, smoking, drinking, trait anxiety	46 573, W 81%, RR 67%	Finland, public sector employee cohort	cross-sectional	2000-2002	analysis of variance	high job strain, passive work, and low job control were related to lower physical activity
(Schneider, Becker 2005)	physical activity	physically strenuous work, working overtime	age, marital status, childlessness, smoking, drinking, food habits, social support etc.	3323, W 44%, RR 61%	representative of the entire country	cross-sectional	1998	logistic regression analysis	physically strenuous work and working overtime were related to low physical activity

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Blanchard et al. 2005)	physical activity	social support	gender, age, race, education, income, and number of co-morbidities.	6739, W % not reported, RR 56%	U.S. panel survey	cross-sectional	2001	linear / hierarchical regression analysis	social support was related to physical activity among normal weight, overweight, and obese employees
(Kouvonen et al. 2006)	sedentary lifestyle (MET- index)	effort-reward imbalance (one item for efforts; three items for rewards)	age, marital status, occupation, job contract, smoking, drinking	38151, W 85%, RR 68%	Finland, public sector employee cohort	cross-sectional	2000-2002	logistic regression analysis with generalized estimating equations	perceived effort-reward imbalance was weakly related to sedentary behavior, no relationships at the work unit level
(Ali, Lindström 2006)	leisure-time physical activity	job strain	age, country of birth, education, economic stress, social participation	5180, W 44%, RR 59%	Sweden, public health survey	cross-sectional	2000	logistic regression analysis	high job strain was related to lower physical activity
(Roos et al. 2007)	leisure-time physical activity	work-family conflicts	age, marital status, number of children, occupation, working hours, time traveling to work, physical and mental work-load	5346, W 80%, RR 66%	Finland, public sector employees (Helsinki Health Study)	cross-sectional	2001-2002	logistic regression analysis	work-family conflicts and family-work conflicts were related to low physical activity, some differences by gender

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4. Working conditions and food habits

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Hellerstedt & Jeffery 1997)	18 item food frequency questionnaire (FFQ): daily calories derived from high fat foods	job demands, job control, job strain	age, marital status, race, education, occupation, income, working hours, time with company, chemical and physical hazards	3843, W 51%, RR 60%	U.S., randomly selected employees of 32 worksites in Minnesota	cross-sectional	1989	mixed model and logistic regression analysis	job demands were related to high fat intake in men
(Callaghan 1998)	food habits	social support	none (reported)	114, W 82%, RR 57%	UK nurses	cross-sectional	not reported	Spearman's and Pearson's correlation tests	social support did not relate to any food behavior except eating fruit
(Nakamura et al. 1998)	dinner time, eating habits such as eating breakfast	working overtime	age, marital status, education, drinking, eating habits, physical activity	269, W 0%, RR 92%	Japan, non-management white-collar employees	prospective (three year follow-up, part of the data cross-sectional)	1990-1993	multiple linear regression analysis	working overtime was related to dinner time; eating habits potentially intervene with relation of overtime and increase in BMI
(Geliebter et al. 2000)	main meals and snacks	shift work	age, years on the shift, smoking status	85, W 54%, RR 95%	U.S. hospital workers	cross-sectional	not reported	simple two-factor analysis of variance	late-shift work had some relationships with eating habits
(van Loon et al. 2000)	daily fruit and vegetable consumption	job demands, job control, job strain, iso-strain, social support	age, education	3309, W 50%, RR 44%	The Netherlands, sex-stratified random sample	cross-sectional	1993, 1996	multiple logistic regression	non-existent associations for both job strain and iso-strain model

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Laitinen, Ek & Sovio 2002)	food consumption (FFQ), stress-related eating	social support	parental social class, education, work history	5150, W 54%, RR 71%	Northern Finland, birth cohort 1966	prospective (31 year follow-up)	1997-1998	analysis of variance, binary logistic regression analysis	lack of emotional support was related to stress-driven eating of unhealthy foods
(Tsutsumi et al. 2003)	food habits: 3 factors derived from 30 item FFQ	job demands, job control, job strain	gender, age, marital status, education, occupation	6759, W 52%, RR 65%	Japan, rural workers	cross-sectional	1992-1995	logistic regression analysis	low job control and job strain were related to less frequent vegetable consumption
(Bohle et al. 2004)	meal patterns	work-home conflicts, working hours	none (reported)	39, W 44%, RR not reported	qualitative case study of hotel employees	cross-sectional	not reported	qualitative	irregular meal patterns/ problems with diet may be related to work-home conflicts
(Kawakami et al. 2006)	daily intake of 17 nutrients	job strain, worksite support	age, education, marital status, occupation, and study site	25104, W 16%, RR 43-100%, average 85%	Japan, employees from nine companies	cross-sectional	1996-1998	analysis of covariance	job strain and social support were weakly and inconsistently related to intake of nutrients
(Nishitani, Sakakibara 2006)	eating behavior, meal contents etc. (30 items)	job demands, job control, job stress (separate questionnaire)	age	208, W 0%, RR 98%	Japan, synthetic fiber-manufacturing plant	cross-sectional	2003	logistic regression analysis	some eating behaviors of workers under job stress resembled those of obese persons

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Devine et al. 2007)	fruit and vegetable consumption	job strain, job satisfaction, type of shift, working hours, work-to-family spillover	gender, age, race, education, income, family factors etc.	1108, W 6%, RR 44%	U.S., a national random sample	cross-sectional	not reported	multivariable logistic and least-squares regression.	high work-to-family spillover was related to low fruit and vegetable consumption
(Roos et al. 2007)	recommended food habits	work-family conflicts	age, marital status, number of children, occupation, working hours, time traveling to work, physical and mental work-load	5346, W 80%, RR 66%	Finland, public sector employees (Helsinki Health Study)	cross-sectional	2001-2002	logistic regression analysis	family-work conflicts were related to less likelihood of following recommended food habits

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5. Working conditions and weight

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W%), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Reed et al. 1989)	BMI	job demands, job control, job strain	age (number of years worked at the jobs)	8006, W 0%, RR not reported	men of Japanese ancestry in Hawaii	prospective (18 year follow-up)	1965-1983	cross-tabulation analysis, Cox proportional hazards model	no significant associations
(Niedhammer, Lert & Marne 1996)	weight gain, overweight	night work	age, parity, smoking, physical activity	469, W 100%, RR 78%	French public sector hospital nurses	cross-sectional/ prospective	1980-1990	logistic and linear regression analysis	weight gain and overweight were related to night work
(Hellerstedt & Jeffery 1997)	BMI	job demands, job control, job strain	age, marital status, race, education, occupation, income, working hours, time with company, chemical and physical hazards	3843, W 51%, RR 60%	U.S., randomly selected employees of 32 worksites in Minnesota	cross-sectional	1989	mixed model and logistic regression analysis	job demands were related to a higher BMI in men, while women with high job strain had a higher BMI
(Wamala, Wolk & Orth-Gomér 1997)	BMI (obesity)	job strain, social support	age, marital status, education, occupation, smoking, physical activity, dietary factors	300, W 100%, RR 83%	Swedish women ages 30-65 years	cross-sectional	1991-1994	analysis of variance, logistic regression analysis	job strain was related to obesity; psychosocial factors explained 33% of the social gradient in obesity
(Nakamura et al. 1998)	BMI, waist circumference	working overtime	age, marital status, education, drinking, eating habits, physical activity	269, W 0%, RR 92%	Japan, non-management white-collar employees	cross-sectional/ prospective (three year follow-up)	1990-1993	multiple linear regression analysis	working overtime was weakly related to increase in BMI and waist

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W%), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Niedhammer et al. 1998)	overweight (BMI>26.9 in women; BMI>27.2 in men)	job demands, job control, work-related social support	age, marital status, children, education, occupation, physical strain at work	13226, W 27%, RR 45% (at baseline 1989)	French GAZEL cohort	prospective/ cross-sectional	1995	logistic regression analysis	high job control and high social support were related to overweight in men, high demands were related to overweight in women
(Shields 1999)	BMI, weight gain	working overtime (41 hours or more)	age, marital status, education, income, occupation, shift work, self-employment, job strain, supervisor support	3830, W 43%, RR 89%	Canadian employees	prospective (two years)	1994-1995 & 1996-1997	multiple logistic regression	working overtime was related to a higher BMI, and change from standard hours to working overtime was related to weight gain in men
(Steptoe et al. 1999)	BMI, waist, obesity (abdominal)	job control, social support	age, weight	156, W 63%, RR 52%	UK, school teachers, aged 22-58 years	prospective (12 month follow-up)	not reported	regression models	low job control was related to larger waist circumference, heavier weight and a higher BMI among women
(Geliebter et al. 2000)	BMI, weight gain	shift work	age, years on the shift, smoking status	85, W 54%, RR 95%	U.S. hospital workers	cross-sectional	not reported	simple two-factor analysis of variance	late-shift work was related to weight gain, but late-shift workers did not weigh more than day-shitt workers

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W%), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Yamada et al. 2001)	weight gain	shift work (8-hour vs. 12-hour shifts)	none (reported)	192, W 0%, RR not reported	Japan, male workers in a factory	prospective (three years)	1996-1999	paired t-tests, repeated-measure analysis of variance	moving from an 8-hour to a 12-hour shift was related to weight gain
(Head et al. 2002)	BMI	job demands, job control, job strain, social support, effort-reward imbalance (ERI)	age, socio-demographic and socio-economic data	10308, W 33%, RR 73%	UK, male and female civil servants of the Whitehall II study	prospective (ca. 12 years, phase 1- phase 5)	1985-1988/ 1997-1999	linear regression analysis, logistic regression analysis etc.	low job demands, low job control and low social support at work were related to obesity
(Kivimäki et al. 2002)	BMI	job demands, job control, job strain, ERI	gender, age, occupation (smoking, physical activity etc.)	812, W 33%, RR 1983=76 %, 2001=81%	Finland, industrial employees; a systematic equal-spaced non-proportional sample	prospective (mean follow-up 26 years)	1973-2001	Cox proportional hazard models	effort-reward imbalance was related to increased BMI at the 10-year follow-up
(Laitinen, Ek & Sovio 2002)	BMI	social support	parental social class, education, work history	5150, W 54%, RR 71%	Northern Finland, birth cohort 1966	prospective (31 year follow-up)	1997-1998	analysis of variance, binary logistic regression analysis	lack of support may partly explain higher BMI among stress-driven eaters and drinkers

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W%), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Parkes 2002)	BMI	shift work	age, education, job type, smoking	1574, W 0%, RR 83%	UK, offshore workers	cross-sectional	1995	hierarchical multiple regression	increase in BMI with an increase in age was steeper for the day-night shift workers than for day-shift workers
(Hannerz et al. 2004)	changes in BMI between 1995 and 2000	job demands, job control, working hours, physical activity at work, job insecurity, etc.	age, marital status, smoking, baseline BMI	1980 W 0%, RR 80% at baseline	Danish National Work Environment Cohort Study	prospective (five year follow-up)	1995-2000	linear regression analysis	high and low job demands and job insecurity were related to weight gain among obese employees, and to weight loss among those with a low BMI
(Overgaard et al. 2004)	weight gain	busyness in job, job speed and job influence	age, marital status, BMI, smoking, drinking, physical activity, working hours, shift work, menopause	6704, W 100%, RR 86% at baseline	Danish nurses working 1993 and 1999	prospective (six year follow-up)	1993-1999	linear regression analysis	low and high busyness in job and low job influence were related to weight gain
(Kang et al. 2005)	BMI	job demands, job control, job strain	not reported (for BMI analysis)	160, W 0%, RR not reported	Korea, study of 20 worksites	cross-sectional	not reported	univariate analysis	no significant associations
(Kouvonen et al. 2005a)	BMI	job demands, job control, job strain, ERI (individual and work unit levels)	age, marital status, job contract, smoking, drinking, physical activity	45810, W 81%, RR 67%	Finland, public sector employee cohort	cross-sectional	2000-2002	linear regression analysis	low job control, high job strain, and high ERI were related to a higher BMI

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W%), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Laaksonen et al. 2005b)	BMI	physical workload, hazardous exposures, computer work, job demands, job control	age	8960, W 80%, RR 67%	Finland, public sector employees (Helsinki Health Study)	cross-sectional	2000-2002	Pearson correlations	physical and psychosocial working conditions were only weakly correlated with BMI
(Ball, Crawford 2006)	weight gain, obesity	social support	education, area of residence, smoking, weight history, BMI	790, W 100%, RR 41% Survey 1, RR 68% Survey 2, random sample RR 66%	Australia, longitudinal study of women's health	prospective (two year follow-up)	1996-2002	linear regression analysis	social support was related to a higher BMI and weight gain
(Kivimäki et al. 2006)	weight gain, weight loss	job strain	age, occupation, baseline BMI	7965, W 30%, RR 73% at baseline	UK, male and female civil servants of the Whitehall II study	prospective (five year follow-up)	1985-1988/ 1991-1993	logistic regression analysis	job strain was related to weight loss among the leanest men with baseline BMI<22, and to weight gain among men with baseline BMI>27
(Nishitani & Sakakibara 2006)	obesity	job stress, job demands, job control	age	208, W 0%, RR 98%	Japan, synthetic fiber-manufacturing plant	cross-sectional	2003	logistic regression analysis	obese employees tended to be in stressful state, but high job demands and low job control were not directly related to obesity

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W%), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Ostry et al. 2006)	BMI	physical work demands, job strain, job efforts, job rewards, ERI, working hours, shift work	age, marital status, education	1101, W 52%, RR 66%	Australia, population-based survey, telephone interviews	cross-sectional	2003	linear regression analysis	physical demands, working overtime, high efforts and high demands in men, and low rewards in women were related to BMI
(Brunner, Chandola & Marmot 2007)	obesity (general and central)	job demands, job control, social support, isolated strain (iso-strain)	gender, age, social position, smoking, drinking, physical activity, food habits	10308, W 33%, RR 73% at baseline (71% by phase 7)	UK, male and female civil servants of the Whitehall II study	prospective (19 year follow-up)	1985-2004	nested multivariate logistic regression analysis (imputed data n=4895 of 10308)	chronic work stress was related to general and central obesity (a dose-response relation)
(Lallukka et al. 2007)	weight gain, BMI	physical strain, mental strain, working overtime, work pace, job efforts, job rewards, ERI	age, education, occupation, initial BMI	449, W 31%, RR 1983=76 %, 2001=81%	Finland, industrial employees; a systematic equal-spaced non-proportional sample	prospective (28 year follow-up)	1973-2001	analysis of variance, logistic regression analysis, linear mixed longitudinal growth model	changes in the physical strain and temporal requirements were related to weight gain

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6. Working conditions and angina pectoris

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Bosma et al. 1998)	angina pectoris assessed by the Rose questionnaire and/or doctor-diagnosed angina	job control, job strain, effort-reward imbalance (ERI)	age, occupation, negative affectivity,coronary risk factors (smoking, BMI etc.)	10308, W 33%, RR 73% (baseline)	UK, male and female civil servants of the Whitehall II study	prospective (5.3 years on average phase 1-phase 3)	1985/ 1988-1991/ 1993	logistic regression analysis	low job control and ERI predicted incidence of angina
(Ferrie et al. 1998)	ischemia (Rose questionnaire or abnormal ECG)	organizational change, job insecurity	age, occupation	7149, W 31%, RR 73% (at baseline)	UK, male and female civil servants of the Whitehall II study	prospective (5.3 years on average phase 1-phase 3)	1985/ 1988-1991/ 1993	Cochran-Mantel-Haenzel tests of association	anticipating change was related to ischemia among women
(Netterstrøm et al. 1998)	angina pectoris (assessed by a nurse)	job strain, social support	gender, age, height, weight, blood pressure, serum lipids, glucose, fibrinogen, ECG etc.	1049, W 49%, RR 63%	Danish urban population	cross-sectional	1993-1994	multiple linear regression analysis	high job strain was related to angina pectoris independently of biological risk factors
(Gorter, Eijkman & Hoogstraten 2000)	chest pain	burnout	gender	709, W 16%, RR 75%	Dutch dentists	cross-sectional	1997	chi-square statistics	risk of burnout was related to pain in chest region
(Head et al. 2002)	angina pectoris assessed by the Rose questionnaire and clinically validated angina	job demands, job control, job strain, social support, effort-reward imbalance (ERI)	age, occupation, exercise, smoking, BMI, cholesterol, hypertension	10308, W 33%, RR 73% (at baseline)	UK, male and female civil servants of the Whitehall II study	prospective	1985-1999	linear regression analysis, logistic regression analysis etc.	high demands were related to angina among women, and low control among men; job strain, iso-strain, and ERI were related to angina (genders combined)

Reference	Outcome(s)	Working condition(s)	Adjustments/ covariates	N, women (W %), response rate (RR %)*	Setting	Study design	Time period	Main statistical method	Adjusted results
(Chandola, Siegrist & Marmot 2005)	angina pectoris (self-reported Rose questionnaire and doctor diagnose)	effort-reward imbalance (ERI)	age, occupation, obesity, blood pressure	3697, W ca. 33%, RR 73%(at baseline, smaller numbers in some analyses)	UK, male and female civil servants of the Whitehall II study	prospective (9-12 year follow-up)	1985/ 1988-1997	pathway models using weighted least squares probit regressions	increase in ERI was related to increased risk of incident angina among men

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