Health and ill health
in working women
– balancing work and recovery

Ulrica von Thiele Schwarz
Abstract

Work conditions within the public health care sector are physically and psychosocially demanding. This means that balancing work with recovery is essential for employees in order to avoid ill health and stay healthy. This thesis is based on four studies. Study I investigated the prevalence of upper extremity disorders (UED) in female dental personnel. Results showed that 81% reported UED. Consequently, interventions aimed at reducing these risks were called for. Study II investigated the health-related effects of two work-place interventions, physical exercise (PE) and reduced working hours (RWH). Health-improvements were more consistent in the PE group, suggesting that PE may be an appropriate intervention to reduce health-risks. However, there were no effects on recovery from work or fatigue, which may result from other factors, such as overcommitment (OC), that prolong or sustain stress-related activity. Study III showed that high OC was associated with poorer next-day recovery and increased fatigue. Also, OC was a more important predictor of lack of recovery and fatigue than were psychosocial work characteristics. This highlights the importance of considering perseverative cognitions in relation to recovery from work and fatigue, and has implications for interventions targeting work-related ill health. Study IV related lack of recovery and fatigue to cumulative biological risk, allostatic load (AL), and to individual biomarkers. Women with a profile characterized by fatigue, sleep difficulties and lack of short-term recovery had a 2.9 increased risk of AL. This was not shown in analyses of individual biomarkers. In sum, this thesis shows that recovery from work is an important factor in relation to women’s work-related health. Fatigue and recovery should be considered interrelated but distinct concepts and recovery should be assessed as an early risk factor for stress-related disease with early risk being investigated using AL rather than individual biomarkers.

Keywords: Allostatic Load, Biological markers, Dentistry, Exercise, Fatigue, Physical Activity, Public health care, Overcommitment, Reduced working hours, Stress, Upper Extremity Disorder
I am so curious. I guess I never stopped asking those questions you hear from a five year old: what is that? How does it work? How is this related to that? WHY?? That’s why I was intrigued by doing research, because to me, asking question (and sometimes, if you’re lucky, get a hint of an answer) is what you do.

Of course, I have met and engaged with a lot of people who has helped me during my PhD studies and to whom I am grateful. I will not pretend to be able to thank you all, but will limit myself to thank only a few.

First, I would like to thank my supervisors Ulf Lundberg and Petra Lindfors. Without Ulf’s support, I would not have started my doctoral studies. His experience was also invaluable in the design of the project, and in getting it funded, approved and started. He has been reassuring and always responsive and helpful. He was also responsible for involving Petra Lindfors in the project, first as a collaborator, then as a co-supervisor, and for the final years, as head supervisor. Petra has been a tremendous support and has also contributed to making the whole experience joyful. I have greatly appreciated the easiness in our collaboration and how our discussions has improvement my knowledge and widened my perspective.

I have also been lucky enough to meet and engage with other researchers, who have helped me move things along. One such opportunity was collaborating with Göran Kenttä in two chapters concerning recovery among athletes. Our discussions concerning the concept of recovery and similarities and dissimilarities in recovery within different settings were, and are, enlightening. Collaborating with Susanne Heiwe, with her deep knowledge on physical activity has also been a very helpful and pleasant experience.

Finally, Dan Hasson, my colleague and friend with whom I never seem to be finished discussing stress and intervention – your reassurance and constant expression of belief in my ability as a researcher is not only highly flattering but also heart-warming.

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In a thesis on work and health, I am happy to say that I am one of those who have an understanding and supportive employer. Thanks to the managers for the financial, practical and emotional support I gained in my effort to do research and thanks for spreading the results outside the
scientific community. Also, thanks to the nurses who without complaining got up early in the morning, travelled far, followed complicated protocols and provided a safe environment for the participants. I appreciated sharing the burdens of logistics with you, as well as the joy of collaboration with the organisations and meeting with the participants.

On the subject of work and health – my appreciations also go to the organisations who wanted to improve the situation for employees, with their health and well-being in mind: the Public Dental Health Service in Stockholm and Hägersten and Skärholmen District Councils. With more employers of your kind, the healthiness of work would be in the centre more often! And of course, thanks to the employees who volunteered to participate in the research project. Without you, this truly wouldn’t have happened.

Most of all, I am thankful to all of you outside the scientific community, who have asked me “so, what are you doing research about” and expected a sensible, understandable answer in maximum three (short) sentences. I am also thankful for questions like “but what is it good for?” To the extent that I have managed to be clear on the practical implications of my findings, I owe it to you.

My final note will be directed towards my family. Thanks to my husband Niklas for being supportive and encouraging, and to my mum, Majvy, for giving me extra time to spend on scientific work. And finally, thanks to our daughter Thea, who makes every thought about research and dissertation disappear by inviting me to play and cuddle instead.
List of publications

The present thesis is based on the following studies, which are referred to in the text by their Roman numerals:

Study I

Study II

Study III
von Thiele Schwarz, U. (2008). Overcommitment as related to poor next-day recovery and work-related fatigue among women. Submitted manuscript

Study IV

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## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ACSM</td>
<td>American College of Sports Medicine</td>
</tr>
<tr>
<td>AL</td>
<td>Allostatic Load</td>
</tr>
<tr>
<td>ANCOVA</td>
<td>ANalysis Of COVariance</td>
</tr>
<tr>
<td>ANOVA</td>
<td>ANalysis Of VAriance</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval (usually 95% CI)</td>
</tr>
<tr>
<td>DHEAS</td>
<td>DeHydroEpiAndrosterone Sulfate</td>
</tr>
<tr>
<td>ERI</td>
<td>Effort-Reward Imbalance</td>
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<tr>
<td>HbA1c</td>
<td>Glycated haemoglobin</td>
</tr>
<tr>
<td>HDL</td>
<td>High-Density Lipoprotein</td>
</tr>
<tr>
<td>HPA</td>
<td>Hypothalamic-Pituitary-Adrenal axis</td>
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<tr>
<td>LDL</td>
<td>Low-Density Lipoprotein</td>
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<tr>
<td>MANCOVA</td>
<td>Multiple ANalysis Of COVariance</td>
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<tr>
<td>MANOVA</td>
<td>Multiple ANalysis Of VAriance</td>
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<tr>
<td>MSD</td>
<td>MusculoSkeletal Disorder</td>
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<td>OC</td>
<td>Overcommitment</td>
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<tr>
<td>OR</td>
<td>Odds Ratio</td>
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<tr>
<td>PA</td>
<td>Physical Activity</td>
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<tr>
<td>PE</td>
<td>Physical Exercise</td>
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<tr>
<td>PSNS</td>
<td>ParaSympathetic Nervous System</td>
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<tr>
<td>RWH</td>
<td>Reduced Working Hours</td>
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<tr>
<td>SAM</td>
<td>Sympatho-Adreno-Medullary system</td>
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<tr>
<td>SNS</td>
<td>Sympathetic Nervous System</td>
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<td>UED</td>
<td>Upper Extremity Disorder</td>
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<tr>
<td>WHI</td>
<td>Work-Home Interference</td>
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<td>WHP</td>
<td>Workplace Health Promotion</td>
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<td>WHR</td>
<td>Waist-Hip Ratio</td>
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<tr>
<td>WRMSD</td>
<td>Work-Related MusculoSkeletal Disorder</td>
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Introduction

The effects of work on health and ill health have been investigated extensively. Particularly, adverse effects of poor work conditions have been thoroughly studied. Health problems, symptoms and diseases associated with poor work conditions include a variety of symptoms and diseases such as musculoskeletal pain, cardiovascular diseases, depression and poor health behaviours such as alcohol consumption, smoking and using drugs (Bongers, Dewinter, Kompier, & Hildebrandt, 1993; Bongers, Kremer, & ter Laak, 2002; Johnson & Hall, 1988; Niedhammer, Goldberg, Leclerc, David, et al., 1998; Niedhammer, Goldberg, Leclerc, Bugel, & David, 1998; Reed, Storr, & Anthony, 2006; Theorell et al., 1998). In recent years, poor psychosocial work conditions such as high work pace, monotonous work tasks and high emotional demands are reported more frequently than are poor physical work conditions such as heavy lifting, strenuous work positions and noxious exposure (The Work Environment 2007, 2008). This can be partly attributed to changes in the labour market, where physically hazardous jobs have become less common, either having been moved to other parts of the world or changing dramatically due to technical achievements, concurrently with an increased internationalization and competition and utilization of information and communication technology that has changed the psychosocial work environment (Kompier, 2006). Besides a decrease in the part of the work force that is subjected to a demanding physical work environment, there have also been improvements for those still exposed to heavy physical workload, uncomfortable working positions, physical hazards and challenges to the five senses (odour, noise, poor air quality, etc.). These improvements include legislation regarding exposure to hazardous factors, ergonomic developments and technical achievements.

For the psychosocial work environment, the improvements are less obvious. This is not due to a lack of knowledge about which psychosocial factors may be harmful for people’s health. We currently know a great deal about what conditions increase the risk for health impairments. In a recent review of the literature, it is concluded that there is a consensus regarding psychosocial factors that may affect health, including organizational culture, roles, career opportunities, decision latitude, social relationships, work-home interference, work tasks, work demands or work pace and scheduling of work (Cox, Griffiths, & Rial-González, 2000). The current understanding builds on decades of research. An influential model on how psychosocial
work characteristics relate to stress and health was presented as early as in the late 70s: the Demand/Control/Social Support model. The model states that high psychological demands in combination with low decision latitude (influence at work), – called job strain, – is the worst situation, particularly if one’s social support is low, as well (Karasek, 1979; Karasek & Theorell, 1990). The Demand/Control/Social Support model was later complemented with a second model, the Effort-Reward Imbalance model (ERI). In the ERI model, balance is also in focus, but this time in terms of balance between effort spent at work (physical, mentally, socially and motivationally) and the rewards (monetary, esteem and status) gained (Siegrist, 1996). In the 90s, a third model relating psychosocial stressors to a cumulative physiological risk over one’s life-course, the Allostatic Load model, was presented (McEwen, 2000; McEwen & Seeman, 1999). Although differentiation between various psychosocial stressors is not part of the model, it shows how protective and adaptive short-term responses to stressors may turn into the harmful consequences of prolonged activation. From this research follows a renewed scientific interest in recovery from work, and a third perspective suggesting that along with balance between demands and control and effort and reward, a balance between activation and recovery is also needed.

In contrast to the focus on the potential harmful effects of work, consistent findings show that paid employment has no adverse effects on health among women (Repetti, Matthews, & Waldron, 1989). On the contrary, some findings suggest that paid employment is related to improved health, including less depression, lower mortality and better subjective health (Klumb & Lampert, 2004). Paid employment has been related to better social support, increased extrinsic gratification including income, intrinsic gratification, creativity, and increased control (Barnett & Hyde, 2001; Bird & Ross, 1993; Hibbard & Pope, 1992; Mirowsky & Ross, 2007; Repetti et al., 1989; Yoshii & Yamazaki, 1999). These findings remain in longitudinal studies even after controlling for the fact that there is a reverse relationship as well: healthy women participate in the labour force to a greater extent than unhealthy women do (Repetti et al., 1989). On the whole, work is not bad for people, but rather the opposite: although having multiple roles may be stressful and decrease autonomy, the negative consequences of multiple roles seem to be overridden by the positive consequences of occupying several roles when this provides an opportunity to take part in paid work (Barnett & Baruch, 1985; Mirowsky & Ross, 2007; Repetti et al., 1989). This may be due to a buffering effect, whereby stressors from one area are counteracted, or buffered, by successes and satisfaction from another, but it may also be related to the quality of the work such as high job reward and job satisfaction and low levels of harassment (Barnett & Hyde, 2001). These positive consequences of paid work may be further enhanced when the workplace is used as an arena for health promotion. There is no other setting where adults spend so much of their waking hours, making employees easier
to reach with health initiatives and making it convenient for them to attend a health program (W. S. Cohen, 1985).

So, work is generally good for health, but under some conditions may be related to ill health. One way to understand this is to look at work from a whole life perspective. In this thesis, the negative effects of work, and work conditions, on health are understood in terms of stress theory and the allostatic load model. There is an upper limit to the benefits of multiple roles, and being exposed to poor work conditions may evoke stress responses that, in the long term, may lead to ill health (Barnett & Hyde, 2001; Rusli, Edimansyah, & Naing, 2008). However, responding physiologically to overload and demands in the environment is not pathological in itself but rather the opposite: it is a beneficial mobilization that is necessary for adapting to changes in the environment (McEwen, 2000). This holds true as long as the stress response is allowed to be reversed, as it is during recovery (McEwen, 2008). Therefore, work conditions (e.g. stressors) and the reactions to stressors (e.g. symptoms) need to be considered in relation to what happens after the removal of the stressor, such as after the workday has ended. Effects of both physical and psychosocial work conditions are assumed to be modified by the time it takes, and the ability, to recover from work (Frankenhaeuser, Lundberg, Fredriksen, & Melin, 1989; Sluiter, de Croon, Meijman, & Frings-Dresen, 2003; Sluiter, Frings-Dresen, Meijman, & van der Beek, 2000; Sluiter, van der Beek, & Frings-Dresen, 1999). Being fatigued after a demanding workday, or after any other activity that requires effort expenditure, may be regarded as a natural and healthy response as long as the reaction can be reversed. This, in turn, is dependent on many factors associated with the individual’s whole life situation: not only the level of stressors and demands at work, but also the individual’s reaction to that situation, as well as the situation outside work – other responsibilities and resources, including time available for recovery and mental activities that may interfere with the recovery process. This extends the focus from the job situation alone to processes and activities that take place outside work as well. This is particularly relevant for women, whom compared to men often have a greater total workload and the main responsibility for the household, despite a labour participation rate similar to men’s (80% compared to 86% in Sweden) (Gjerdingen, McGovern, Bekker, Lundberg, & Willemsen, 2000; Statistics Sweden, 2005). Although having multiple roles in itself is rewarding, juggling work with other responsibilities and needs, particularly the need to recover from work, may be challenging.

Drawing on the theoretical perspective of stress theory, this thesis focuses on various aspects of health and ill health among women with emotionally and physically demanding jobs employed by the public health care sector. The general aim was to investigate health and ill health among working women, with specific focus on how efforts associated with work need to be
balanced with recovery and the time off work in order to prevent ill health and promote health. The theoretical and empirical framework is presented in the next section, starting with a description of public health care in general and dentistry in particular and followed by an introduction to the work-related health problems associated with public health and dentistry. Afterward, stress theory is introduced, including a description of the concept of recovery, followed by an introduction to interventions in the workplace, particularly physical activity interventions and reduced working hours. The section ends with the aim of the thesis and specific research questions.
In Sweden, the labour market is gender segregated. Women form the great majority in the municipal service, including elderly care, child care and health care. Jobs in this sector are often physically demanding, involving heavy lifting and working in strenuous positions (Bäckman, 2001; The Work Environment 2007, 2008). They are also emotionally demanding, involving care for other people. The psychosocial work environment is poorer in comparison to other sectors and is characterized by great time pressure and low possibility to influence one’s work pace and when tasks should be done. While the proportion of employees reporting poor psychosocial work conditions has remained largely unchanged in other sectors, there has been an increase in employees within the public sector reporting high psychological demands and low autonomy (O. Lundberg & Gonäs, 1998). Jobs in the municipal sector also often carry low status, offering limited career opportunities and lower salaries. These are all factors that, according to the Demand-Control model and the ERI model, increase the risk for ill health.

In comparison with other human-service workers, dental health workers often report a poorer work environment (Bejerot, 1998; Finsen, Christensen, & Bakke, 1998). Dentistry has been described as the most stressful of the health care professions (R. Freeman, Main, & Burke, 1995). Common stressors are problems connected to the compliance, pain and anxiety of the patient; interpersonal relations; the physical strain of the work; economic pressures; third-party constraints; and the strain of perfectionism and seeking ideal results (O'Shea, Corah, & Ayer, 1984). In Sweden, questionnaires concerning the work environment have been administered in the Swedish Public Dental Health Service (PDHS) since the 40s, revealing dissatisfaction with high demands and low rewards, piece-work wages, detailed control systems and lack of self determination (Bejerot, 1998). Research has indicated that the work environment differs depending on occupation, with dentists and dental hygienists having the highest demands (Murtomaa, Haavio-Mannila, & Kandolin, 1990; Rundcrantz, Johnsson, Roxendal, & Moritz, 1991); see also (Bejerot, 1998). However, since dentists and dental hygienists, but not dental nurses, have been in focus in most research, less is known about these variations (Murtomaa et al., 1990; Öberg, Karsznia, Sandsjö, & Kadefors, 1995; Rundcrantz, Johnsson, & Moritz, 1991;
Dentistry does not only involve a challenging psychosocial work environment. Most of the workday is spent bent over a patient’s mouth in order to access the teeth, particularly for dentists and dental hygienists. This imposes visual demands and requires fixed postures and repetitive movements for extended periods of time which generates a high muscular load, particularly on the trapezius muscle (Åkesson, Hansson, Balogh, Moritz, & Skerfving, 1997; Mileråd, Ericson, Nisell, & Kilbom, 1991; Öberg et al., 1995). Moreover, the three most common tasks performed by dentists are similar with no significant differences in muscle activity, posture or frequency of posture between them. Therefore, the physical load of dental work seems to be quite stable (Finsen et al., 1998). Working with strenuous arm postures is particularly risky for women, who have an increased risk for neck/shoulder pain compared to men (Hooftman, van Poppel, van der Beek, Bongers, & van Mechelen, 2004).

**Work-related health problems in public health care and dentistry**

With challenging work conditions, the prevalence of work-related ill health in the municipal sector is relatively high. Among the most frequently reported health problems are musculoskeletal problems including low back pain and pain in the neck, feeling physically exhausted after work and fatigue (W. Eriksen, 2003; Leighton & Reilly, 1995; The Work Environment 2007, 2008). There is also a relatively high prevalence of major depression and stress-related mental disorders (Wieclaw, Agerbo, Mortensen, & Bonde, 2005). These physical and mental problems are reflected in a high sickness absence (Lund, Labriola, & Villadsen, 2007), which may be an indicator of both health problems and decreased work ability.

It has been debated whether work-related ill health is particularly common within dentistry. While some research suggests that dental personal are as well off and happy as other professional groups (Craven, 2008), other research has indicated that dentists have an increased risk of coronary artery disease and hypertension, as well as depression and suicide (Gerschman & Burrows, 1998). Also, a high prevalence of headaches (60%) and sleeping difficulties (60%), as well as minor psychiatric illness (32%), has been reported (Myers & Myers, 2004).
Upper Extremity Disorder

Although there are inconsistencies regarding the frequency of work-related ill health in dentistry, it is commonly agreed that there is a high incidence (risk of new occurrences within a specific time period) and prevalence (total number of cases in a population) of musculoskeletal disorder (MSD) among dental personal (Alexopoulos, Stathi, & Charizani, 2004; Finsen et al., 1998; Myers & Myers, 2004; Åkesson, Johnsson, Rylander, Moritz, & Skerfving, 1999). MSD is an unspecific diagnosis, including several factors relating to the function of the muscular system, including muscular strength and endurance, neuromuscular function (coordination, balance, speed), joint flexibility and stability, skeletal strength, but also the subjective experience of pain (self-reported and/or palpation soreness) and functional decline (Barnekow Bergkvist, 2006). When factors in the work situation are part of the aetiology, development or exacerbation, MSD is called work-related musculoskeletal disorder (WRMSD). Different definitions of WRMSD exist, but they commonly refer to any musculoskeletal condition, either specific or unspecific, that is caused by work or work practices (Boocock et al., 2005). The commonness of MSD and the high risk of sickness absence, productivity loss and early exit from the workplace make it an important problem from both an individual and organizational perspective, as well as from the society. In dentists, the one-year prevalence of complaints was 65% for neck-shoulder complaints and 59% for low back pain in one study (Finsen et al., 1998). In another study, similar levels were found for point prevalence levels for at least one musculoskeletal complaint, 62%, with 30% reporting chronic complaints, 32% seeking medical care and 16% having spells of absence (Alexopoulos et al., 2004). Comparable numbers from another study suggest that the in the general population, the point prevalence of non-specific MSD was 26.4%, with 19.0% reporting reported chronic complaints (Huisstede et al., 2008).

In this thesis, the focus is on WRMSD that origins from the muscles in the back and leads to symptoms from the upper extremities (upper back, neck, shoulders, elbows and wrist-hands), upper extremity disorder (UED). The work-related character and aetiology of these problems has been acknowledged frequently (Buckle & Devereux, 2002). UED is particularly relevant for dentistry, given the specific demands in the physical work environment, including strenuous working positions and monotonous, fine-tuned movements. However, it is not only physical work environment that has been related to MSD. Mental stress and cognitive demands such as time pressure, repetitive tasks, lack of control, high demands and poor social support have been associated with increased muscle tension and a high prevalence of MSD, particularly in the upper extremities (Bongers et al., 1993; Bongers et al., 2002; U. Lundberg, 2002b; van den Heuvel, van der Beek, Blatter, Hoogendoorn, & Bongers, 2005). Interactions between high
physical and psychosocial demands seem particularly harmful (Devereux, Vlachonikolis, & Buckle, 2002).

The trapezius muscle, which is at the origin of many UEDs, seems to be particularly sensitive to emotional stimuli, which has been linked to their evolutionary role in emotional communication (e.g. shrugging of shoulders). Psychosocial stimuli may contribute to increased muscular tension. They may also affect breathing, causing hyperventilation which reduces blood CO$_2$-levels and leads to increased PH-levels, which in turn contribute to elevated muscular tension and enhanced sensitivity to sympathetic activity (Schleifer, Ley, & Spalding, 2002; Schleifer et al., 2008). Long-lasting mental and/or physical activity may also increase weariness in the first recruited muscle units, since this keeps these “Cinderella” units active continuously, causing fatigue (Hägg, 1991; Sjøgaard, Lundberg, & Kadefors, 2000). The experience of UED may also increase due to change in pain sensitivity, which is due partly to physical changes in the muscles (vicious circles in the muscle spiders) (H. Johansson & Sojka, 1991; Leeuw et al., 2007) and partly to increased pain awareness, pain catastrophizing and behavioural changes, including escape and avoidance-behaviours (H. Johansson & Sojka, 1991).

**Stress-related disorders**

Along with musculoskeletal disorders, other stress-related disorders are common in the municipal setting. High job strain (the combination of high demands and low influence) shows strong associations with sleep difficulties, tension prior to work, physical discomfort after a workday and physical and mental symptoms (Statistics Sweden, 2004). These associations have strengthened during the past decade (Statistics Sweden, 2004). Among employees in the human service sector, low possibilities for development, high meaning of work, low predictability, high quality of leadership, low role clarity, and high role conflicts have been found to predict burnout three years later (Borritz et al., 2005). 60% of women experiencing high strain at work reported a lack of sleep (Statistics Sweden, 2004). Moreover, among women, experiencing high demands is related to an increased risk for stress-related sickness absence, even when their influence is high (which is normally regarded as a better situation). This has been suggested to be particularly relevant in women working in human-service professions where emotional demands are high (Statistics Sweden, 2004).

**Disease, ill health and health**

When workplace health is studied empirically, it is often in terms of ill health, symptoms and disease, or a lack thereof. However, theoretically, it is
often pointed out that health is something more than mere absence of disease. This is in line with the 1946 definition of health from the World Health Organization (WHO), which states that health is not simply the absence of disease but rather a state of complete physical, mental and social well-being (World Health Organization [WHO], 1946). Put in another way, health has also been conceptualized as the ability to have and reach goals, meet personal needs and cope with everyday life (Raphael et al., 1999; Ryff & Keyes, 1995). Moreover, physical health has been described as referring to an individual’s ability to perform physical activities free of role limitations due to physical problems, bodily pain or general health status (Ware, Kosinski & Keller, 1996), whereas mental health and psychological well-being refers to an individual’s capacity to realize his or her own ability, cope with the normal stressors of life, work productively and fruitfully, and contribute to his or her community (Jahoda, 1958). Viru and Smirnova (1995) suggest that health may be defined as the resistance to pathogenic factors. They propose that, as a mechanism, resistance depends on the effectiveness of specific homeostatic regulations, asserting that being healthy equals being effective in adapting to change. In sum, although there is a general agreement that health should be considered as something more than simply the absence of disease or symptoms, practically, challenges associated with measuring health contribute to operationlizations of health that differ from the theoretical perspective, often focusing on a lack of symptoms or disease as an indicator of health improvements. This thesis follows the WHO definition of health, but due to the vast amount of previous research that equates health with a decrease in symptoms, it will sometimes appear in that context as well.

Stress
In this thesis, work conditions are understood within the framework of stress research and stress physiology. In previous research, the term stress has been used for several different aspects, including the stress stimuli, the stress experience, the stress-response and the experience of the stress response (Ursin & Eriksen, 2004). In the following text, the focus will be on the physiological stress response. However, it should be noted that this response takes place within individuals whose perceptions of the stress stimuli differs, as do their expectations on the possible outcomes of the stress response (H.R. Eriksen, Murison, Pensgaard, & Ursin, 2005). From this follows that although the stress response is generally considered to be universal, the level of the stress response may differ between individuals. These differences depend on the individual’s stimulus- and outcome expectancies. Hence, the stress response is dependent on both psychological and physiological factors.
The physiology of stress

Responding physiologically to variations in internal and external stimuli is an important ability (McEwen, 2000; Meaney, 2000). Evolutionarily, it has been necessary for survival in an ever-changing world. This kind of response is known as the stress response and includes changes in five interrelated bodily systems, namely the neural, cardiovascular, automatic, metabolic and immune systems (McEwen, 2008). The regulation of these systems ensures that the individual is well adapted to the environment by changing the internal milieu of various bodily organs and systems in accordance with changes in the demands placed on the body (Chrousos & Gold, 1992; McEwen, 2004). For example, the pressure the heart and blood vessels have to apply in order to provide oxygen to different parts of the body differs depending on body posture, oxygen consumption, etc. Hence, in order to function properly, our blood pressure must be allowed to vary: it is lower when we are at sleep or lying down, higher when we are sitting up and even higher when we are running. The same goes for variation in emotional and psychosocial stimuli. This process has been labelled allostasis, which means “stability through change” (McEwen & Seeman, 1999; McEwen & Stellar, 1993). In contrast to organs and systems that only tolerate small changes in a set value, e.g. body temperature or oxygen saturation, the systems involved in allostasis tolerate variation. In fact, it is through these variations that the homeostasis of other organs and systems can be ensured.

**SAM-system and the HPA-axis**

When a person is confronted with a stressor, changes in two neuroendocrine systems are of central importance for adaptation. These systems are the sympathetic adrenal-medullary (SAM) system and the hypothalamic-pituitary-adrenocortical (HPA) system (see for example U. Lundberg, 1999). The systems are activated in response to a variety of factors, including physical threats, e.g. an attacking lion, modern stressors like a computer shutdown or emotional and psychosocial stressors such as a heated argument, uncontrollability and social evaluation (Dickerson & Kemeny, 2004). In response to a stressor, the SAM, which includes both the sympathetic part of the autonomic nervous system (ANS) and the adrenal medullary system, is quickly activated (U. Lundberg, 2000). Catecholamines (adrenaline and noradrenaline) are released and contribute to increased heart rate, blood pressure, muscle tension, mental activity and total energy consumption (Chrousos & Gold, 1992; U. Lundberg, 2000). This alarm reaction calls upon the individual to act so that the stressor is dealt with and so that the extra activation of the system is no longer required. When this is achieved, the effects associated with activation of the sympathetic nervous system abate quickly, due to decreased activity in the sympathetic nervous system and the short half-life of catecholamines (Berne & Levy, 1993).
Concurrently, another part of ANS, working in an antagonistic fashion with the SNS, is activated: the parasympathetic nervous system (PSNS). This results in decreased heart rate, blood pressure and blood flow in the skeletal muscles (Lasley & McEwen, 2002). Meanwhile, the blood flow in the visceral muscles and in the abdomen is increased, as is the saliva secretion. In short, if the activation of SNS is necessary for survival in the presence of a stressor, the activation of PSNS ensures survival in the long run by allowing the focus of the body to be redirected from adapting to the outside world to taking care of the inside: facilitate metabolism, relieve tension, allow blood vessels to rest, etc. (Lasley & McEwen, 2002).

When the stress response is activated for more than a few minutes, the activation of the SAM system is accompanied by activity in the HPA-axis, which governs the release of cortisol (Berne & Levy, 1993). Two of the most important properties of cortisol are its immunosuppressant and energy mobilizing abilities (Tsigos & Chrousos, 2002). Cortisol helps replenish energy by increasing the levels/concentration of blood lipids and blood sugar in the bloodstream. This ensures that the bodily systems have sufficient access to energy, which is particularly important in the face of prolonged stressors, when energy consumption is high over a period of time. In comparison to the catecholamines, the physiological effects of cortisol have a slower onset, a longer time until they reach maximum effect and a much longer duration of maximum effect (Haynes, Gannon, Orimoto, O'Brien, & Brandt, 1991). Since it is also more responsive to the psychological and emotional qualities of the stressor (Dienstbier, 1989; Haynes et al., 1991), effects of the HPA axis are particularly relevant for many of the stressors of today. And again, although the short-term effects of the activation of the HPA axis are essential for survival, there are costs in the long run (U. Lundberg, 2005).

Allostatic load

In sum, human beings are remarkably well equipped to respond through changes within our bodily systems that allow us to adapt our internal milieu in accordance with the external environment. However, this adaptive ability comes at a cost: the processes that allow this place demands on our internal milieu (McEwen, 2008). If these demands appear and disappear, there do not seem to be any long-term negative effects (apart from those associated with aging). Between demands and the accompanying activation of the stress-related systems, other processes that restore and replenish the internal resources are activated. However, when the activation in the SAM system and the HPA axis is prolonged, these processes are hindered (Seeman, Singer, Rowe, Horwitz, & McEwen, 1997): the activation starts to wear on the organs involved. When wear is not adequately repaired, the result is a depletion of internal resources and increased damage to the processes and
organs involved (Seeman, Singer et al., 1997). This process is called Allostatic Load (AL) and shows how even an adaptive response may prove harmful if it is activated in excess or beyond the limits of the systems it depends on (McEwen & Stellar, 1993). Four situations when this may occur have been described (McEwen & Seeman, 1999): 1) Too much stress, e.g. too-frequent activation of the stress systems in response to exposure to repeated, novel stressors that do not allow the system to reach baseline for long enough periods; 2) lack of adaptation of the stress response to the repeated occurrence of the same stressor; 3) inability to shut off the stress response after the end of the stress exposure, for instance being unable to unwind in the evening after work; and 4) dysregulation of the involved systems, so that the function of one part negatively affects the other parts. In psychological terms, it has been suggested that situations characterized by uncontrollability and unpredictability are particularly likely to lead to sustained activation (Sapolsky, 2004). Drawing from learning theory, this has been described in terms of response outcome expectancy (H.R Eriksen, Olff, Murison, & Ursin, 1999). Both expecting the outcome to be negative no matter what is done, or completely lacking the ability to predict and influence the outcome, have been related to sustained, or tonic, activation (Ursin & Eriksen, 2004).

The consequences of these processes that are related to sustained activation typically involve the dysregulation of multiple bodily systems, and are characterized by biological responses deviating from the optimal range, or by increased difficulties in returning to baseline levels, or resting levels (McEwen & Seeman, 1999). The AL model also acknowledges that over one’s life course, the stress of dealing with everyday life and the stress places on the body by poor diet, smoking, lack of exercise, etc., may start to wear down the bodily systems involved (Glei, Goldman, Chuang, & Weinstein, 2007; McEwen, 2008; McEwen & Seeman, 1999). This increases the natural deterioration of the bodily systems associated with aging. This cumulative dysregulation may result in an allostatic load, which in turn, increases the risk for future ill health and disease (Seeman, McEwen, Rowe, & Singer, 2001). Hence, the AL model describes a mechanism by which the protective effects of the acute (short-term) stress response turn into the maladaptive, harmful effects of chronic or long-term stress. This means that the AL model may explain how daily stress relates to health and disease (Lasley & McEwen, 2002).

Recovery

In the AL model, the virtue of recovery is evident: processes activated during a stress response need to be counteracted during a time when no demands are being placed on the body. Recovery has been discussed in
relation to stress-induced arousal since the 1930s, when G.L. Freeman (1939) suggested that psychological recovery from experimental load was related to the ability to withstand conflict and was thereby important in psychiatry. The notion that quick recovery from stress-induced arousal was an important coping characteristic was supported by other researchers in the 60s and 70s (G. Johansson & Frankenheuser, 1973; Mason, 1968) and again in the 90s (Haynes et al., 1991; Linden, Earle, Gerin, & Christenfeld, 1997). Since then, scientific interest has slowly grown within multiple sub-disciplines: work and organizational psychology, sports psychology and experimental psychology.

Within work psychology, lack of recovery, or poor unwinding, has been suggested as a key factor in the increasing levels of stress-related ill health in the working population of industrialized countries (Frankenhaeuser et al., 1989; Sluiter et al., 1999; Sluiter et al., 2000; Sluiter et al., 2003). Not surprisingly given the AL model, lack of recovery from work has been related to high levels of psychosomatic complaints in both cross-sectional (Frankenhaeuser et al., 1989; Sluiter et al., 1999; Sluiter et al., 2000; Sluiter et al., 2003) and longitudinal research (Sluiter et al., 2003). A high need for recovery has also been linked to health factors such as long-term disease and poor general health status (Jansen, Kant, & van den Brandt, 2002) and increased sickness absence (de Croon, Sluiter, & Frings-Dresen, 2003; Sluiter et al., 2003).

Definitions of recovery

Despite a recently growing interest in the concept of recovery, no commonly agreed on definition exists. In its simplest form, recovery has been defined as “a poststress rest period that provides information about the degree to which the elevation (i.e. reactivity) in the physiological and psychological parameters being measured persists after the stressor has ended” (Linden et al., 1997). As such, recovery is defined in relation to the stress response, stress stimuli (stressors), various unspecific physiological and psychological parameters and within a given time frame (post-stress rest period). However, although this puts recovery in a context, multiple definitions of each of the concepts that recovery is related to exist. Within work psychology, A. Craig and Cooper (1992) defined recovery as “the timing and efficiency by which an individual is able to return to an adequate or pre-stressor level of functioning after the termination of a stressor”. Hence, they defined recovery in relation to the termination of the stress stimuli (the stressor) rather than in relation to the stress response, and without explicitly stating what “pre-stressor level of functioning” refers to. Again, both the time at which the process takes place (timing after a stressor) and the result of the process (efficiency in returning to a pre-stressor level of functioning) are incorporated in the definition.
Extending the work of A. Craig and Cooper (1992), Meijman & Mulder, (1998) described recovery in the effort-recovery model. The model describes how effort during work leads to load reactions that need to be reversed, so that the psychological, biological, and behavioural states can return to their pre-demand levels. Thereby, fatigue and other effects of stressful situations may be reduced. Hence, the effort-recovery model differs from the previous models by relating the recovery process to the experience of stress (effort during work) and the experience of the stress response (load reactions), rather than to the stress stimuli and the stress response. It also explicitly states that not only physiological but also psychological processes need to be considered. The effort-recovery model predicts that if this normal process of effort and recovery is interrupted, load may accumulate, resulting in ill health and reduced well-being.

In the definitions described above, recovery involves both a process of recovering or restoring health and strength after a stressor, and/or the result of that process, either absolute or relative to baseline or to the stressor (stress stimuli), the stress response or the stress experience. In this thesis, the operationalization of recovery focuses on relative recovery in relation to a stressor (a workday) and the latency to recover (whether one feels recovered after a specific time period) (see methodology). This is motivated by the limited information available on the characteristics of the process of recovery. The operationalization of recovery in this thesis also leaves to the participants to judge what it, in fact, means to be recovered. Hence, the operationalization includes recovery in relation to the experience of the stress response, since this is what the individual is aware of. This allows for a more holistic approach to recovery than merely viewing it as a physiological return to baseline.

Time frame (timing) of recovery

Following the definitions of recovery, the time course of the recovery process and the variables studied as outcome of recovery need to be considered. From this follows that empirically, an assumption about the time frame within which recovery needs to take place always needs to be made, in order to schedule measurements. However, the magnitude of this parameter – that is the time required for recovery to take place – is, with some important exceptions, seldom discussed explicitly (Sluiter et al., 2000). Besides being important in order to time the measurement correctly, the time frame of recovery may be important in order to understand differences in recovery between individuals, and possibly between different situations. If recovery from a stressful workday is twelve hours for one individual but 24 hours for another, the practical implications are huge. Differences may also arise within a given time frame. It is possible that two individuals are equally recovered eight hours after a stressor, but still differs in how and when this
recovery happened, that is, the slope of the recovery curve. For example, one might have done most recovery within the first few hours, while the other may have remained unrecovered until seven hours after the stressor, and then recovered completely in the last hour. These questions remain to be investigated.

The time frame of recovery is also important in relation to long-term ill health. It has frequently been acknowledged that when it comes to harmful effects, it is the long-term activation of the stress response that is important (e.g. “long-term stress”). Acute, short-lasting stress may even have a protective effect (McEwen, 2008). Distinguishing acute stress from long-term stress is therefore of great value. However, there is no clear evidence indicating when acute stress turns into the harmful effects associated with long-term stress. Put another way: we do not know when recovery needs to take place after a stressor, before harm has been done. It may also be relevant to distinguish between different kinds of “harmful effects”: while months of frequent or sustained stress activation may cause health problems, demanding work weeks that is followed by rest and recovery may not lead to bodily harm, but may still have adverse social effects or negative effects on quality of life. This issue, too, needs to be investigated.

Within work psychology, recovery from work has frequently been studied as an acute and short-term reaction to work, focusing on recuperation after one day of work (Jansen et al., 2002; Sluiter et al., 2003). Although there also are several studies investigating the effects of vacation on recovery (Etzion, 2003; Westman & Eden, 1997), few have simultaneously considered recovery after different time intervals. This is the approach taken in Studies II and IV in this thesis. The time intervals used are similar to those proposed by Sluiter and colleagues (2000), who defined four categories: reactivity (the time during a stressor/workday), mesorecovery (10-60 minutes after a stressor, e.g. a coffee break or a lunch break), metarecovery (recovery between workdays) and macrorecovery (recovery after a weekend off work).

Fatigue and recovery

Fatigue is a concept that is closely related to recovery from work. It may be described as part of a continuum stretching from tiredness to exhaustion, with fatigue being placed in the middle of these two (Kenttä & Svensson, 2008). As such, the continuum stretches from a neutral or even pleasant sensation to an unpleasant, troubling experience. Tiredness, or acute fatigue, has been described as task-specific and reversible, in that it can be managed and reversed by switching activity or by resting, while long-term fatigue is more resistant to change and less sensitive to the ordinary recovery strategies (Beurskens et al., 2000). In occupational psychology, the focus has been on fatigue as an unpleasant, unwanted experience related to high work-related
effort, high work-family interference and health complaints (van Hooff, Geurts, Kompier, & Taris, 2007). Also, the extreme version of fatigue, e.g. exhaustion, is one of the core dimensions of burnout (Borritz et al., 2006).

In relation to fatigue, recovery may be considered as the other end of the fatigue continuum, stretching from recovered to feeling refreshed and alert. However, in relation to recovery, fatigue could also be described either as a reaction to a stressor (in the context of work stress, short-term fatigue is often translated into fatigue during and after a workday) or, if the time frame is longer, a consequence of lack of recovery. This is equal to the distinction between the acute and long-term fatigue described previously (Beurskens et al., 2000). From this follows that the relationship between recovery and fatigue may vary according to the time frame of the study. With shorter time frames (minutes or hours) fatigue will most likely be a reaction to stress, and precede recovery. With wider time frames (weeks, months or even years), which is more common within work and organizational psychology, the relationship between fatigue and recovery is likely to be reciprocal since lack of recovery, in the long run, is likely to increase fatigue (Sluiter et al., 2003).

Irrespective of how the relationship between fatigue and recovery is defined, it seems reasonable to separate fatigue from recovery in the measurement of recovery. Empirical support for separating fatigue and recovery can be found in a previous study (Jansen et al., 2002). To investigate the validity of self-ratings of recovery, items measuring recovery, fatigue, and psychological distress were subjected to principal component analyses (using the Need for Recovery Scale, the Checklist Individual Strength (CIS), and the General Health Questionnaire (GHQ-12)) (Jansen et al., 2002). The results suggest that self-rated recovery, fatigue, and psychological distress are distinct, although related, concepts (Jansen et al., 2002). A parallel to this can be found in research that suggests that recovery and stress reactivity is different rather than opposing constructs, since factors that affect recovery not necessarily affect stress reactivity. For example, research comparing individuals who differ in physical fitness has shown that difference in speed of recovery after a stressor serves as a more relevant distinction than does difference in reactivity to the stressor (Haynes et al., 1991). Hence, recovery is not merely another way of tapping stress reactivity, and it may be reasonable to separate recovery from fatigue in measurements of recovery. However, despite this and despite that fatigue seldom is part of the theoretical definitions of recovery, previously, fatigue have often been included in measurements (self-ratings) of recovery (Aronsson, Svensson, & Gustafsson, 2003; Jansen et al., 2002; Sluiter et al., 2003; van Veldhoven & Broersen, 2003).
Recovery from work stress

As precursors of the need for recovery from work, the emphasis has been on characteristics of the work situation. Both quantitative aspects of work such as number of hours worked (Jansen, Kant, van Amelsvoort, Nijhuis, & van den Brandt, 2003; Jansen, van Amelsvoort, Kristensen, van den Brandt, & Kant, 2003) and qualitative aspects such as mental and physical demands and lack of decision latitude have been suggested as affecting the need for recovery (Sluiter et al., 2003). However, non-work activities may also influence recovery from work. For example, work-related activities during off-job time have been shown to delay recovery (Sonnentag & Zijlstra, 2006). A number of studies have shown that for women, an interaction between conditions at work and conditions at home may also contribute to stress (U. Lundberg & Frankenhaeuser, 1999; Nordenmark, 2004). Since recovery from work requires the absence of new stressors, factors associated with the time off may be as important as the characteristics of the work situation for the process of recovery from work. For example, among women, being in an unhappy marriage has been related to poor recovery (Saxbe, Repetti, & Nishina, 2008). Hence, domestic, individual and social factors such as marital status, total workload and work-home conflict may influence the time, ability and opportunity available for the individual to return to the pre-stressor level, thereby modifying the need for recovery.

Non-work hours may involve many different activities and processes, some of which may hinder recovery and some of which may promote recovery. Recovery is often described as requiring rest or at least a lack of stimulation, but frequently, active non-work activities such as exercise as well as creative and social activities have been found to promote recovery (Rook & Zijlstra, 2006; Sonnentag, 2001; Winwood, Bakker, & Winefield, 2007). Consequently, active non-work activities may be more effective in promoting recovery than passive activities, like watching TV. From this follows that it is not only the preceding stress level and the time allocated for recovery that are of importance in determining the recovery process, but also what activities take place.

Perseverative cognitions

It is not only the type of non-work activity, which is a behavioural factor, which affects recovery. Mental activity, without apparent exertions, may also contribute to the total load and impede recovery. According to the perseverative cognition hypothesis, prolonged activation of the stress systems is often caused by perseverative cognitions (Brosschot, Gerin, & Thayer, 2006; Brosschot, Pieper, & Thayer, 2005). These are defined as active cognitive representations of stressors that are prolonged and
manifested in phenomena such as worry, rumination and anticipatory stress. Despite some difference between these concepts, such as worry typically being associated with anxiety about future events, and rumination being associated with depression over past events (Papageorgiou & Wells, 1999), they share some important features. These include the experience of having repetitive, intrusive, negative cognitions (Papageorgiou & Siegle, 2003; Segerstrom, Tsao, Alden, & Craske, 2000).

Perseverative cognitions may lead to prolonged activation of the cardiovascular, endocrinological, immunological and neurovisceral systems (Brosschot et al., 2006; Brosschot et al., 2005). For example, worry has been shown to increase automatic activation (increased heart rate and decreased heart rate variability) (Brosschot, van Dijk, & Thayer, 2007). Among women, but not men, worry has also been related to increased morning levels of cortisol (Gustafsson, Lindfors, Aronsson, & Lundberg, 2008). This prolonged activation may be a mechanism by which perseverative cognitions prevent recovery from work (Pravettoni, Cropley, Leotta, & Bagnara, 2007).

A related hypothesis has been proposed by Sonnentag and Bayer (2005), who concluded that the ability to detach from work is important in order to recover from work stress. Lack of detachment has been related to high negative activation and fatigue the next morning (Sonnentag, Binnewies, & Mojza, 2008). In line with this, rumination, particularly among individuals experiencing high-strain work, has been related to poor unwinding after work (Cropley & Purvis, 2003). Other studies, focusing on mental activity and recovery in terms of sleep, have shown that being unable to stop thinking about work is related to poor sleep (Cropley, Dijk, & Stanley, 2006) and that this may be a stronger predictor of disturbed sleep than high job demands are (Åkerstedt et al., 2002). Anticipatory stress, that is worrying about the next day, has also been related to disturbed sleep, in terms of distorted physiological sleep patterns and subjectively poor sleep (Kecklund & Åkerstedt, 2004).

Overcommitment (OC) is described as a motivational pattern characterized by excessive work-related commitment and a high need for approval (Siegrist et al., 2004). The core construct in OC is inability to withdraw from work obligations. As such, OC may be interpreted as perseverative cognitions, but within a specific context (i.e., work). Consequently, OC has also been associated with a number of physiological factors that may be related to an increased physiological activation, such as higher basal sympathetic activation (Vrijkotte, van Doornen, & de Geus, 2004), lower noradrenaline stress reactivity (Wirtz, Siegrist, Rimmele, & Ehler, 2008) and factors that may increase risk for cardiovascular disease such as an impaired fibrinolytic system (Vrijkotte, et al. van Doornen, & de Geus, 1999). OC has also been related to vital exhaustion (Preckel, von Kanel, Kudielka, & Fischer, 2005). However, the direct relationship between
OC and recovery has not been investigated. In addition, most research on OC has been restricted to men (Steptoe, Siegrist, Kirschbaum, & Marmot, 2004), and when both men and women have been studied, the relationships between OC and recovery-related measures have differed between the two groups. Generally, associations between OC and factors such as poor sleep quality and signs of sustained physiological activation has been found among men but not among women (Eller, Netterstrøm, & Hansen, 2006; Kudielka, von Känel, Gander, & Fischer, 2004; Steptoe et al., 2004). This is somewhat surprising, given that women often report more worry and rumination than do men (Butler & Nolen-Hoeckema, 1994; Nolen-Hoeckema, Larson, & Grayson, 1999; Robichaud, Dugas, & Conway, 2003). The relationships between OC and recovery and fatigue among women are investigated in Study III.

Interventions in the workplace

Considering how much of the waking time humans spend at work, factors associated with the workplace may have powerful effects on individual function and health. Interventions in the workplace can be placed into three categories: promotion, prevention and rehabilitation. These categories are roughly equivalent to primary, secondary and tertiary prevention, respectively. Rehabilitation and tertiary prevention are activities that are initiated in response to a disease or problem that is already present, in order to rehabilitate or prevent its worsening (Quick, 1999a). This makes these interventions after-the-fact. Secondary prevention refers to interventions that aim at preventing disease from evolving from early symptoms, while primary prevention means preventing illness or disease before any symptoms are present, that is, focusing on health risk factors and/or occupational demands (Quick, 1999a). Both these perspectives are covered in the prevention category in the first list. Sometimes, but not always, primary prevention is said to include health promotion, that is activities that are not focused on decreasing problems or disease but on increasing health (Quick, 1999b; Tetrick & Quick, 2003). WHO defines health promotion as “the process of enabling people to increase control over, and to improve, their health” (WHO, 1986). In this thesis, the focus is on primary prevention and health promotion, and, to some extent, on secondary prevention. Distinguishing between these is often difficult in workplace interventions, as all employees, both those at risk and those not at risk, are targeted (Tetrick & Quick, 2003). The focus in this thesis on an occupational field with high prevalence of UED and stress-related illnesses suggests that the interventions investigated in Study II should be considered secondary. However, since the employees are still at work and may be considered part of a healthy population, and since not all of them report symptoms, the interventions may
be considered primary prevention or health promotion. Rehabilitation or tertiary prevention is not discussed in this thesis.

When the context of health promotion is the workplace, workplace health promotion (WHP) has been defined as the combined efforts of employers, employees and society to improve the health and well-being of people at work (European Network for Workplace Health Promotion, 2005). This includes improvements in the work organization and working environment, promoting employees’ participation in health activities and encouraging personal development. WHP has been described as mutually beneficial to employers and employees: while employees may improve their health, job satisfaction (Parks & Steelman, 2008) and motivation at work, employers benefit from this through a reduction of sickness absence and sickness absence-related costs (Aldana, Merrill, Price, Hardy, & Hager, 2005; Golaszewski, 2001; Parks & Steelman, 2008), a higher quality of products and services, more innovation and a rise in productivity (Goetzel & Ozminkowski, 2008; Mills, Kessler, Cooper, & Sullivan, 2007). Focusing on WHP may also be a prestige factor that improves goodwill and makes the organization more attractive as an employer (European Network for Workplace Health Promotion, 2005).

WHP can take one or both of at least two perspectives on employee health. From one perspective, health can be regarded as influenced mainly by individual factors. From the other, health is considered multifactorial, influenced by both individual factors and by the workplace (and society). In the first perspective, WHP mainly includes health initiatives targeting the individual, e.g. smoking, physical activity or diets. Using the workplace as an arena for reaching adults with these kinds of health initiatives have been suggested to have a number of advantages (Ilgen, 1990) including reaching a greater number of individuals compared to individual-based settings (Drach-Zahavy, 2008). They also have the advantage of utilizing social support for recommended changes (Bamberger & Sonnenstuhl, 1996) and have a greater opportunity of providing cues and reinforcement that help maintain behaviour change, e.g. make relapse less likely (Hays, Hays, DeVille, & Mulhall, 2000). In the second multifactorial perspective, the focus is more often on factors in the workplace, such as job design, stress management, ergonomics, etc. This places this perspective close to the notion of healthy organizations, in which organizational factors associated with increased employee health are identified and strengthened (Semmer, 2003; Wilson, DeJoy, Vandenberg, Richardson, & McGrath, 2004).

The worksite as an arena for health promotion has also been criticized, since WHP often targets a selected group of already healthy, highly educated white-collar workers, predominantly men, within large organizations in Western countries (Dishman, Oldenburg, O'Neal, & Shephard, 1998; Janer, Sala, & Kogevinas, 2002; Shephard, 1996). From a public health perspective, other groups may gain more from health promotion initiatives.
Physical activity interventions

One of the most common focuses of WHP is physical activity (PA). Getting people to engage in physical activity has long been considered a public health interest, given that low levels of PA have been related to several common disorders, including heart disease (2.0 increased risk for individuals with low levels of PA), hypertension (1.5), type II diabetes (1.5), osteoporosis and related factors (2.0), colon cancer (2.0) (Colditz, 1999), depression (1.3) (Stephenson, Bauman, Armstrong, Smith, & Bellew, 2000) and breast cancer (1.4-1.7) (Friedenreich, 2001). Despite these risks, many individuals in Western society are physically inactive. In 2007, 34% of men and 38% of women in Sweden failed to meet the general guidelines for physical activity, which correspond to 30 minutes a day of moderate intensive activity (Statens folkhälsoinstitut [Swedish National Institute of Public Health], 2008).

Definitions of Physical activity and physical exercise

Often, PA of low to moderate intensity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure, while planned, structured and repetitive bodily movement with the goal of enhancing or sustaining physical capacity is denoted as physical exercise (PE) (Caspersen, Powell, & Christenson, 1985; Pate et al., 1995). PA and PE may also be distinguished by differences in intensity levels. Moderate-intensity PA is generally equivalent to a brisk walk and noticeably accelerated heart rate, while PE involves exercise of greater intensity, over 60 or 70% of maximal oxygen uptake, and causing rapid breathing and a substantial increase in heart rate, for example jogging (Physical Activity and Public Health, 2007). In this thesis, when the term PA is used alone, it refers to physical activities of all intensities. When a distinction is made between PA and PE, PA refers to physical activity of low to moderate intensity while PE refers to planned physical activity of moderate to high intensity. According to the American College of Sports Medicine (ACSM), both PA and PE are appropriate in meeting the guidelines for PA (Physical Activity and Public Health, 2007). However, while both moderate and vigorous activities involves aerobic activity, that is, engage large muscular groups in dynamic muscular activity that affects the circulatory and metabolic systems, only activities of higher intensity (>70%) have effects on cardiovascular capacity, while activities of lower intensity (<70%) have effects on periphery circulation and muscular endurance (American College of Sports Medicine Position Stand, 1998; Kraemer et al., 2002).

Recommended levels of PA

ACSM suggest that a minimum of 30 minutes of moderate daily PA five days a week, or vigorous-intensity aerobic physical activity for a minimum
of 20 min on three days a week, is sufficient to avoid problems related to a sedentary life style, and to gain health effects (Pate et al., 1995). These recommendations are based on total physical activity being a function of frequency, intensity and duration of each bout of activity. From this follows that shorter bouts of vigorous activity give health effects equal to those from longer bouts of moderate-intensity activity. This can be illustrated using metabolic equivalent (MET), which estimates energy expenditure during PA: jogging (8 METs) for 12 minutes equals walking (3.3 METs) for 29 minutes (8 x 12 and 3.3 x 29 both equals 96 METs/min) (Physical Activity and Public Health, 2007).

Concurrent with recommendations for physical activity, the need to decrease time spent on sedentary behaviour has also been discussed. Sedentary behaviour is commonly defined as being static and is associated with sitting, watching TV, working in front of a computer and travelling by car, equalling 1-1.5 METs (Clark et al., 2008; Owen, Leslie, Salmon, & Fotheringham, 2000). Recent research suggest that the combination of high levels of sedentary behaviour such as watching TV and low levels of physical activity may be particularly harmful (Sugiyama, Healy, Dunstan, Salmon, & Owen, 2008). Importantly, those meeting the guidelines for physical activity but spending much time in sedentary behaviours and those not meeting the guidelines but spending less time in sedentary behaviours have been shown to have a similar risk of being overweight or obese (Sugiyama et al., 2008). Therefore, reducing sedentary behaviours may be as important as increasing physical activity.

**PA in the stress-recovery relationship**

From a public health perspective, initiatives to increase PA in the population is motivated given the solid epidemiological evidence for lack of PA being important in the development of many of the most common diseases. However, PA is also relevant from a stress-recovery perspective. While acute effects of PE involves activating many of the same physiological systems as in the stress responses, repeated PE leads to a physiological and behaviour adaptation, so that the same load requires less response and becomes associated with more positive affect (Anshel, 1996; Salmon, 2001; van Doornen & de Geus, 1989). This means that a physical fit individual shows an attenuated reactivity to stressors compared to an unfit individual. This adaptation has also been shown to generalize to psychosocial stressors (Forcier et al., 2006; Salmon, 2001). Also, PE has also been related to speedier recovery after a stressor (Chafin, Christenfeld, & Gerin, 2008; Traustadottir, Bosch, Cantu, & Matt, 2004). Hence, PE may decrease the physiological burden on stress both by attenuating the reactivity and by decreasing the time it takes to recover. Moreover, it has been suggested that PA is related to increased general adaptability and more
effective homeostatic regulation, thereby increasing the individual’s resistance to pathogenic factors (Viru & Smirnova, 1995).

On the psychological level, being fit has been related to increased psychological resources, including boosting self-esteem and increasing social support, which in turn leads to less distress (Ensel & Lin, 2004). PE has also acute effects on mood, both enhancing positive mood and alleviation of negative mood in the three-four hours following a training session (Yeung, 1996). This may be particularly important in relation to effects of WHP PA, since this means that some of the acute effect on mood may take place while still at the workplace.

**Effects of WHP PA**

There is a general agreement that PA is health-promotive (Marcus et al., 2006). In the following section, the focus is on effects of PA and/or PE interventions conducted at the worksite. First, PA interventions have been shown to be effective in increasing levels of physical activity (Titze, Martin, Seiler, Stronegger, & Marti, 2001), despite problems with self-selection of already physically active individuals. It has also been related to increased physical fitness, improved perceived health status and prevention of early decline of work ability (Pohjonen & Ranta, 2001). Moreover, PA interventions have been related to a reduced risk of developing MSD (Proper, Koning, et al., 2003) and decreased headache and neck pain (Sjögren et al., 2005). PA has also been related to increased levels of subjective physical well-being (H.R Eriksen et al., 2002; Sjogren et al., 2006). Also, effects on total energy expenditure, cardiorespiratory fitness, percentage of body fat and blood cholesterol have been reported (Proper, Hildebrandt, van der Beek, Twisk, & van Mechelen, 2003). Hence, WHP PA has been related to both physiological and psychological effects. However, reviews and meta-analyses present inconclusive findings regarding effects of worksite physical activity interventions (Marcus et al., 2006). For instance, effect sizes for worksite physical activity interventions have been small (mean r = 0.11) (Dishman et al., 1998; Wilson, Holman, & Hammock, 1996). These results have been explained with reference to the poor quality of the research in the field (Dishman et al., 1998; Wilson et al., 1996) but it may also be argued that small effect sizes are to be expected in studies when the outcome is physical and/or mental health, since there are many possible determinants of these outcomes. From this follows that the variance explained by each factor (such as physical exercise) is small (Zapf, Dormann, & Frese, 1996).

One frequent problem in worksite physical activity interventions involves low participation rates and self-selection of participants (Alexy, 1991). Frequently, participation rates in worksite fitness programs range from 15% to 30% for white-collar workers (Conrad, 1987). With some important
exceptions (H.R Eriksen et al., 2002; Pohjonen & Ranta, 2001), participation levels may be even lower among blue-collar workers (Marshall, 2004). Moreover, participators are often younger, more educated, more physically fit and healthier than non-participators prior to the intervention (Alexy, 1991; Conrad, 1987; Marshall, 2004).

**Strategies for WHP PA**

There are a number of different strategies for implementing PA in the workplace. Two main categories of WHP are individual-change centred or environment- or ecological-centred interventions, hence differing in how much they utilize the workplace as such as an instrument to initiate or maintain change. Individual-change interventions are by far the most common, while few environment intervention studies have been conducted (Yancey et al., 2004). In individual-change interventions, strategies include health checkups, educational programs or workplace exercise programs, or a combination thereof (Marshall, 2004). The most common strategy in ecological or environmental interventions (the words are used interchangeably) is providing motivational prompts to be more active (including posting signs and creating walking trails) (Yancey et al., 2004), although strategies utilizing existing social structures for support (Campbell et al., 2002; W. S. Cohen, 1985) and incentive-based programs (W. S. Cohen, 1985; Marshall, 2004) have also been investigated. Apart from this, attempts to integrate PA into the workday have been made, including providing time for PA during the workday. These initiatives have proved promising, in both attracting employees and reaching higher participation levels than otherwise, and in terms of results on employee health (H. R. Eriksen et al., 2002; Pohjonen & Ranta, 2001; Yancey et al., 2004). Since women are particularly likely to motivate lack of physical activity with time constraints (Tavares & Plotnikoff, 2008), this strategy may be particularly promising in this group.

**Reduced working hours**

In the Nordic countries, the demands of working life within municipal services have contributed to that several WHP initiatives involving reduced working hours (RWH) have been carried out (Åkerstedt, Olsson, Ingre, Holmgren, & Kecklund, 2001; Anttila, Nätti, & Väisänen, 2005; Brynja, & Bildt, 2005; Malmberg, Hansson, & Byrgren, 2003; Wergeland et al., 2003). In contrast to various types of part-time work, work-time arrangements involving RWH mean that employees work fewer hours but still retain their full-time salaries. Often, additional employees are recruited by the organization to provide full time services (Brynja & Bildt, 2005; Malmberg et al., 2003). RWH often differs from part-time work in that it involves a systematic change in work hours, and that it includes all employees at a
workplace. The motives for RWH and part-time work also differ: while RWH is motivated from a health perspective, part-time work may be motivated by either economic or scheduling motives of the employer or by employee considerations such as own illness, caring for children or other personal responsibilities, studies, etc. (Statistics Sweden, 2005).

The mechanism for how RWHs can promote health is still unclear. One obvious reason RWH is assumed to promote health is that by spending fewer hours at work, one’s exposure to different risk factors in the work environment decreases. From a whole-life perspective, RWH may also have other effects. By reducing time spent on paid work, the total workload (paid and unpaid work) may decrease, thereby reducing stress. RWH may also help combine different life domains (e.g. work and family life), thereby reducing work-family interference and role ambiguity. Moreover, RWH may allow more time for non-work activities that promotes health, for example increase time for recovery and time spent on leisure activities such as physical activity (Åkerstedt et al., 2001; Anttila et al., 2005; Brynja & Bildt, 2005; Malmberg et al., 2003). In sum, this assumes that the RWH is replaced by activities that are more health-promotive than work is.

As described in the background, there is support for work having positive effects on health. So, working fewer hours may not only decrease exposure to potential health hazards but may also reduce the potentially positive effects of work. This means that the health benefits of not being exposed to risk factors may be counteracted by reduced time for social interaction and other positive factors at work. Moreover, it remains to be investigated if an eight-hour workday, or a 40-hour work week, is associated with increased health risks compared to a shorter workday or work week (Spurgeon, Harrington, & Cooper, 1997). In fact, research has shown that not even extended work hours (12-hour shifts or 48-hour work weeks) are necessarily harmful or affect performance negatively (Smith, Folkard, Tucker, & Macdonald, 1998; Tucker & Rutherford, 2005).

One of the most common types of RWH involves a reduction in working hours from eight to six hours a day or from 40 hours to 30 hours a week. This kind of RWH has been related to positive social effects and decreased work-family conflict, particularly in employees with children (Åkerstedt et al., 2001; Anttila et al., 2005). Apart from positive social effects of the six-hour workday, the potential health-related benefits of RWH remain unclear, although there is some support for RWH in relation to a reduction of pain in the neck/shoulder area in employees within the public sector (Bildt, 2007; Wergeland et al., 2003). Also, decreased stress levels have been reported in one study (Bildt, 2007). Apart from this, evaluations of different types of RWH have produced only minor effects on other health-related outcomes, such as fatigue, disturbed sleep and physiological factors (Åkerstedt et al., 2001; Bildt, 2007; Brynja & Bildt, 2005).
With few exceptions (Åkerstedt et al., 2001; Anttila et al., 2005), evaluations of health-related effects of RWH often suffer from methodological shortcomings (Brynja & Bildt, 2005; Malmberg et al., 2003). For instance, systematic longitudinal research with measurements before, during and after the implementation of RWH have been scarce, referents have seldom been included, and, often, existing studies lack adequate measures reflecting different aspects of health. Also, it remains unclear whether the effects of RWH are direct or mediated via psychosocial factors, which follows from the lack of theoretical understanding of various health-related effects of RWH.

**Aim of the thesis**

The main aim of this thesis was to investigate different aspects of health and ill health in relation to recovery from work among women in the public health care sector with physically and emotionally demanding jobs. There is a specific focus on how efforts associated with work need to be balanced with recovery during the time off work in order to prevent ill health and promote health. This thesis includes a descriptive study of UED in dentistry, a study on intervention and an investigation of how recovery from work is related to psychosocial factors and physiological processes. More specifically, the following specific research questions were asked:

- How are musculoskeletal disorders in the upper extremities (neck, shoulders, arms, elbows, wrists, hands or fingers) (UED) related to other health problems and physical and psychosocial work characteristics in a workplace meeting modern ergonomic standards (Study I)?
- Are there any health-related effects of two worksite interventions, physical exercise (PE) and reduced working hours (RWH) (Study II)?
- How are job demands, job control and social support at work and overcommitment related to fatigue and next-day recovery (Study III)?
- How is self-rated recovery from work stress related to biological dysregulation in terms of allostatic load (Study IV)?
Method

Design of the studies

This thesis is based on four studies ranging from 1) a descriptive study relating poor work conditions to UED and 2) an intervention study of the health-related effects of reduced working hours and physical exercise during work, to two studies focusing on recovery from work: 3) how overcommitment to work interfere with the recovery process and 4) the relationship between fatigue and lack of recovery and a cumulative biological load. Different statistical methods were used for these studies, as well as partly different data sets. Data for Studies II-IV were gathered using the same protocol, while a completely different data set was used in Study I. In the next section, the design of each study is presented and afterward follows a description of the central concepts in this thesis and how they were measured. A description of the data sets can be found in the beginning of the Summary of empirical studies section.

Study I is a descriptive study of the work conditions in dentistry in relation to UED. The study was set among female employees of a large public dental health care organization consisting of 48 workplaces. Data were drawn from a pre-existing sample gathered as part of a general work environment assessment. The women were categorized into two groups, those with and those without UED. All items measuring psychosocial work characteristics were subjected to a principal component analysis (PCA) before further analysis. The main analyses were performed using MANOVAs and a hierarchical multiple regression analysis.

From the 48 workplaces that were part of the organization participating in Study I, six were selected by the employer to participate in an intervention project studying the effects of reduced working hours (RWH) and physical exercise (PE) on health. The results from this intervention are presented in Study II. The inclusion criteria for the workplaces were a) having at least 25 employees b) being economically sound and c) having local management and a majority of employees consenting to participate. Moreover, three of the selected workplaces had high short-term sickness absence (that is, counting all sickness absence with a duration of 21 days or less) and three had low short-term sickness absence. Workplaces with high and low sickness absence were then matched into pairs based on number of employees and the three pairs were randomized into one of the three
conditions (RWH, PE or a reference group). This means that randomization was done on the organizational level rather than the individual level. Having a cluster of individuals randomly allocated to intervention groups rather than each individual is the principle behind cluster randomization, which is a common method within research areas where individual randomization is often practically impossible and intervention is naturally applied to the cluster level (e.g. a workplaces, a doctors office, a classroom, etc.) (Jo, Asparouhov, Muthen, Ialongo, & Brown, 2008). In Study II, one matched pair of workplaces was randomized to each condition. To minimize risk of pre-intervention differences between clusters influencing the result, as well as non-intervention-related changes that may affect one cluster but not the other, a number of measures were taken: only workplaces belonging to the same organization within the same work field took part, all workplaces had at least 25 employees, and the workplaces were matched into pairs based on sickness absence. Thus, correlations within and between clusters were designed to be as similar as possible.

The design of Study II was longitudinal, including a reference group and repeated measures over time. More specifically, data including both self-ratings and physiological measures were gathered before the start of the intervention (T1), after six month (T2) and after 12 months (T3). Data were analysed using individuals as unit of analysis. To examine the effects of the interventions on outcome measures, interaction and overall time effects were tested using repeated measures analyses of variance (ANOVAs), considering all three time points for self-ratings and two time points (T1 and T3) for the physiological measures. Significant main effects of time and interaction effects were followed by separate repeated measures ANOVAs for the three groups, with time of measurement as a within-subjects factor. From this follows that for each interaction effect or main effect, each group was studied individually.

Study III was also of a longitudinal design, using the same data set as Study II but utilizing data only from T2 and T3 (obtained six months apart) and only self-ratings. The predictive value of job demands, job control and social support, and overcommitment to work, on poor next-day recovery and fatigue six months later, respectively, was analysed using hierarchical multivariate regression analyses. In contrast to the automated stepwise regression procedure, this approach is guided by theory or logic, meaning that the researcher controls the analysis (Babyak, 2004; Tabachnick & Fidell, 2007). In the first block, occupation and having children at home were entered as predictors. Job demands, job control and social support was entered in the second block, followed by OC in the third block. In the fourth block, next-day recovery was entered as a predictor of fatigue six months later, and fatigue was entered as a predictor of next-day recovery.

In Study IV, the design was cross-sectional. The data set was partly the same as in Studies II, but also included employees from another part of the
public health care sector (elderly care). Data from both self-ratings and a health checkup from T1 were utilized. The data were analysed using a person-oriented approach (cluster analysis) before being subjected to variable-oriented analyses (logistic regression analyses, MANOVA and MANCOVA). In contrast to variable-oriented approaches, in which continuous variables in terms of means and variance are related to other variables, a person-oriented approach allows assessment of differences in the participating individuals’ configuration of responses to items of a factor (Bergman, El-Khoury, & Magnusson, 2003). This means that instead of looking at a group of individuals based on their total sum on an index or their mean on a scale, their pattern of response on the scale is in focus (Bergman et al., 2003). Individuals with similar response patterns are grouped together, leading to the emergence of subgroups. These subgroups are interpreted as mirroring underlying common categories, or types, with typical characteristics.

Measuring health and ill health

In this thesis, health and ill health among women working in public health care are in focus. However, the scientific study of health is complicated by the variety of definitions and operationalizations of health that exist (Marks, 2000). Frequently, it is argued that health should be considered a separate concept and not simply the opposite to disease/ill health (Sarafino, 2002). Following this line of thought, health may include aspects such as the subjective experience of health, well-being, positive functioning or coping abilities. Practically, however, health has often been defined in line with the biomedical model, by the absence of disease or lack of symptoms (Mellner, 2004).

In Study II, health is an essential concept since the study concerns the effect of RWH and PE on many aspects of functioning. The importance of assessing health as something more than a lack of symptoms and disease was particularly important since previous interventions studies of reduced working hours have suggested that the effect may be found in outcomes related to subjective aspects of well-being and functioning rather than in the prevention of ill health (Åkerstedt et al., 2001; Anttila et al., 2005). It was also important since the intervention was set among a working population. This may be considered a healthy population per se, thereby reducing the variance in symptoms and ill health and providing a ceiling effect of improvements in these areas. To account for the variation in the many aspects of these concepts, in Study II, health and ill health were measured in several ways (see below). In Studies II and IV, both self-ratings and biological markers were used. Using data from both self-ratings and biological markers allows for triangulation of the data (Breitmayer, Ayres, &
Knafl, 1993). This means using different methods to study the same phenomena, thereby cross-validating the results against each other for confirmation. This increases the reliability of the studies. When different kinds of data point in the same direction, the risk of misinterpretation of the data is reduced. Also, the use of different kinds of data may provide a fuller picture of the phenomena under study (Breitmayer et al., 1993).

Physiological parameters

In Studies II and IV, physiological measures of health and ill health were part of the assessment, along with self-ratings. Physiological measures are often regarded as more objective than self-rated ones (Åkerstedt & Theorell, 2002). They are also important in providing information on possible pathways between work conditions and health, ill health and symptoms. Many physiological markers may also act as early warning signs of illness or disease that are yet not perceivable or diagnosable (Gruenewald, Seeman, Ryff, Karlamangla, & Singer, 2006). A disadvantage is that many biological markers show seasonal and circadian, particularly diurnal, variability, which needs to be considered in the planning of the studies (Garde, Hansen, Skovgaard, & Christensen, 2000; Imai et al., 1996; Ockene et al., 2004; van Anders, Hampson, & Watson, 2006). Besides being sensitive to when the measurements are taken, they are also sensitive to how they are taken. To account for this in this thesis, health checkups followed a standardized protocol. This involved sampling of blood followed by measurements of waist-hip ratio (WHR) and measurements of blood pressure and heart rate (supine position), repeated three times with five minutes of rest in between. An average of the two last recordings was used in analyses. Blood samples were collected between 7:30 and 10 a.m. and participants were instructed to refrain from eating for 12 hours prior to the checkup. In addition, they were asked to rise at least two hours before the checkup and, in the meantime, refrain from consuming coffee and nicotine and to avoid intense mental or physical activity. Moreover, in Study II which was a longitudinal study, only data collected during the same season were used in the analyses. This was done because seasonal variation is particularly pronounced in countries such as Sweden, which is located far from the equator and subjected to large variations in temperature and sunlight (Al-Tamer, Al-Hayali, & Al-Ramadhan, 2008).

In this thesis, both markers that are related to known risk factors (such as high blood pressure, high levels of blood lipids and blood sugar, etc.) and markers related to the stress and recovery processes (e.g. prolactin and DHEAS) are included. These are described below.
Cardiovascular measures

Blood pressure and heart rate were assessed as markers of the function in the cardiovascular system. Blood pressure reaches its highest levels when the heart is contracting: this is the systolic blood pressure (SBP). When the heart relaxes, the blood pressure reaches its lowest level, which is known as the diastolic blood pressure (DBP). The magnitude of the blood pressure depends on how forceful the heart contracts and on the resistance in the vessels of the body. Blood pressure varies depending on activity. For example, standing up requires higher pressure than sitting down, and running requires higher pressure than walking. Prolonged exposure to high blood pressure, which may result from heritage factors, overweight, stress or poor health habits, may lead to increased blood pressure at rest, called chronic hypertension. In this thesis, blood pressure was measured at rest, when blood pressure is at its lowest.

Blood lipids

As part of everyday life, energy is mobilized by transporting blood lipids such as cholesterol and triglycerides to the muscles. Cholesterol is also needed in order to build cells, insulate around nerve cells and to produce sex hormones like testosterone and oestrogen, and is transported in the blood by proteins. Two of the most widely known transport proteins are low-density lipoprotein (LDL), which carries the cholesterol to the blood vessels, and high-density lipoprotein (HDL), which carries the cholesterol from the vessels to the liver where it is broken down. From this follows that LDL has been related to increased atherosclerosis, while HDL protects against it (Slyper, 1994). Therefore, total cholesterol, LDL, HDL, triglycerides and a ratio between LDL and HDL are of interest in evaluating changes in blood lipids. Traditionally, genes, age, diet, smoking and physical activity levels have been described as the most important factors affecting blood lipid levels (Lussier-Cacan, Xhignesse, Kessling, Davignon, & Sing, 1999; Unden, Krakau, Hogbom, & Romanus-Egerborg, 1995) but psychological stress has also been shown to increase these levels (Brindley, McCann, Niaura, Stoney, & Suarez, 1993; Dimsdale & Herd, 1982; Niaura, Stoney, & Herbert, 1992). Some studies also indicate relationships between blood lipids and sustained emotional arousal (Melamed, 1994) and between blood lipids and work conditions such as effort-reward imbalance (Peter et al., 1998). Although the mechanisms for the relationship between blood lipids and stress are not yet fully known, it has been suggested that they are related to the activation of the SAM system, including the elevation of catecholamines, cortisol and blood pressure in response to a stressor (Stoney, Bausserman, Niaura, Marcus, & Flynn, 1999). Therefore, blood lipids may be used both
as an indicator of cardiovascular disease risk and a mirror of energy mobilization and stress reactivity.

**Metabolic measures**

Glucose (blood sugar) and glycated haemoglobin (HbA₁c) are important parts of the metabolic system. As with blood lipids, glucose and HbA₁c have been shown to increase in response to psychological stress (Netterstrøm, Danborg, & Olesen, 1988; Schuck, 1998). They have also been found to be elevated in burnout patients (Grossi, Perski, Evengard, Blomkvist, & Orth-Gomer, 2003). This is related to the function of both cortisol and adrenaline: while cortisol stimulates the production and storage of glucose in the liver, adrenaline stimulates the breakdown and release of glucose from the liver. While glucose levels are relatively instable (but within a very limited range) and are affected by a number of immediate factors, particularly food intake, HbA₁c mirrors the average glucose levels during the previous few weeks (Netterstrøm, 2000). Since HbA₁c is not affected by food intake, menstruation cycle variations, physical activity levels or body position (although it has been related to high age, high weight, coffee and alcohol intake and smoking) (Björntorp, 1996; Netterstrøm & Sjol, 1991) it is relatively easy to assess.

Another indicator of metabolic functioning is the waist-hip ratio (WHR). A high WHR (above 0.8 for women and above 1.0 for men) has been related to increased risk for cardiovascular disease, diabetes and overweight (de Koning, Merchant, Pogue, & Anand, 2007).

**Endocrine measures**

The neuroendocrine systems have both anabolic and catabolic effects. Catabolic refers to the destructive metabolic process involving energy mobilization and the conversion of substances into metabolites. Anabolic effects refer to the opposite functioning: the synthesis of proteins and other substances that help rebuild and replenish our bodily systems. In the well-functioning organism, these two complementary parts are in balance. However, the balance may be disturbed if the organism is put under prolonged pressure, e.g. long-term stress, so that the concentration of catabolic hormones such as prolactin and cortisol increases and that of growth hormones and sex hormones decreases.

DHEAS (dehydroepiandrosterone sulfate) is a form of the steroid hormone DHEA (dehydroepiandrosterone), which is a precursor of both male and female sex hormones (including testosterone and oestrogen) (Buvat, 2003; Leowattana, 2004). In this thesis, DHEAS was chosen over DHEA since DHEAS has a longer half-life (8-11 hours compared to 30-60 minutes), which means that it is less sensitive to acute effects (Leowattana, 2004). Both DHEA and DHEAS are believed to have general anabolic effects (Buvat, 2003). In this thesis, DHEAS is assessed as a stress-sensitive
marker of the functioning in the anabolic system, as it is a functional antagonist of cortisol. Some studies have indicated that high levels of DHEAS have been related to fewer mobility limitations and better cognitive function, particularly among women (Glei, Goldman, Weinstein, & Liu, 2004), although this result has failed to be replicated in other studies (Goldman & Glei, 2007). Low levels of DHEAS have been associated with perceived stress (Goldman, Glei, Seplaki, Liu, & Weinstein, 2005) and DHEAS in combination with high levels of catabolic markers, e.g. HbA$_{1c}$, is associated with increased risk of cardiovascular disease (Alexandersen, Haarbo, & Christiansen, 1996). DHEAS has also been related to changes in the work environment. In one study, levels of DHEAS increased in concordance with a worsening of the psychosocial work environment (Netterstrøm & Hansen, 2000).

Prolactin is a peptide that modulates the activity and the receptor sensibility in the dopamine and the serotonin system and is well known for its role in lactation in women (M. E. Freeman et al., 2000). However, it has also been related to psychosocial processes and stress (Armario, Marti, Molina, de Pablo, & Valdes, 1996; Biondi & Picardi, 1999; M. E. Freeman et al., 2000). On the behavioural level, prolactin concentrations have been associated with depression, lack of interest, decreased libido and irritability (Theorell, 2000). In association with job characteristics, high levels of prolactin have been related to high emotional strain (Ohlson, Soderfeldt, Soderfeldt, Jones, & Theorell, 2001). It has been suggested that high levels of prolactin are particularly related to stress responses characterized by hopelessness or powerlessness (Drago et al., 1989).

**Allostatic Load**

In Study IV, a composite measure was computed including parameters from multiple regulatory systems (Seeman, Singer et al., 1997). This was done to assess cumulative biological dysregulation, such as allostatic load (AL). This may reduce uncertainties associated with the analysis of each biological marker separately. To date, the operationalization of AL differs between studies, depending on the type and number of biomarkers available (Gruenewald et al, 2006; McEwen & Seeman, 1999; Seeman, Singer et al., 1997; Seeman et al., 2001; Seeman et al., 2004). In Study IV, the following parameters were included (for a description of each measure, see above): heart rate and systolic and diastolic blood pressure (measures of cardiovascular activity); HDL, LDL, LDL/HDL ratio and total cholesterol (blood lipids associated with increased risk of atherosclerosis and cardiovascular disease) and triglycerides (measures of fat deposits; high values are associated with diabetes and overweight); serum DHEAS (a functional HPA axis antagonist); glucose and HbA$_{1c}$ (metabolic measures); prolactin (sensitive to sleep and stress) (Armario et al., 1996; M. E. Freeman, Kanyicska, Lerant, & Nagy, 2000) and WHR (reflects adipose tissue
deposition and metabolism). Using empirical cut-points (Crimmins, Johnston, Hayward, & Seeman, 2003; Karlamangla, Singer, McEwen, Rowe, & Seeman, 2002; Seeman, McEwen, Singer, Albert, & Rowe, 1997; Seeman, Singer et al., 1997; Seeman et al., 2004) and observed values (that is including those on medication potentially affecting one or more of the parameters), the participants were categorized into quartiles for each of the 13 parameters. The number of parameters for which the individual had a value in the highest risk quartile was added, and the upper quartile of the AL index was calculated to form a high AL group (for all parameters except for HDL and DHEAS, the top quartile equals highest risk). Means, standard deviations and cut-points can be found in Table 1. A quartile distribution of biological parameters allows for the identification of individuals with higher activity in their biological systems and an increased risk for future ill health. This way of summarizing the data has yielded results similar to those yielded by other ways for various health-related outcomes (Seeman, Singer et al., 1997), and a recent study recommended this method for the cross-sectional analysis of AL (Karlamangla, Singer, & Seeman, 2006).

Table 1. Allostatic load calculations: Criterion cut-points, means and standard deviations for individual biological components for the three cluster profiles of recovery

<table>
<thead>
<tr>
<th>Measure</th>
<th>75% Cut-point</th>
<th>Recovered n =108 M (SD)</th>
<th>Non-recovered n = 51 M (SD)</th>
<th>Fatigued N = 82 M (SD)</th>
<th>Total N= 241 M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allostatic load</td>
<td>≤ 5.0</td>
<td>3.38 (2.51)</td>
<td>2.84 (2.61)</td>
<td>3.88 (2.57)</td>
<td>3.43 (2.57)</td>
</tr>
<tr>
<td>Controlled for age</td>
<td></td>
<td>3.20</td>
<td>3.11</td>
<td>3.99</td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>≤ 127.0</td>
<td>117.4 (17.5)</td>
<td>113.8 (17.6)</td>
<td>115.4 (19.3)</td>
<td>115.9 (18.1)</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>≤ 87.5</td>
<td>80.8 (11.8)</td>
<td>77.8 (11.6)</td>
<td>78.0 (12.6)</td>
<td>79.2 (12.1)</td>
</tr>
<tr>
<td>Heart rate</td>
<td>≤ 69.3</td>
<td>64.6 (8.9)</td>
<td>61.9 (8.4)</td>
<td>66.0 (9.2)</td>
<td>64.5 (9.0)</td>
</tr>
<tr>
<td>Waist-hip ratio</td>
<td>≤ .87</td>
<td>.82 (.07)</td>
<td>.80 (.08)</td>
<td>.82 (.07)</td>
<td>.82 (.07)</td>
</tr>
<tr>
<td>Total cholesterol</td>
<td>≤ 5.80</td>
<td>5.12 (.96)</td>
<td>4.99 (1.04)</td>
<td>5.20 (1.00)</td>
<td>5.12 (0.99)</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>≤ 1.20</td>
<td>.95 (.42)</td>
<td>.94 (.48)</td>
<td>1.02 (.48)</td>
<td>.97 (.46)</td>
</tr>
<tr>
<td>High-density lipoprotein (HDL)</td>
<td>≥ 1.54</td>
<td>1.81 (.36)</td>
<td>1.73 (.31)</td>
<td>1.73 (.40)</td>
<td>1.76 (.36)</td>
</tr>
<tr>
<td>Low-density lipoprotein (LDL)</td>
<td>≤ 3.50</td>
<td>2.89 (.82)</td>
<td>2.82 (.93)</td>
<td>3.02 (.80)</td>
<td>2.92 (0.84)</td>
</tr>
<tr>
<td>LDL/HDL ratio</td>
<td>≤ 2.10</td>
<td>1.67 (.60)</td>
<td>1.70 (.71)</td>
<td>1.83 (.65)</td>
<td>1.73 (.65)</td>
</tr>
<tr>
<td>Glucose</td>
<td>≤ 5.50</td>
<td>5.07 (.41)</td>
<td>4.95 (.46)</td>
<td>5.05 (.44)</td>
<td>5.03 (0.44)</td>
</tr>
<tr>
<td>Glycated haemoglobin (HbA1c)</td>
<td>≥ 4.60</td>
<td>4.39 (.29)</td>
<td>4.38 (.31)</td>
<td>4.45 (.35)</td>
<td>4.41 (0.31)</td>
</tr>
<tr>
<td>Prolactin</td>
<td>≤ 11.0</td>
<td>7.99 (4.14)</td>
<td>8.62 (3.16)</td>
<td>8.71 (4.20)</td>
<td>8.37 (3.97)</td>
</tr>
<tr>
<td>DHEAS</td>
<td>≥ 2.50</td>
<td>3.95 (1.95)</td>
<td>4.61 (2.55)</td>
<td>3.91 (1.79)</td>
<td>4.07 (2.05)</td>
</tr>
</tbody>
</table>
Self-ratings

One of the most frequently used measures of health and ill health in relation to work is self-ratings (Hurrell, Nelson, & Simmons, 1998). These have the advantage of being relatively easily distributed, non-invasive and able to assess aspects such as general well-being and quality of life that are not easily measured by “objective” measures. Often, getting a picture of an individual’s perception of a situation (e.g. perceived work situation or perceived health) is at least as important as getting the objective picture, not least since it is the individual’s subjective experience of a situation that to a large extent governs his or hers responses to that situation. The subjectivity of self-ratings also has some disadvantages that may bias the results. For example, self-ratings are known to be affected by social desirability (giving the answer one believes is the “correct” one) and negative affectivity (a general tendency to perceive things negatively) (Hurrell et al., 1998; Watson & Pennebaker, 1989). These problems are particularly pronounced when both exposure and outcome are measured using self-ratings, since they may lead to spurious relationships (Hurrell et al., 1998).

Lack of recovery and fatigue

Assessment of lack of recovery from work and work-related fatigue has often been done using an index including both items related to recovery and items related to fatigue. In this thesis, except in Study I, fatigue and lack of recovery were assessed using the eight-item “Recovery from work scale” (Aronsson et al., 2003; Gustafsson, Lindfors, Aronsson, & Lundberg, 2006). This scale includes items assessing general levels of fatigue during and directly after the workday (e.g. “I feel tired during work”, “I feel mentally exhausted after the workday”), one item assessing sleep difficulties and four items concerning recovery from work after different lengths of time off work, e.g. after a night’s sleep, in the morning before work, after a weekend, and after a vacation (e.g. “Generally, I feel refreshed and recovered by the time my workday begins”, “Generally, I feel refreshed and recovered when I am back at work after a weekend off”). Respondents were asked to indicate their overall level of recovery and fatigue in a five-point response format with never and very often as endpoints. The items for each subscale were added so that high scores indicated poor recovery/high fatigue. In Study III, modified versions of the recovery and fatigue subscales were used. From the fatigue scale, the item measuring sleep difficulties was omitted to avoid an overlap with the overcommitment scale used in the same study. The revised recovery scale included two of the four recovery items, namely those focusing on recovery between workdays. This was done to simplify the interpretation of the relationships between fatigue and recovery over time, by focusing on an experience relating to approximately the same time period for
both fatigue and recovery. In Study IV, all eight recovery and fatigue items were used in the cluster analyses.

Study I, which utilized data from a general work environment assessment, assessed a factor labelled fatigue through three items: disturbed sleep, tiredness after work and inability to stop thinking about work-related issues during one’s free time. All items were rated along a six-point response format with low and high as endpoints. Scores on both items were added to high scores indicating more fatigue. From this follows that the operationalization of fatigue differs somewhat between the studies: the narrowest definition including only mental and physical fatigue during or after a workday is used in Study III, while the widest definition is used in Study I.

**Overcommitment**

In measuring OC, the motivational pattern characterized by excessive work-related commitment and a high need for approval, the six-item subscale of the effort-reward instrument has been widely used (Siegrist et al., 2004). Five of the six items on the scale focus on one core notion of the concept: the inability to withdraw from work obligations. The sixth item measures impatience/irritability. In Study III, OC was used to assess perseverative cognition relating to work. Responses were given in a four-point response format and items were added to form an overcommitment index.

**Physical activity**

The level of physical activity was assessed through two items: Overall physical activity (exemplified in the questionnaire as walking, biking, household chores, gardening, playing with children) and physical exercise (exemplified as aerobics, running and swimming). This was based on the general recommendations for physical activity and exercise (Jansson, 2003). The respondents were asked to rate how much time on average they spent on physical activity and physical exercise, respectively, during a normal week. Ratings were made on a four-point scale ranging from Less than one hour a week or No activity at all (1) to 5-6 hours a week or More than one hour a day (4).

**Upper extremity disorder**

UED was assessed using a symptom report including three items covering pain in the neck or shoulder area, pain in arms or elbows, and pain in wrists, hands or fingers, following previous research (Bongers et al., 2002; Kuorinka et al., 1987). For each item, respondents were asked to indicate whether they suffered from such health problems. Sum scores were computed and ranged from 0 to 3, with high scores indicating more symptoms. In Study I, the UED index was also used to categorize individuals into different groups, those with and those without UED.
**General symptoms**

In Study I and II, symptom reports were used and from these, indices of general symptoms were computed. In Study I, the symptom report included five items (heartburn and stomach pain, headache, chest pains, colds and skin problems) and in Study II, a modified version of the QPSNordic was used, including nine common symptoms (heartburn, nausea, stomach ache, palpitations, coughs, colds, headaches, fatigue and sleep disturbances) (Dallner et al., 2000). In both reports, respondents were asked to indicate whether they had experienced a symptom during the past six months. Sum scores were computed, with high scores indicating more symptoms. Forming an overall symptom report may provide an indicator of the total “load” of symptoms. It also helps to keep down the number of statistical tests in the analyses compared to doing separate analyses for each symptom.

**Self-rated health**

One straightforward and commonly used way to assess health is to simply ask people to rate how they perceive their overall health (Manderbacka, Lahelma, & Martikainen, 1998; Miilunpalo, Vuori, Oja, Pasanen, & Urponen, 1997). This has been suggested to capture an individual’s overall perception of health, including biological, psychological and social health dimensions (Fylkesnes & Forde, 1992; Manderbacka, 1998) such as general health status, sleep quality, self-esteem, social support, sense of coherence, clinical health ratings, chronic physical and emotional problems and stress (Goldman, Glei, & Chang, 2004; Hasson, Arnetz, Theorell, & Anderberg, 2006; Idler & Benyamini, 1997). Often, this is done in a single-item format (Burström & Fredlund, 2001; Fylkesnes & Forde, 1992; Goldman et al., 2004; Idler & Benyamini, 1997; Miilunpalo et al., 1997). In this thesis (Study II), self-rated health was assessed using a single-item question, in which respondents were asked to rate their current health status compared to other individuals of the same age. Ratings were made on a five-point scale ranging from Very good (1) to Very poor (5) (Eriksson, Unden, & Elofsson, 2001).

**Work ability**

Another aspect of health is the individual’s work ability. Like self-rated health, this is a general rather than specific measure of health. It includes aspects such as the ability of the worker to perform at work with respect to factors associated with work, such as job demands, ergonomics and supervisor behaviour as well as individual resources including health, competence and motivation (Ilmarinen et al., 1991; Ilmarinen, Tuomi, & Seitsamo, 2005; Tuomi & Oja, 1998). Since work ability decreases with age, it has been extensively studied in relation to aging workers to investigate the sustainability of working life, but studies have shown that it is also relevant.
for younger workers (Torgén, 2005). It is also related to sickness absence, which in Sweden, like in most Western countries, is defined not just as the presence or absence of disease, but as an individual’s ability to perform his or hers work duties, that is by relating the symptoms to how it affects one’s work capacity and work ability (Tengland, 2006). As such, self-rated work ability is highly correlated with future sickness absence (Kujala et al., 2006). Work ability is part of the assessment in Study II. It was measured using a single item adopted from the Work Ability Index (Dallner, 1999; Dallner et al., 2000; Ilmarinen, 2007; Tuomi & Oja, 1998). Respondents were asked to rate their current work ability as compared to their work ability at its best on a ten-point scale ranging from Completely lacking work ability (1) to Work ability at its best (10).

Work-related measures

Physical work characteristics

Physical work characteristics were assessed in Study I. As described earlier, dentistry presents a very demanding physical work environment due to the specific work situation. This includes strenuous and/or fixed postures for extended periods of time, fine-tuned yet forceful movements and exposure to vibration and noise. In the assessment, physical work characteristics were divided into physical work environment and physical load. Physical work environment was measured with five items covering computerized work, lighting, indoor climate and exposure to two types of noise. Physical load was measured with four items including monotonous movements with the hands or arms, painful or strenuous work positions, heavy lifting and sedentary work. These items cover factors associated with an increased risk for work-related disorders (Arbetsmiljöverket [Swedish Work Environment Authority], 2004). All these items were rated along a six-point scale ranging from All the time to Never. For both measures, additive indices were calculated with high scores indicating poor conditions.

Psychosocial work characteristics

As described in the introduction, a number of psychosocial work factors are known to influence individual health and functioning. Since different data sets were used in Study I than in Studies II-IV, the measures in Study I differ from those analysed in the other studies. In Study I, psychosocial work characteristics were examined using ten items rated along a six-point scale with Yes, absolutely and No, not at all as endpoints. An initial data reduction was performed resulting in three components: 1) support (5 items), 2) influence at work (3 items), and 3) work-related worries (2 items). Additive
indices were calculated for all three measures. For support and influence at work, low scores indicate poor conditions. For work-related worries, low scores indicate less worry.

In Studies II and III, psychosocial work characteristics were covered by three factors: job control (2 items), job demands (5 items) and social support (6 items) (Karasek, 1979; Karasek & Theorell, 1990; Schreurs & Taris, 1998). All items were rated along a four-point scale which ranged from No, almost never (1) to Yes, very often (4) for all factors but social support that ranged from No, completely disagree (1) to Yes, completely agree (4). The job demand-control model postulates that two characteristics of a job are particularly important as a source of job stress: psychological job control and job control, or decision latitude. While job demands are relate to workload, job control involves the employee’s ability to control his own activities and skill usage (Karasek & Theorell, 1990). The job demand-control indexes have been used extensively during the recent decades and have been related to several ill health factors, including increased risk for cardiovascular disease (Belkic, Landsbergis, Schnall, & Baker, 2004) and MSD (Bongers et al., 2002). Social support has also been suggested as an important factor in the stress-strain relationship (S. Cohen & Wills, 1985). For example, social support has been found to reduce the strains experienced, mitigate perceived stressors and moderate the stress-strain relationship (Viswesvaran, Sanchez, & Fisher, 1999). As suggested by previous research (Schreurs & Taris, 1998), the three factors were analysed separately.

Work-home interference

Work-home interference (WHI), that is, whether working life interferes with home life, was included in Study II and assessed using two items (Frone, Russell, & Cooper, 1992). Both items were rated on a seven-point scale ranging from Very seldom (1) to Very often (7) and the ratings were added into a WHI-sum score, with high scores indicating high interference.
Summary of Empirical Studies

This thesis includes four studies. The designs of these studies and relevant measures are presented in the Method section. Since the data sets coincide in some of the studies, a general description of the data sets is given first, followed by a brief description of the background, results and conclusions for each of the four studies.

Participants

In Study I, 1,795 individuals of the 2,025 employees at a large dental health company, including all personnel (both dental health workers and other categories of personnel) who were on duty and present at their workplace during the two weeks of data collection were invited to participate. Hence, besides those who were temporarily absent, those on long-term absence (e.g., parental leave and long-term sick leave) were excluded. The response rate was 96%. For the purpose of the present study, only data from female dental health workers, $n = 945$ were included (31% dentists, 12% dental hygienists and 57% dental nurses). The average age of the respondents was 45.4 years ($SD = 10.4$) and the majority of the women, 70%, were employed full-time.

In Study II, 197 employees at six workplaces in the dental health organization described above were invited to participate in the three-wave study, and 195 volunteered. Of the 177 women who completed all three waves of data collection, blood samples were missing for six women. In addition, physiological data from three diabetics and six pregnant women were excluded. This means that for analysis of biomarkers, data from 162 women were available. For Study III, data from the second and third wave of the data collection was utilized. 179 women participated in both waves, after a dropout of 4.8% (due to change of jobs, parental leave and, in one case, a declination to participate in the follow-up). Due to missing data on self-rated next-day recovery or fatigue or any of the independent variables, the final sample consisted of 160 women.

In Study IV, the data from the first wave of data collection from Study II was extended to include participants from two different public health care organizations in Stockholm, Sweden. 367 of the 390 persons invited to participate volunteered. For the purposes of the present study, only data from
female employees \((n = 312)\) were included. The final sample consisted of 241 women, after excluding those who were pregnant \((n = 9)\), individuals with known diabetes medulla \((n = 7)\), those with missing data \((n = 38)\) and those with univariate outliers in biomarkers considered erroneous \((n = 17)\). There were no significant differences in demographic characteristics between the women included in the final sample and the others.

**Procedure**

In Study I, questionnaire data were collected at 48 workplaces by their occupational health company as part of an assessment of working conditions, occupational hazards and employee health, initiated by the employer. Participation was voluntary but was encouraged by the employer. To ensure anonymity and confidentiality, all employees were asked to complete the questionnaire individually and return it to a representative of the occupational health company within two weeks. Thus, the employer had no access to individual answers.

Since Studies II, III and IV are based on the same large data set, the same procedure was applied in all three studies. Biomarkers and self-ratings in questionnaires were obtained before any intervention took place (T1), and six months (T2) and 12 months after the interventions (T3) to allow analyses of changes between different points in time (Taris & Kompier, 2003). The time lag between measurements was based on experiences from previous studies (Anttila et al., 2005; Wergeland et al., 2003). Prior to each of the three phases, the participants were given detailed oral and written information about the project, ethical issues and procedures for the measurements involved (questionnaire and a health checkup). The questionnaire was completed at home and returned to the licensed nurse who performed the health checkups (for a description of the protocol for these, see *Physiological parameters* in the Method section).

**Study I**

By the very nature of the work, dentistry constitutes a work setting that is both psychosocially and physically challenging and the prevalence of musculoskeletal disorders is high. The aim of Study I was to investigate how musculoskeletal disorders in the upper extremities (neck, shoulders, arms, elbows, wrists, hands or fingers) (UED) are related to work characteristics, fatigue and general health problems in a high-demand work. Moreover, since dentistry involves different occupations a second aim was to investigate differences in work characteristics, fatigue and general health problems in relation to work position.
Of the 945 participants, 81% reported UED with no significant differences between occupations. Women with UED reported significantly worse physical work environment \((p = .0001)\), higher physical load \((p = .0001)\) and more work-related worries \((p = .040)\), and less influence at work \((p = .0001)\) and poorer support \((p = .003)\) than did employees without UED. They also reported more fatigue \((p = .0001)\) and more general health problems \((p = .0001)\) than did women without UED. Significant differences were also found between dentists and nurses in work conditions \((p = .0001)\) and health problems \((p = .0001)\). Dentists reported significantly higher physical load than did nurses \((p = .0001)\) and higher scores on fatigue than did the other two groups of employees \((p = .0001)\), whereas nurses reported significantly lower scores on influence at work \((p = .0001)\).

A hierarchical regression analysis showed that in predicting numbers of UED, a higher physical load was the most important predictor, followed by more general health problems, higher age and a poorer physical work environment. Neither marital status, position, number of years performing current tasks, fatigue nor the psychosocial work characteristics made a unique contribution to the model. The full model explained 18% of the variance in UED.

The authors conclude that the prevalence of UED in this sample (81%) was extremely high, particularly since the workplaces met all modern ergonomic and physical work environment requirements. It was also concluded that although all employees objectively worked in the same environment, those reporting UED regarded their physical and psychosocial working conditions as poorer compared to their colleagues who did not report UED. The differences between occupational groups were expected: dentists and dental hygienists, who spend more time in strenuous positions doing monotonous, fine-tuned movements, reported higher physical load and dental nurses, who have their workday planned by the dentist, reported less influence at work. In predicting UED, physical load was, not surprisingly, the most important predictor. More surprisingly, psychosocial work environment did not contribute to the prediction at all. Also, 82% of the variance in UED was not explained by the investigated factors. The authors suggest that in dentistry the effects of psychosocial work conditions are overshadowed by the high physical load. In sum, the study shows that female dental health care workers are at risk of developing musculoskeletal disorders and are therefore likely to benefit from additional improvements to the work environment, targeted prevention and intervention aimed at reducing these risks.
Study II

As shown in Study I and in previous studies, even when ergonomic standards are high, many employees in dentistry report UED and high physical and psychological demands. To improve health and prevent decreased work ability and sickness absence, workplace interventions that improve employee health are therefore important, from both an individual and an organizational perspective. Reducing exposure by reducing work hours, or increasing tolerance by increasing physical exercise, are two possible interventions. The aim of Study II was to examine the health-related effects of two worksite interventions, physical exercise (PE) and reduced working hours (RWH). A reference group (R), for which no intervention was carried out, was also included. In both intervention groups, 2.5 hours of work/week were allocated to intervention. In the RWH group, full-time weekly hours were reduced from 40 hours/week to 37.5 hours/week with no expectations on how to spend the extra free time. In the PE group, the 2.5 hours, divided into two occasions, were allocated to a free choice of physical exercise as long as it was of medium to high intensity, corresponding to 55% to 89% of maximum heart rate. Hence, the intervention involved PE rather than PA. The reasons for this were to decrease the variation in intensity levels associated with letting the study participants make their own choices, to be able to study effects related to cardiovascular capacity and to have an appropriate intensity level considering the duration of the training (2.5 hours/week). To ensure proper implementation, all employees recorded in writing the type of activity and the duration of each exercise session and these written reports were checked weekly by a specifically assigned employee. For employees working part time, the reduction of working hours was less than 2.5 hours so that, instead of similarity in absolute numbers, the reduction was similar in relative numbers. A great majority had either a reduction of 2.5 hours (46%) or 2 hours (39%). All employees retained their salaries. No additional personnel were employed and all workplaces were expected to deliver full services throughout the study period. The PE group included 62 women, the RWH group included 50 women and 65 served as referents. The mean age for the whole sample was 46.6 years.

The results showed increased levels of physical exercise \( p_{PE} < .001; p_{RWH} < .001; p_{R} < .001 \) in all groups, but the increase was significantly greater in the physical exercise group than in the other two groups \( p < .001 \). Physical activity levels increased as well \( p_{PE} < .001; p_{RWH} = .039; p_{R} = .016 \). The interaction effect was approaching significance \( p = .077 \), with post hoc analyses suggesting greatest increase in PA in the PE group. For blood lipids, neuroendocrine markers and cardiovascular measures, no significant time x group effects were found. However, there was a time effect showing increased levels of blood lipids from T1 to T3 for all blood lipids but the LDL/HDL ratio. Post hoc analyses showed increased levels of all blood
lipids in the R group and increased levels of total cholesterol and HDL in the RWH group while only total cholesterol had increased significantly in the PE group. Significant effects were also found for metabolic measures. For glucose, there was a significant time x group effect \((p = .04)\), with post hoc analyses showing significant decreases in the PE group only \((p = .036)\). A significant interaction effect also emerged for WHR \((p = .02)\), with post hoc analyses revealing that WHR increased in the RWH group \((p < .001)\). For HbA\(_{1c}\), there was an effect of time showing decreased levels of HbA\(_{1c}\) \((p = .03)\), but no interaction effect. Post hoc analyses showed a decrease in the PE group that was approaching significance \((p = .084)\).

For self-reports, no significant effects emerged for self-rated health, WHI, lack of recovery or fatigue. For work ability, however, the time x group effect \((p = .01)\) was significant. Post hoc analyses showed that work ability decreased in the R group \((p = .005)\), while there were no significant changes in the PE and the RWH groups. Similar results were found for general symptoms \((p = .063)\): the number of symptoms increased in the R group \((p = .006)\). For UED, the interaction effect was approaching significance \((p = .062)\), suggesting significant decreases in UED in the PE group only \((p = .012)\).

It was concluded that the greater increase in physical exercise in the PE group suggests that the intervention was successful in implementing increased physical activity. Taken together, Study II shows that RWH increased levels of physical activity and exercise, and was related to positive effects on HDL but also negative effects on total cholesterol and WHR. When it was mandatory to spend the reduced working hours on physical exercise, the increase in physical exercise was even greater and was associated with positive effects on glucose and UED, but also with an increase in total cholesterol. Hence, the effects seemed to differ between interventions. In addition, work ability decreased and general symptoms increased in the reference group, a pattern similar to findings from previous studies (Pohjonen & Ranta, 2001). This means that beside some health improvements in the intervention groups, a decline in health, or increase in ill health, was found among referents but not in intervention groups. This may suggest that part of the health benefits of workplace interventions may be in terms of delaying or preventing negative effects otherwise found. However, an overall decline in health is most likely to happen over a longer period of time, implying that in order to find such effects, longer follow-up periods would be needed. Somewhat surprisingly, no improvements were found in either group in recovery from work.

It was also concluded that most interaction effects failed to reach significance. This was discussed as resulting from the small effect sizes often associated with workplace health interventions and the study of health effects among a healthy population (Dishman et al., 1998; Wilson et al., 1996), but also that the conditions may have been too similar, particularly
since levels of physical activity increased in all groups and since participants were quite physically active to begin with. In sum, as a practical implication, interventions involving a modest reduction in working hours seem to be more effective when the time is spent on physical exercise, at least in terms of physical health.

Study III

Psychosocial work conditions have been related to stress-related disorders, and lack of recovery and fatigue have been suggested as a mediator in this relationship. However, mere time for recovery, for example as follows from a reduction in working hours, does not necessarily improve recovery. One reason for this may be that factors such as worry and rumination may prolong or sustain the physiological activation associated with a stress reaction. The purpose of Study III was to investigate the relationships between psychosocial work characteristics in terms of job demands, job control and social support at work and perseverative cognitions related to work in terms of overcommitment, and fatigue and next-day recovery among women.

The results showed that overcommitment to work were a strong predictor of poor next-day recovery from work and work-related fatigue among women. More specifically, fatigue at T3 was predicted by having children at home, high job demands, high OC and poor next-day recovery six months earlier (42% of variance explained) while poor next-day recovery at T3 was predicted by job demands and fatigue in the final model (explaining 31% of the variance). OC was a significant predictor of poor next-day recovery only when fatigue was not considered in the model.

It was concluded that perseverative cognitions relating to work, such as overcommitment, may be an equally, or even more, important predictor of next-day recovery and fatigue than are psychosocial work conditions. This is interpreted in terms of adaptive and unadaptive process: even though job demands may be considered a stressor, and may lead to stress reactions such as fatigue after a workday, individuals may be able to cope with these demands and stress reactions and recover, e.g. return to a pre-stress level when the stressor has ended (e.g. after the workday). This would constitute an adaptive stress-recovery process. If the individual, on the other hand, is unable to withdraw from work cognitively and/or emotionally, his or her ability to recover may be limited.
Study IV

In the allostatic load (AL) model, the importance of rest and recovery for avoiding the harmful consequences associated with long-term stress activation is evident. However, the concept of recovery from work stress has not been directly investigated in relation to AL. Therefore, the aim of Study IV was to investigate the relationships between self-rated recovery from work stress and biological dysregulation load in terms of AL in employed women.

All eight items from the recovery from work scale (Aronsson et al., 2003; Gustafsson, et al., 2006), including both recovery and fatigue items, were used in a cluster analysis. This produced three clusters denoted recovered, non-recovered and fatigued, that are presented in Figure 1 in terms of the deviation from total mean on each item of the recovery measure.

![Figure 1. Deviation from total mean on self-rated recovery and fatigue for three clusters with distinct recovery profiles (N =241).](image)

Along with a recovered group consisting of 108 women with a pattern suggesting overall better recovery and less fatigue than the other clusters, two profiles with poorer recovery and more fatigue emerged. A cluster denoted non-recovered, consisting of 51 women, showed a pattern
characterized by poor recovery from work, particularly in terms of long-term recovery (weekends and vacations). Moreover, these women reported not being thoroughly rested after sleep. The fatigued cluster, consisting of 82 women, was characterized by high levels of mental and physical fatigue after work, frequent sleeping problems, and relatively poor recovery between workdays. However, their long-term recovery was better than that of the non-recovered cluster. In the recovered cluster, there were more dental nurses (\( p = .002 \)), older women (\( p = .013 \)) and women working part-time (\( p = .025 \)) than in the other clusters.

The percentage of women belonging to the highest risk group for a cumulative biological load (the top quartile of AL) is presented in Figure 2. Though logistic regression analysis, the odds of being in the top quartile of the AL measure were predicted.

![Figure 2](image_url)

*Figure 2. Percentage of women belonging to the top quartile of AL for three clusters with distinct recovery profiles.*

In the full model, 17.7% of the variance in the dichotomized AL was explained (Nagelkerke R\(^2\)). Both age and cluster membership reliably predicted the odds of high AL. Odds ratios (OR) indicated that along with higher age, belonging to a fatigued group compared to a recovered group increased the risk of belonging to the upper quartile of AL (OR 2.86). Analyses of differences between cluster groups in separate biomarkers using MANOVA and MANCOVA controlling for age showed that the groups did not differ significantly in separate biomarkers. The results suggest that self-rated recovery and fatigue is related to a cumulative biological dysregulation, but not necessarily to differences in individual biological parameters. The risk of high AL was more pronounced among women whose profiles were characterized by sleeping problems and mental and physical fatigue, and to some extent poor recovery between workdays,
(fatigued profile) than when these characteristics were absent (the recovered profile). Moreover, a third profile particularly characterized by poor long-term recovery emerged and hence, two profiles characterized by poor recovery but differing in risk for AL were found. In sum, Study IV provides support for a focus on cumulative load when investigating the biological pathways of self-rated recovery from work stress. It also shows that recovery is an important factor to consider in relation to biological cumulative dysregulation, supporting previous findings suggesting that recovery may be a pathway in the stress/ill health relationship.
Discussion

The main aim of this thesis was to investigate different aspects of health and ill health in working women, with a specific focus on how efforts associated with work need to be balanced with recovery and the time off work in order to prevent ill health and promote health. Hence, the theoretical context was stress theory. This suggests a very wide aim, and within this, this thesis focuses on such aspects of health and ill health that are likely to be (at least) partly work-related and associated with balance between effort and recovery (e.g. stress-related). Moreover, the inclusion of both health and ill health in the aim of the study reflects an effort to investigate factors associated both with symptoms and risk-factors of disease (e.g. a negative aspect) and positive aspects of human functioning. From this follows that the results are interpreted with both prevention (of ill health) and promotion (of health) in mind.

Interpretation of findings

As described in the introduction, work has frequently been related both to positive aspects of health and functioning and to ill health and disease (Barnett & Hyde, 2001; Bongers et al., 1993; Bongers et al., 2002; Johnson & Hall, 1988; Klumb & Lampert, 2004; Niedhammer, Goldberg, Leclerc, David, 1998; Niedhammer, Goldberg, Leclerc, Bugel et al., 1998; Reed et al., 2006; Repetti et al., 1989; Theorell et al., 1998). While some factors associated with ill health (e.g. UED) were investigated directly in this thesis, the positive role of work that is pointed out in the Background section was not. However, the results from the studies in this thesis may be interpreted with both prevention of ill health and promotion of health in mind. In this section, the findings from the studies are discussed in relation to the aim of the thesis. First, the results are interpreted in terms of prevention of ill health and promotion of health in general. Then the discussion focuses on interpreting the findings in relation to recovery from work.
Promoting health and preventing ill health

In Study II, the preventive and promotive effects of two WHP initiatives were investigated directly. The selection of type of WHP was guided by stress theory and the effort to investigate effects on both ill health and health. There were several reasons for choosing PE and RWH as interventions: both were relevant to the theoretical framework of this project and both were preferred by the employees (as expressed in an earlier workplace assessment) and the employer. In addition, physical activity and reduced working hours were discussed as possible interventions in several organisations and in the media, motivating a scientific evaluation of these initiatives. The results indicated that PA may have some positive effects in terms of prevention of ill health, while the effects of RWH remain unclear. Overall, PA was related to decreased glucose levels and decreased UED, while RWH was related to increased levels of HDL, total cholesterol and WHR. Moreover, in follow-up analyses of changes over time in each intervention group separately, a significant decrease was also found in systolic blood pressure in the PA group and a significant increase was found in DHEAS in the RWH group (unpublished results). These results are discussed in more detail below.

The effects of PA on glucose (and systolic blood pressure), that is metabolic and cardiovascular measures, are a common finding in relation to PA and PE (Eaton, 1992; Yang et al., 2008), and these effects are particularly likely in an intervention that focuses on cardiovascular or cardiorespiratory fitness. It shows that PE may be effective in prevention of these risk-factors. However, the effect of PA on UED requires more elaboration. In previous studies, some have reported positive effects of PA on MSD (Oldervoll, Ro, Zwart, & Svebak, 2001; Proper, Koning, et al., 2003; Sjögren et al., 2005) while others have found no such effects (Gerdle, Brulin, Eliert, Eliasson, & Granlund, 1995; Takala, Viikari-Juntura, & Tynkkynen, 1994). This may be related to differences in kind of PA. Along with cardiovascular fitness, PA and PE may also involve muscular strength and endurance, coordination and musculoskeletal flexibility (Barnekow Bergkvist, 2006). In a review of the effects of work-related physical exercise on musculoskeletal health, it was concluded there was support for a positive effect on neck-shoulder pain from specific training of the neck and shoulders, involving strength or muscular endurance, among women working with persistent but low physical load and lack of variation (Barnekow Bergkvist, 2006). The result from Study II is somewhat at odds with this, given that the training was non-specific (not explicitly targeting the upper extremities) and did not require maximal muscular strength or endurance training (the ability to perform repeated contractions over a specific period of time). However, there are several possible mechanisms that may explain the effect of PA on UED, drawing from the research on
mechanisms in the development of WRMSD. These mechanisms may explain direct physiological effects of PA and PE on muscle function, but also indirect effects related to changes in psychological and psychosocial factors.

First, PA may help wash out lactic acid that has accumulated during physical work (Baynard, Miller, & Fernhall, 2003). Second, it may provide rest for the muscles, particularly the “Cinderella” muscle units that are first engaged in muscle activities (Hägg, 1991; Sjøgaard et al., 2000). Third, PA may increase muscle strength or muscle endurance (Barnekow Bergkvist, 2006) or coordination and mobility, which is important for an efficient power transference as well as for decreasing risk for overload (Hodges, 2000). Fourth, it may enhance memory and/or concentration and vigilance during work, which in turn may decrease the risk of injury or wear due to tiredness (Potter & Keeling, 2005). Fifth, PA during work hours may facilitate short-term recovery by providing a break from the ordinary work tasks (Schleifer et al., 2008). As such, PA may be equivalent to any activity that constitutes a change in work task or work flow. Sixth, the fact that there was no increase in perceived demands despite the fact that full productivity was expected supports the possibility that PA is related to increased resistance or increased resources, suggesting a moderation effect of PA in the stress-distress relationship (Ensel & Lin, 2004). Seven, PA during work hours may decrease hyperventilation and the associated disruption of the acid-base equilibrium (Schleifer et al., 2002). This may either be a direct effect of PA due to changes in briefing behaviour, or an indirect effect that follows from having a break which may relieve acute stress reactions, including hyperventilation. Eight, PA may decrease the experience of pain due to an increased release of endorphins (Barnekow Bergkvist, 2006). Nine, decrease in UED may steam from lowered levels of mental stress which in turn may decrease muscle tension. This explanation is, however, less likely in this study, since no decrease in perceived stress was found (analyses not shown).

Unfortunately, the data presented in Study II are not sufficient for drawing any firm conclusions regarding which of these explanations, if any, that are the most important in explaining the effect of PA on UED: clarifying these mechanisms is a task for future research. However, it is likely that the mechanisms relating to having a break is more important than those focusing on maximal strength, given that the type of work performed by the participants in this study does not require maximal strength but involves persistent, lower load levels. It may also be suggested that different mechanisms may be relevant for different individuals, depending on their choice of PE and on their muscular functioning and PA levels before the intervention. For example, for an individual who was not physically active before the intervention, benefits relating to increased PE in itself, such as increased muscular strength and/or cardiovascular fitness, may be most
relevant. For an individual who was previously active, on the other hand, doing PE during work hours (instead of, or in combination with, the previous exercise regime) may assert effects in terms of providing rest for muscles that are strained during work and by providing a break in the ordinary work tasks, thereby decreasing stress and promoting short-term recovery. Moreover, the mechanisms suggested above are not mutually exclusive and are likely to interact, and they may be related both to direct physiological effects of PE and indirect effects, as a mediator of psychological processes affected by PE. Nevertheless, the results from Study II suggest that PA may be related to prevention of ill health in terms of decreased UED and risk factors for metabolic and cardiovascular disease. However, no effects in terms of the promotion of health were found in the PE group. For example, no changes were found in self-rated health, WHI or positive health (unpublished results). Hence, previous findings suggesting positive effects of PE on psychological factors such as subjective well-being (H.R. Eriksen et al., 2002; Sjögren et al., 2006) were not replicated in Study II. This may be related to differences in the assessment of well-being. It may also be related to differences in pre-intervention PA levels. The women in Study II were already relatively physical active before the intervention, and while the physiological effects may stem from changes in intensity level (e.g. increasing PE), psychological effects may be more pronounced in individuals who were not previously physically active (e.g. changing from a sedentary to a physical active lifestyle).

The effects of RWH on health and ill health were more subtle than the effect of PA. It may be suggested that RWH, if anything, may rather be related to the promotion of health than the prevention of ill health. Although the increase in HDL may be interpreted in relation to the cardiovascular and metabolic systems, the concurrent increase in total cholesterol left the LDL/HDL ratio unchanged. This makes the interpretation of the increase in HDL as a reduction of risk factors for cardiovascular disease uncertain, particularly since there also was an increase in WHR in the RWH group. However, in the follow-up analyses of changes over time in the intervention groups separately (analyses not shown), an increase in DHEAS was found in the RWH. Both HDL and DHEAS have been suggested to be related to increased anabolic activity (McEwen, 2000; McEwen & Seeman, 1999). As such, the increased HDL and DHEAS could be markers of unspecific effects on the processes that help build up organs and tissues, which work in antagonism with the catabolic stress responses. This would make RWH more relevant as health promotion than prevention ill health. However, the interpretation is weakened both by the lack of solid evidence of positive health effects of HDL and DHEAS and by the fact that while DHEAS increased in the RWH group in separate ANOVA for the RWH group, the interaction failed to reach significance in the repeated measures ANOVA with comparisons between groups. Similarly, a time effect but no interaction
effect was found for HDL, which also increased in the reference group. An increase in total cholesterol also contributes to the difficulties in drawing any firm conclusions, as does the lack of effect on any of the self-ratings of health and well-being. In sum, any anabolic effects of RWH remain speculative.

Besides potentially differentiated effects of PA and RWH on the prevention of ill health and the promotion of health, both may be related to a different kind of positive effect. In the reference group, but not in the PA or RWH group, self-rated work ability decreased and the number of general symptoms increased during the time period. Similar results have been found in a previous study, where a decrease in work ability was found among referents but not among an intervention group (Pohjonen & Ranta, 2001).

From this follows that some of the effects of these WHP may rather be in terms of a delay or reduction of future health problems. However, the change in general symptoms was only a trend and should be interpreted with caution. On the other hand, an overall decline in health is more likely to be evident over a longer period of time, implying that in order to find more robust effects, longer follow-up periods would be needed.

While Study II investigated the direct preventive and promotive effects of WHP on health and ill health, the contributions of Studies I and III were mainly to provide data on the relationships between work conditions and health, ill health and recovery, from which promotive and preventive actions can be suggested. The results from Study I clearly show that UED is a great problem in dentistry, affecting over 80% of employed women. Even though the point prevalence of UED is frequently higher among dental personnel than the general working population (Alexopoulos et al., 2004; Finsen et al., 1998; Myers & Myers, 2004; Åkesson et al., 1999), the prevalence found in Study I is particularly high. This may follow from the study group, which included only women, who often report more UED than men do (Rundcrantz, 1991; Rundcrantz, Johnsson, & Moritz, 1991) and the long tenure of the employees (mean tenure 15 years, unpublished results). Also, a majority (70%) were working fulltime, that is 40 hours/week. This is more than in other public health care professions in Sweden, in which fulltime weekly work hours are usually 37 to 38 hours due to union agreements. The relationship between UED and high physical workload was clear, despite the fact that the workplace met all modern ergonomic requirements. This suggests that having a good ergonomic environment may not be enough to prevent UED, but rather that it may be necessary to implement other initiatives. These are discussed further in the practical implications section of this thesis. Another contribution from Study I is the inclusion of dental nurses in the study. Most studies on dentistry focus on dentists and/or dental hygienists despite the fact that a majority of dental personnel are dental nurses (57% in Study I) (see for example (Craven, 2008; Finsen et al., 1998; Rundcrantz, Johnsson, & Moritz, 1991). The results from Study I suggest
that in order to prevent ill health and promote health, differentiated initiatives may be called for. Although the prevalence of UED was similar among dental nurses and dentists/dental hygienists, they rated their work environment and other symptoms differently. While dentists reported the highest levels of physical load and fatigue, dental nurses reported the lowest levels of influence at work.

The results from Study III suggest that in order to find effective prevention of stress-related ill health, it is not only psychosocial work conditions, including job demands, that need to be considered. Specifically, being overcommitted to work as evident in an inability to stop thinking about work after leaving for the day may have an even greater impact on processes that are vital to sustained health than do conditions during work. This does not contradict the vast amount of research showing that high job demands, low job control and other job factors act as stressors and are related to stress-related ill health (e.g. Belkic et al., 2004; Bongers et al., 1993; Niedhammer, Goldberg, Leclerc, Bugel et al., 1998). However, it does suggest that in the framework of stress theory, time off work is important to consider. Even when the job situation leads to stress reactions, these may be counteracted during time off work. Overcommitment to work may therefore be particularly troubling in relation to recovery, and may act both as a stressor in itself and by worsening the effect of job stressors by preventing recovery after these stressors. As such, OC may both start an activation period and/or prolong an activation period associated with previous stressors.

Overcommitment may also be related to work conditions more directly. Although most research on worry, rumination and overcommitment has mainly focused on personality traits (Nolen-Hoeksema & Davis, 1999; Siegrist, 1996), there is some evidence that factors in the environment may increase worry as well. For example, uncertainty and unpredictability, which have been suggested as core elements in psychosocial stress factors (Sapolsky, 2004), have also been suggested as predictors of worry (Dugas, Freeston, & Ladouceur, 1997). It may be argued that work factors that increase uncertainty may also increase OC. Such factors may include unclear work goals, poorly specified work tasks and lack of feedback on when work is completed. The importance of these factors has been showed in recent research investigating factors associated with work-related health (Hellgren, Sverke, & Näswall, 2008). From this follows that interventions targeting both individual and organizational factors may be motivated in the prevention of OC and the promotion of recovery from work.

Health and ill health as related to recovery from work

In recent decades, the theoretical framework for stress research has expanded to focus on sustained activation and lack of recovery for understanding
health consequences of demands in the workplace. Study IV shows that lack of recovery, particularly in individuals with a pattern characterized by fatigue and sleep difficulties, is related to an increased risk of allostatic load, that is, a cumulative biological wear and tear. However, this association did not show up in analyses of separate biomarkers. Since analyses of separate biomarkers have been the most common way to investigate associations with health and ill health, the relationship between lack of recovery and fatigue and biological wear may have been missed. From this follows that taking a multisystem approach may be more relevant than investigating separate biomarkers in order to investigate the health consequences of lack of recovery and fatigue. This is particularly true when prevention is of interest: with longer follow-up periods, the AL may have turned into diseases and turned prevention into rehabilitation.

In relation to the aim of this thesis, the result from Study IV suggest that in order to promote health and prevent ill health, factors related to recovery need to be considered. Some of these factors were investigated in Study III. As described above, the main contribution of Study III was the relative importance of overcommitment in contrast to psychosocial work conditions such as high demands and job control. Previous studies relating psychosocial work conditions to lack of recovery have not simultaneously considered overcommitment. From Study III follows that in the promotion of health and the prevention of ill health in the context of recovery, the ability to mentally let go of work should be considered along with, for example, job demands.

Study III also untangled some of the confusion concerning the relationship between fatigue and recovery. The relationship between overcommitment and poor next-day recovery was mediated by fatigue and vice versa. A conceptual model drawn from the result is presented in Figure 3 and shows how having children at home, high job demands, OC and fatigue and next-day recovery may be interrelated. More specifically, it shows that while all these factors predicts fatigue six months later, poor next-day recovery is predicted directly only by job demands and fatigue. The relationship between OC and poor next-day recovery six months later (dotted line) is partly indirect, through the effect of OC on fatigue. Also, the model shows that the relationship between OC and job demands and fatigue six months later is partly mediated by poor-next day recovery, as suggested by the decrease in Beta values for these factors in the regression models in Study III. The results suggest a dual role for fatigue: both as an outcome of stressors and lack of recovery, and as a precursor of lack of recovery (for example, as a stress reaction). This is similar to the distinction between acute and long-term fatigue (Beurskens et al., 2000). Hence, depending on the time frame of the study, fatigue may be either a precursor of recovery (a stress reaction) or a consequence of lack of recovery (a health consequence). Separating the stress response from the recovery process and the consequences of poor recovery is important not least from a preventive
perspective, since fatigue associated with the stress response and fatigue associated with lack of recovery may call for different kinds of interventions.

As suggested in the model, fatigue and poor next-day recovery may have mediating effects in their interrelations with job demand and OC. However, they may also be considered moderators, in that an individual who is already fatigued or have difficulties recovering between workdays may respond differently to job demands and OC, thereby changing the relationship between these factors and poor next-day recovery.

Figure 3. A conceptual model presenting how having children at home, high job demands and OC are related to fatigue and poor next-day recovery, and their interrelations.

The importance of OC in relation to fatigue and poor next-day recovery from work may be one explanation for the lack of effect of RWH and PA on recovery from work (Study II). Reduced working hours would hypothetically increase the time for recovery. But, this would assume that the hours not spent on work are instead spent on activities that promote recovery. Previous research has shown that active non-work activities like social and physical activities promote recovery while passive activities such as watching TV may not. In fact, increasing time for sedentary behaviour (including watching TV) may not only be insufficient in promoting recovery but harmful in itself, according to recent research on sedentary behaviour (Hu, Li, Colditz, Willett, & Manson, 2003; Sugiyama et al., 2008). While type of non-work activity was not assessed in Study II, it may be suggested that the result of RWH may differ depending on what type of non-work activity the individual engages in. For example, if the RWH means replacing
paid work with non-paid household work or other duties, positive effects of recovery are not to be expected. From this follows that with RWH initiatives, it is up to the individual to decide how to spend the extra free time, thereby having a great influence on the outcome of the intervention. In all RWH initiatives to date, the employers have had no influence on how the RWH is spent. Hence, the outcome of the intervention may depend on factors that the employer does not have any influence over. This may make RWH less appropriate as a WHP initiative.

While the lack of effect of RWH on recovery from work may be dependent on what the RWH was replaced by, no simple explanation can be offered for the lack of effect on recovery in the PA group. Previous research has shown that physical activity promotes processes that are related to recovery (Barnekow Bergkvist, 2006), although no studies have directly investigated the effect of a PA WHP initiative on recovery. It is possible that doing PA during work hours is stressful, particularly when expectations on performance are maintained despite a decreased number of work hours (Gerdle et al., 1995). However, no effects of perceived stress were found, and perceived job demands did not increase (unpublished results). Another explanation may be a ceiling effect for PA on recovery. The participants were by no means sedentary before the intervention. With a mean level of low-intensity physical activity corresponding to approximately 3-4 hours of weekly physical activity before the intervention, the increase in PA may not have a profound effect on recovery. More research is needed to learn about dose-response effects of PA on recovery.

Study I showed that in dentistry, the prevalence of UED was extremely high and that individuals with UED perceived their work environment as significantly worse than their colleagues without UED did. They also reported more work-related worries and more fatigue, including tiredness after work, disturbed sleep and an inability to stop thinking about work. Since this was a cross-sectional study, the direction of these relationships is unknown, although results from previous prospective studies have shown that a poor work environment increases the risk of UED (Bongers et al., 2002; van den Heuvel et al., 2005). However, although there was a relationship between having UED and a poor work environment and some aspects of recovery, namely fatigue, and with work-related worries, neither psychosocial work conditions, work-related worries or fatigue turned out to be predictors of UED. In Study I, this was attributed to the physical work situation in dentistry being so demanding that it overshadowed the acute effects of the other factors on UED. Also, the full model only explained 18% of the variance of UED. This suggests that factors other than those investigated, for example heritage factors, health behaviours, correct utilizing of ergonomical equipment, body awareness, etc. need to be investigated to provide a fuller answer.
In Study I, there was a difference in fatigue between occupational groups, with dentists reporting more fatigue than nurses. This may stem from differences in the work situation. Dentists reported greater influence at work than nurses did, which likely is a consequence of the fact that during work, the dentist decides and plans the subsequent steps in the treatment and in doing so, determines the tasks and work pace of the assisting dental nurse. Although influence at work is generally considered a positive work characteristic, it may also have some negative consequences. Being responsible may increase mental stress, including an inability to stop thinking about work (which was one item on the fatigue scale in Study I). In combination with the higher physical load experienced by the dentists, the higher level of fatigue among them is not surprising. However, the dental hygienists also had high levels of influence at work but in contrast to the dentists, showed lower levels of fatigue after work. Again, this may result from differences in the work situation: while dentists decide and plan work for a team, the dental hygienists usually decide and plan only their own work. The additional responsibility of planning work for a colleague may act as a stressor, or increase role overload, which has been reported as a stress factor among supervisors (R. Clark & Smith, 1987).

Conceptual issues

The concept of recovery

As described in the introduction, the concept of recovery contains some problematic aspects and lacks a common definition. Not at least, the same word is used for both the process and the result, and for both the physiological response and the subjective experience. Moreover, recovery is related to different parts of the stress process in different definitions: to the stress stimuli or stressors, the stress experience, the stress response and the result, or experience, of the stress response (e.g. stress level, health consequences), or to the whole process. This lack of precision in the use of the term recovery is problematic and its clarity would probably improve if different words were used for the different parts of the process. Unfortunately, this lack of precision may be evident also in this thesis. Although the term recovery, as stated in the introduction, in this case refers to the experience of the stress response in relation to a stressor (a workday) and the latency to recover (whether one feels recovered after a specific time period), other parts of the process have not been consistently denoted. For example, “the recovery process” is discussed in Study IV, referring to the whole process. Also, inconsistencies may appear when referring to previous studies, since their definition of recovery may differ. In this thesis, no effort will be made to present new denotations for the different parts of the
recovery process. However, it is stressed that in studies of recovery (that is, whatever part of the process it may refer to), it should be clearly stated what part it refers to. Special care should also be taken to ensure that the theoretical definition is in accordance with the empirical definition (the operationalization).

**A model of recovery**

Drawing on the discussion of some of problematical aspects of the concept, previous research and the results from this thesis, a hypothetical model of the recovery from work process is presented in Figure 4. In this model, recovery (that is, the sustained level of arousal (or fatigue) including both the stress response and the subjective experience a period of time after the removal of the stressor) is suggest to be determined by at least four parts: 1) the type, intensity and experience of the stressor (or stimuli); 2) the stress response and the experience of this response, e.g., fatigue, that is reactivity; 3) the time allowed for the recovery process (e.g., time between shifts or time off work); and 4) qualitative aspects that facilitate or impede the process. Hence, the first two are related to the activation (stress) phase, and two to the counteracting recuperation phase. The recovery process may be defined as having ended either a) when the stress reactions are reversed b) after a specific time period or c) when vigour is achieved. These parts are discussed more thoroughly below.

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**Figure 4.** A conceptual model of the recovery process starting with the stress reaction, followed by recovery and supercompensation.
In the first part of the model it is stated that a number of factors may act as stressors that may lead to a need for recovery. Work-related factors acting as stressors that have been shown to increase the need for recovery include high job demands and low job control (Sluiter et al., 2003; Sonnentag & Kruel, 2006), high job involvement (Sonnentag & Kruel, 2006) and high number of hours worked (Jansen, Kant et al., 2003). However, very few stressors (e.g. only physiological stressors such as extreme heat or cold or pain) have the capacity to always inflict a stress response. Instead, it is widely accepted that it is the individual’s appraisal of the stressors as either threatening or challenging that determines his or her reaction to the situation. This will determine the individual’s experience of the situation as stressful or not. The individual’s response to the stressor constitutes the second part of the model. This may be determined by predispositions such as the reactivity of the stress systems, the individual’s appraisal of the stressor and the expectancy he or she has on how he or she will be able to respond to the stressor.

The second part of the model includes both the type of reactivity (different kind of stress responses such as increased heart rate, muscular tension and experience of fatigue and discomfort) and the intensity of the response (how much the individual reacts). It also includes the individual’s experience of the response. From these two parts of the model, it is implied that the need for recovery varies with the intensity of the stressor and the stress reaction, e.g. that more recovery is needed to return to a pre-stressor level after an intense stressor and/or stress reaction than after a less intense one. This seems to be the underlying assumption in most studies of recovery, in which most analyses assume linear relationships. The second part also includes the notion that the stress response may be delayed, remain high or even increase after the stressor is removed. This is a consequence of stress hormones that do not immediately disappear from the blood after the removal of the stressor. For example, the half life of cortisol is about one hour (Barton, Horan, Clague, & Rose, 1999). The stress response may also be sustained for other reasons, including cognitive and emotional processes. These are discussed in the fourth part of the model.

The third part of the model concerns the time during which recovery from work takes place. This dimension is generally included in definitions of recovery. However, the actual amount of time (e.g. minutes, days, weeks, etc.) needed for recovery is, with some important exceptions (Sluiter et al., 2000), seldom discussed. Also, often, no factors other than the passage of time are considered. Instead, it seems that an underlying assumption is often that recovery is a function of time alone, as in the Effort-Recovery model (Meijman & Mulder, 1998). From this follows that with adequate time between work shifts or other effort expenditures, recovery is assumed to occur automatically. This makes recovery a passive process and may be a more relevant view if recovery is discussed solely from a physiological
perspective. However, if recovery is discussed from a biopsychosocial perspective, there is evidence suggesting that recovery is an active process that is affected by different activities, behaviours and individual predispositions. This constitutes the fourth part of the model. Among factors believed to intervene with the recovery process (either facilitate or impede it) is doing work-related activities during off-job time (impedes recovery) (Sonnentag & Zijlstra, 2006; Zijlstra & Sonnentag, 2006), worrying or ruminating (impedes recovery) (Pravettoni et al., 2007; Sonnentag et al., 2008), doing active non-work activities such as exercise and creative and social activities (facilitates recovery) (Rook & Zijlstra, 2006; Sonnentag, 2001; Winwood et al., 2007) and being physically fit (facilitates recovery) (Traustadottir et al., 2004).

It is also possible that different kinds of activities affect recovery differently depending on what kind of activity caused the need for recovery. In sport psychology, this is known as the matching principle of recovery (Kenttä & Hassmen, 1998). This means that different kinds of loads give rise to different kinds of recovery needs (as well as differences in magnitude). For example, high physical energy output may require dietary supplements to facilitate recovery, while mental and emotional load may require physical activity or social support, rather than carbohydrates. From this follows that some recovery activities may be appropriate under some circumstances while others are not. Although this has not yet been investigated within work psychology, related findings have been presented. A study that showed that evening recovery experience predicted affect next morning also suggested that different aspects of the recovery experience, that is detachment, mastery and relaxation, may be related to different affects (Sonnentag et al., 2008). While mastery, which was defined as challenging off-job experiences that offer opportunities for learning and success, was related to positive activation (e.g. feeling alert, strong and interested), relaxation was related to serenity (e.g. feeling calm, laid-back and placid). Low psychological detachment from work was related to negative activation (e.g. distressed, upset and jittery) and fatigue. Although these results do not directly investigate the matching principle (that is matching load with recovery), they do suggest that specific recovery activities are related to different outcomes.

Another important factor affecting the recovery process, which is relevant for recovery from a biopsychosocial perspective and the fourth part of the model, is sleep quality and sleep disturbances (Rook & Zijlstra, 2006). Since this thesis focuses on recovery from work in general and not sleep in particular, the importance of sleep will be discussed briefly with no ambition to cover the whole research area. The importance of poor sleep in the stress-strain relationship has been highlighted recently (Åkerstedt et al., 2002; Åkerstedt, 2006). Although the full function of sleep is not known, anabolic processes are plentiful during sleep, while catabolic processes are at their lowest. As such, sleep is likely to be necessary for recovery. However,
recovery is also likely to be necessary for sleep: high levels of stress impede
the sleep process and compromise the quality of sleep. Particular, worry over
the stressors of the next day is troublesome, as is rumination over past events
(Åkerstedt, 2006; Åkerstedt, Kecklund, & Axelsson, 2007; Cropley et al.,
2006; Ellis, Hampson, & Cropley, 2007). This is parallel to the findings in
Study III, whereby overcommitment was related to lack of recovery and
fatigue. The consequences of poor sleep, in combination with mental and
physical fatigue during and after the workday and not feeling fully rested
were also highlighted in Study IV, in which the group with this profile had a
higher risk of AL. Unfortunately, the results do not yield any information on
the temporal order of the items included in the profile, or their relative
importance. However, drawing on previous results concerning the health
consequences of poor sleep (Åkerstedt & Nilsson, 2003), the sleep
difficulties may very well be important in the relationship between the
fatigued profile and AL.

Generally, recovery is defined in relative rather than absolute terms, that
is, in relation to a baseline or pre-stressor level, a stressor, and/or a stress
response. This does not yield information on any absolute levels of recovery,
that is, whether the result of the process needs to reach a certain level for it
to be sufficient, regardless of the starting level. For example, is return to
baseline always necessary, if baseline is very low, or is return to baseline
always sufficient, even if baseline levels are very high? (As mentioned in the
introduction, baseline lacks in precision but in this case should be interpreted
as resting levels of, for example, blood pressure). This may very well be the
case. Keeping this in mind, the relative model fits most cases, and is the
approach taken in this model.

When does the recovery process end?
As described in the model, the termination of the process may be determined
by different factors. Three possible ways are suggested in this model, two
theoretically motivated (a and c in the model) and one motivated by practical
reasons. Of these, the first (a), in which recovery is said to be achieved when
arousal levels have returned to baseline or a pre-stressor level of functioning,
is cited most frequently in theoretical models. However, in empirical studies
and for practical reasons, the second option (b) is the most common: A
specific time period during which the recovery should have taken place is set
(e.g. after a night’s sleep), and the level of remaining arousal at that time is
assessed. This was the approach taken in this study, with participants being
asked to rate their level of recovery at different time points after the workday
had ended (assumed to equal the termination of work stressors). However,
choosing a meaningful time frame for the study of recovery is compromised
by the lack of information on the timing of recovery. As described in the
introduction, in the research of recovery from work, the time frame is often
same-day recovery, e.g. immediately after work or before sleep (Jansen et
Longer time frames, such as the next morning or after a weekend, are more seldom considered. An exception to this is recovery after vacation, which has been investigated more thoroughly (Etzion, 2003; Westman & Eden, 1997). The concentration on short time frames may be unfortunate. If the assessment of the recovery process takes place too soon after the termination of the stressor, the assessment will contain information on the stress response rather than the efficiency of the recovery process. Lack of same-day recovery may therefore be tapping stress reactivity rather than recovery (e.g. a strong stress reaction that takes time to subside). The value of this information from a health perspective may be questioned: being fatigued or aroused in the proximity of the removal of the stressor may be part of a natural and well-functioning stress-recovery response. This may also contribute to the confusion concerning the relationship between recovery and fatigue, since, as discussed in the introduction and Study III and as is evident in the model, fatigue may very well be both precursor to recovery and a consequence of lack of recovery. Moreover, focusing on short time frames may miss associations relating to not feeling fully rested after a night’s sleep, that is not being recovered between workdays. This has previously been related to elevated cortisol levels (Gustafsson et al., 2008) and has strong face validity: while it may be reasonable to be fatigued after a workday, feeling refreshed again when it is time for the next workday is of practical importance. Including more than same-day recovery in the assessment of recovery from work was also supported in an inspection of the frequency distribution for the fatigue and recovery items from Study IV. This shows that although approximately half of the participating women reported that they often or very often felt fatigued (mentally and physically) during and after the workday, the percentage of women reporting that they never or seldom were recovered after a night's sleep and before the next workday was approximately 30%. This dropped to 11% after a weekend and 3% after a vacation (unpublished results). Although this gives an indication of the timeline for recovery from work, data with more time points are needed to yield more information on this process, including intense data from both self-ratings and physiological measures. In addition, it is suggested that in future research, time frames of recovery should be explicitly discussed and motivated given the aim of the study, including both the theoretical and empirical definitions. Efforts should also be made to distinguish between the reactivity phase and the recovery phase. This means being certain of whether the assessment is done on the up-slope or down-slope of the curve (see Figure 4).

Along with the ending of the recovery process being determined by a return to baseline, or a specific time period, a third option for determining the end of the recovery process is suggested: when vigour is achieved. This is a direct parallel to what is expected as an end product of recovery in sports. In the study of recovery within that discipline, recovery is an
indispensable part of the training process. The sought-after result is not merely a return to baseline but improved function, for example muscle strength, a process labelled supercompensation (Fry, Morton, & Keast, 1992). Does a parallel to supercompensation in sports exist within recovery from work? That is, does stress that is followed by sufficient recovery lead not only to a return to baseline but to vigour, an improved functioning or toughness? This may be dependent on what the individual is recovering from. For example, if the individual is severely fatigued, or exhausted, recovery may be interpreted as “not being fatigued any longer”, that is as a return to a baseline. If the individual is merely tired or experiencing less severe fatigue, recovering may include feeling alert or invigorated. This could be a psychological parallel to super-compensation.

While the overall model of improved functioning after a stressor if followed by sufficient recovery can be translated from sport psychology into work psychology, the mechanism likely cannot. The mechanism for supercompensation within sport is physiological, involving overtraining (exceeding the load previously handled) and recovery, which leads to adaptation by muscles, joints and cells (Kanttä, 2001). Similar physiological mechanisms relevant for recovery from work and work stress may involve physiological habituation, e.g. a reappearing stressor that does not evoke as large a stress response as a novel stressors does, or adaptation, e.g. up- or down-regulation of transmitter systems and/or receptors (H.R. Eriksen et al., 1999). Moreover, psychological mechanisms may be important. Such psychological mechanisms relevant to supercompensation may be found within the literature of coping. For example, positive effects of successful coping, defined as the reduction of uncertainty that follow from having a positive outcome expectancy, are indicated (although not further discussed) in the cognitive activation theory of stress (Ursin & Eriksen, 2004). Moreover, although coping is frequently related to the regulation of distress and the management of problems causing distress, it may also be related to positive outcomes (Folkman & Moskowitz, 2000). Such outcomes may include positive emotional experiences, including mastery, gain, happiness, pride or relief (Folkman & Lazarus, 1985). In discussing the mechanism for how coping may help individuals minimize or avoid the adverse effect of health, Folkman and Moskowitz (2000) have suggested that one such mechanism may be the experience of positive affect. The function of positive affect has been described as involving decreased vigilance and a change in information processing (Aspinwall, 1998), including a broadening of an individual’s attentional focus and behavioural repertoire, which in turn has been suggested to build social, intellectual and physical resources (Fredrickson, 1998). Physiologically, positive emotions have been described as undoing the after-effects of negative emotions (Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000), thereby buffering against negative effects of stress. Future research needs to clarify the role of
recovery in relation to an analogue to supercompensation, coping, positive affects and other aspects that may be related to improved functioning.

Methodological considerations

This section focuses on the some of the general methodological considerations that are relevant in this thesis. Issues already discussed in the Method section will not be repeated here. For those methodological considerations discussed in each study, which can be found in the reprints at the end of this thesis, only issues that need further elaboration will recur here. Finally, considerations with direct relevance to the interpretation of the findings are discussed in the Interpretation of findings section, earlier in the discussion.

Intervention Research

Much is known about the basic relationships between work conditions and health and ill health. That is, we are now able to say with some certainty that factors such as high job demands, low job control, effort-reward imbalance, lack of social support, etc., increase stress and are potentially harmful to health. However, there are still relatively few intervention studies compared to observational studies, despite good reasons for conducting them: 1) intervention studies are usually more conclusive regarding causality and 2) allow the investigation of implementation of workplace change, 3) positive results are often more convincing, particularly to people outside the scientific community and 4) are more easily disseminated from research to practise and 5) by necessity involve collaboration between researchers and workplaces, facilitating learning and communication on both sides (Kristensen, 2005). One reason for the relative lack of intervention research may very well be the inherent challenges in this kind of research, ranging from difficulties in finding organizations willing to participate, high costs, low participation rates when individuals are not approached dependent on their own needs but the needs of the organization and high dropout rates due to change of jobs, etc., to low power and lack of understanding for conducting workplace interventions within the research community, etc. Also, conducting workplace interventions of high methodological quality, particularly randomized controlled trials (RCT), is often difficult. For example, only rarely is it possible to use a blinding procedure and a placebo condition and often, individual randomisation is not acceptable from an organizational perspective (Shephard, 1996). Therefore, the use of methodologies other than RCTs has been suggested as acceptable in workplace intervention studies (Kristensen, 2005). These designs include quasi-experimental designs, such as in Study II. However, not using RCT
still means that effort has to be put into overcoming some of the problems stemming from not using experimental methodology. In Study II, the use of a control group, the randomization on the organizational level and the prospective design with evaluation against baseline measures are three things that improve the study’s methodological quality (Kristensen, 2005).

One of the major problems with non-experimental designs is the lack of control over confounding variables. Using a randomization procedure on the organizational level minimizes the risk of confounding factors related to the workplace, such as differences in leadership or motivation for change that would make one work group more prone to participate than another. It is also administratively convenient and may enhance subject compliance, help avoid intervention contamination and be more easily translated into practice (Raudenbush, 1997). However, this kind of randomization does not protect against confounders associated with individual differences. When control over confounders cannot be achieved by individual randomization, statistical control is an option. However, controlling for too many confounders is not only statistically challenging and may cause problems with interpretation, but also decreases external validity. In Study II, differences between groups at T1, before the intervention, were carefully investigated, and very few significant differences (in fact, only one, higher perceived demands in the RWH group) were found. Therefore, no confounding variables were controlled for. Still, without an experimental design, there is no guarantee that factors other than the intervention did not affect the outcome. Despite these issues, intervention research provides a great opportunity to clarify relationships between variables. But most of all, its high external validity makes it more powerful in providing evidence of the effectiveness of interventions and WHP to organizations. Along with providing an example of possible interventions that may be used as guidelines for organizations, this may contribute to bridging the gap between science and practice. Not least, this is a powerful argument for doing intervention research.

Randomizing on the organizational level is similar to using cluster randomization in that pre-existing natural groups, or clusters, are randomized instead of individuals. However, cluster randomization usually involves more clusters, making the randomization procedure more similar to an individual randomization (Raudenbush, 1997). In Study II, only three pairs of clusters, that is pairs of matched workplaces (see Method section for a description of the matching and randomization procedure), were allocated to the three conditions, which means that it was a very restricted randomization. As described above, the main reasons for using any kind of randomization were to protect against confounders associated with organizational factors such as differences in leadership and motivation, increase compliance, avoid intervention contamination and maintain the natural groups. Matching, on the other hand, was used to protect against confounders associated with pre-existing individual differences in health as
measured by sickness absence levels. Another goal of the matching procedure was to minimize differences between clusters. This is important in order to minimize or avoid cluster effects, which may distort results if baseline differences between clusters are large, since data from individuals within a cluster tend to be correlated (Raudenbush, 1997). Baseline comparison between groups showed that this goal was achieved.

All study participants for whom values on biomarkers deviated outside the expected range and needed medical consideration were immediately informed of this. This means that some participants received information on their biological indicators during the project. Getting this information may have influenced individual behaviours, for example seeing a doctor, starting or changing medication or making changes in health behaviours that in turn may have influenced the outcome measures in Study II. However, there were no differences in the number of participants receiving feedback in each intervention group. This, in combination with the relatively large groups, may have limited the risk of having feedback influencing the result. In addition, giving feedback to participants on medical issues is highly motivated from an ethical perspective and was in accordance with the ethical guidelines.

In Study III, longitudinal data from an intervention project were used, despite the fact that the intervention was not in focus. However, data from the second and third wave of data collections were utilized and hence, no systematic change took place between the measurements. Also, none of the interventions had any effect on the factors of interest in the Study III (as shown in Study II). Furthermore, there were no effects of intervention groups when controlling for this in Study III (analyses not shown). Despite this, the interventions did affect other factors, as shown in Study II. The results from Study III should therefore be replicated on longitudinal data that are not part of an intervention project.

Measurement issues
As discussed in the introduction, the main drawback of self-ratings are subjectivity and the risk of shared response bias (if both independent and dependent variables are self-ratings), while biological markers may suffer from seasonality and diurnal variation and sensitivity to confounding factors associated with the time of assessment, as well as interpretation difficulties (Åkerstedt & Theorell, 2002; Hurrell et al., 1998; Watson & Pennebaker, 1989). Control over well-known confounding factors such as smoking, eating, wake-up time and high stress levels was sought after by providing detailed instructions to the participants on how to behave before the health checkups. Data on compliance were gathered at the health checkup to allow statistical control. Information on medical conditions and medications was gathered in the questionnaire, and data from individuals with metabolic
disorders and those who were pregnant or breastfeeding were removed from further analyses. Overall, compliance with the health checkup instructions was high with small and/or few deviations. Moreover, biological markers in women may be particularly difficult to interpret due to variations in hormone concentration over the menstrual cycle. However, the biological markers included in this study do not vary with the menstrual cycle (Ahmad, Pollard, & Unwin, 2002; Epstein, McNeilly, Murray, & Hockaday, 1975).

Measuring health is particularly challenging (for a systematic discussion, see the Method section). A number of steps were taken to provide a valid picture of health. These included using multiple markers of health as well as using data from different systems (e.g. different biological systems and self-ratings). Although effort was made to assess a broad map of indicators of health and ill health, the markers included still represent a selection of possible aspects of health and ill health. This means that, for example, oxygen uptake, adrenaline and noradrenaline, personality traits, self-efficiency, coping and resilience were not assessed. Oxygen uptake, as measured using a sub-maximal cycle test, would have been helpful in evaluating the effects of PA on cardiovascular fitness. However, this would have complicated the measurement protocol and as such, increased costs and may have led to increased dropout. The same argument was made against the assessment of catecholamines, which is most reliably done from urine samples (U. Lundberg, 2002a). Extra blood samples for the assessment of immunomarkers were drawn and saliva samples for the assessment of cortisol were collected but were not yet analysed for inclusion in this thesis, due to time- and financial restraints.

The questionnaire used in this thesis was constructed with the intervention project in mind. Since the theoretical foundation for effects of RWH is limited, and since a wide range of factors may be affected by changes in PA, the self-rating questionnaire was constructed to assess a wide range of possible outcome factors. The questionnaire was extended to also include factors that may act as confounders, making statistical control possible if necessary. Therefore, the questionnaire used in this thesis was extensive. Despite this, possible confounding factors such as personality traits, self-efficiency and coping were not assessed. The main reason for this was to avoid an even lengthier questionnaire by focusing on assessing factors more directly related to ill health, health, work and balance between work and non-work.

In Study I, data from a general work environment assessment were used. This means that the items were pre-existing, and were not influenced by the researchers. Before statistical analysis, the data were inspected to ensure their suitability for data analysis. For example, new scales were constructed using factor analysis. Although it is a disadvantage not to use frequently used scales, the pre-analytic procedures increased the reliability of the measures while avoiding analysing single-items, which would increase the
risk of Type I error. However, for one factor in particular, the statistical analyses yielded a result that may be somewhat confusing given the other operationalizations in this thesis. This was the factor labelled fatigue, which in Study I included three items: disturbed sleep, tiredness after work and an inability to stop thinking about work-related issues during one’s free time. In Study III, which focused more specifically on these concept, inability to stop thinking about work is the core construct of OC (Siegrist et al., 2004). This shows one of the disadvantages of exploratory factor analysis: the results are dependent on which items are included in the analysis. This means that items may load on different factors in different analyses, depending on which items are included. In the interpretation of the results from Study I, it is important to keep in mind that the items of the fatigue factor differ from the fatigue factor in the other studies, and that caution is needed in interpreting the relationship between this factor and UED, since the factor includes items relating to both fatigue and OC.

The operationalization of fatigue also differed somewhat between Studies II and III. Sleep difficulties related to excessive thinking of work is included both in the fatigue measure used in Study II and in the OC scale. To avoid overlaps in Study III, where the interrelationships between fatigue and OC was analysed, the sleep item was omitted from the fatigue scale in this study. In Study III, the overlap with the OC scale meant increasing the risk for the triviality trap, that is having an independent and a dependent variable that are so similar that they come close to measuring the same thing (Hurrell et al., 1998). In Study II, no such risks were evident and in that case, keeping a previously used scale in its original form was considered more important.

No objective measure of physical activity was assessed in this thesis. This is unfortunate, since self-ratings of physical activity frequently deviate from objective levels, with low correlations with absolute time spent on physical activity and energy expenditure (C. L. Craig et al., 2003; Wareham et al., 2002). However, other ways of measuring PA that are more valid than self-ratings, such as accelerometers (pedometers), involve considerably more complicated protocols, making such measures expensive, rather invasive and time-consuming. Also, questionnaires on physical activity usually have good reliability and can be used to assess prevalence estimates and to categorize participants into activity categories (C. L. Craig et al., 2003; Wareham et al., 2002). This makes self-ratings of PA and PE suitable for this thesis, since its aim makes relative levels of physical activity and physical exercise (between groups and, particularly, between time points) more relevant than absolute levels. However, using a scale with a wider range than the four-point scale used in this thesis may have allowed for more detailed analysis. On the other hand, the differentiation between PA and PE is a strength, and decreases the drawbacks of using a four-point scale.

PA level was a factor that was deliberately manipulated as part of the intervention in one of the groups in Study II. This means that PA was
controlled for in the design, and from this follows that, with respect to the PA group in Study II, the self-ratings served as a control of the compliance with the intervention (that is, did those who were supposed to exercise really exercise? This is equivalent to “Did the patient really take the pill?” in medical studies). This is an important aspect of any intervention study, since it has direct relevance to the validity of the study: if a participant in the intervention groups participates in the study but not in the intended activity, it is not the effect of the intended activity that is investigated. Along with measuring self-ratings of physical activity, follow-through was also encouraged more directly through the design of the intervention: each PA session was scheduled during work hours and each participant was to record their PA sessions each week in a shared forum. This was then checked weekly by a specially assigned employee, and any deviations were discussed.

Using three time points, six months apart, is in line with previous studies (Anttila et al., 2005; Wergeland et al., 2003). Furthermore, in both Study II and Study III, it was sufficient to show relations between the studied variables. However, using more time points may have further highlighted the effect of the interventions. For example, longer follow-up times may have clarified the effects on work ability and general symptoms. Also, more intense data points may have elucidated the process of recovery and mechanisms involved in RWH. Moreover, to further clarify the different part of the recovery process, more intense data points would be helpful. However, including more data points may also increase reactivity to the measures and the risk of increased dropout, leading to a biased sample and measures (Kompier & Kristensen, 2001).

Person-oriented versus variable-oriented approach

In most studies, as well as in Studies I-III in this thesis, a variable-oriented approach is taken. As described in the Method section, in variable-oriented research variables instead of individuals are studied. This means that in the analyses, the individuals are considered replaceable, randomly selected data carriers. This allows for a wide range of statistical analyses to be used and relationships between variables to be investigated. However, it is based on the assumption that all individuals in a population are homogenous (Tabachnick & Fidell, 2007). Individual differences are considered error-variance. This may be considered provocative and counter-intuitive, particularly within the behavioural science. In a person-oriented approach, which was taken in Study IV, the assumption is that a population consists of subgroups, and that the “error variance” consists of meaningful, individual differences (Bergman et al., 2003). In its smallest entity, the subgroup consists of one individual. However, since this is impractical in studies, individuals who exhibit similarities are combined into larger subgroups. In
contrast to the variable-oriented approach, behaviours instead of variables are sampled. Unfortunately, person-oriented methods are sparsely used in biological and work psychology and therefore, many researchers are unfamiliar with the methods. The use of person-oriented methods is motivated when subgroups exhibiting different patterns are expected, because these may be masked when a variable-oriented approach is used. Such patterns appeared in Study IV, in which not all women with poor recovery and fatigue were likely to have an increased risk for AL. Letting the aim of the study influence the approach taken, and/or combining variable-oriented and person-oriented approaches is an important task for future research.

Operationalization of AL

In Study IV; the separate biological markers were added to form a cumulative score of AL. This measure has several advantages as a stress-related outcome compared to individually analysed biomarkers, including having a clear theoretical foundation and making it possible to minimize statistical test by using a sum variable. The biological parameters included in the operationalization of AL differ somewhat between studies, but the reasons for choosing them are similar: the parameters should reflect multiple regulatory systems, and have known or hypothesized links to various health endpoints (Gruenewald et al., 2006; McEwen & Seeman, 1999; Seeman, Singer et al., 1997; Seeman et al., 2001; Seeman et al., 2004). These reasons guided the selection of parameters in this thesis as well. Furthermore, and similar to previous studies (Gruenewald et al., 2006; McEwen & Seeman, 1999; Seeman, Singer et al., 1997; Seeman et al., 2001; Seeman et al., 2004), the choice was restricted to the parameters available in the present dataset. Although this means that catecholamine, cortisol and immunomarkers were not included, the AL measure included markers of cardiovascular activity; blood lipids associated with increased risk of atherosclerosis and cardiovascular disease; measures of fat deposits associated with increased risk of diabetes and overweight; integrated measure of glucose metabolism, a measure of adipose tissue deposition and metabolism, a functional HPA axis antagonist and a hormone sensitive to sleep and stress.

Unfortunately, as with most other studies using different operationalizations of AL, similarity between the AL measure used in Study IV and those used in other studies cannot be established. Recent research comparing different operationalizations of AL has shown that differences in the biological markers included have only a modest effect on various health-related outcomes, although it indicates that keeping the continuous properties of the included biological markers in the summary index may yield stronger predictions regarding some health outcomes (Seplaki, Goldman, Glei, & Weinstein, 2005). However, the additive method used in
this thesis is the most common, and has the advantage of being more easily interpreted and allowing for comparison with other studies using the same method.

Studies using AL also differ in the calculation of cut-points and data from individuals using medication. Cut-points can be derived either clinically or empirically, or a mix. In this thesis, empirically based cut-points were used. This is in line with previous studies on AL (Crimmins et al., 2003; Karlamangla et al., 2002; Lindfors, Lundberg, & Lundberg, 2006; Seeman et al., 1997; Seeman, Singer et al., 1997; Seeman et al., 2004). Using empirical cut-points may be motivated by the fact that since AL is a pre-clinic measure, cut-points should also be pre-clinical. This is particularly relevant given the population studied. Using clinical cut-points in a group of healthy, working women would mean that only a very restricted number of cases would be available for analysis. Scoring of individuals taking medication that might influence levels of one or more of the biological parameters is a common dilemma in research on AL (for instance, see Seeman, Singer, Ryff, Dienberg Love, & Levy-Storms, 2002). In our study, the number of individuals taking such medication was low (16%). In addition, the analyses were rerun excluding women reporting that they currently took medication that alters blood pressure, cholesterol or glucose levels to examine the effect of medication on our results. These results were not different from those reported in the Study IV (unpublished results) and consequently, we conclude that the impact of medication on AL is of minor importance in the present sample which includes healthy, employed women.

Statistical considerations

In this thesis, different statistical methods were used. As discussed above, with only one exception, these were variable-oriented approaches. The general approach guiding the choice of statistical method in this thesis, besides being appropriate in answering the research questions and having data that met the relevant assumptions, was 1) to use analyses of variance whenever groups differences were of interest and number of covariates was limited 2) to use logistic regression when relative risk was of importance (Tabachnick & Fidell, 2007) and 3) to use the most uncomplicated methods whenever possible. With the exception of Study II, a number of different analytic strategies were used in each study.

Using multiple indicators of health and ill health has many advantages as discussed previously, but may also have some unfavourable consequences. One of the more important risks is that of Type I error (false positive), which increases with the number of statistical tests performed. This problem is specifically relevant in Study II. Simply decreasing the number of significance tests empirically (for example, by factor analysis) was not feasible, since this would decrease the validity of the study. Nor was the
A theoretical framework sufficient for guiding the removal of outcome factors. A Bonferroni correction was not done, since the power of this kind of intervention study is limited to begin with. A further decrease in power would inflate the risk of Type II error substantially. Instead, the results are interpreted as patterns rather than focusing on each individual outcome. To further minimize the risk of Type I error, the effect in each group was tested only after a significant time- or interaction effect was present. By doing this, more detailed information on what contributed to the interaction and/or main effect was gained while all factors for each condition still did not have to be analysed.

Generalizability
This thesis was set among municipally employed women working with dental care or elderly care. This sector employs very few men and therefore, the results from this thesis can be argued to be valid for the sector as such. However, the results may also be generalized to working women in other sectors, particularly those with similar job characteristics. Self-employed or home-staying women or men, on the other hand, may differ in aspects relevant to the results. Employment status may interact with financial, health and social factors. Employed men and women differ in their work-home configuration, with women generally taking more responsibility for home and children and doing more unpaid work (Gjerdingen et al, 2000; Krantz, Berntsson, & Lundberg, 2005; U. Lundberg & Frankenhaeuser, 1999). Men and women also differ endocrinologically, which may obscure relationships between self-ratings and biological markers. Therefore, results from this thesis, particularly from Studies III and IV, needs to be replicated among men.

As described in the introduction, some work factors are particularly pronounced within this field, including a combination of high emotional and physical demands, and the prevalence of work-related illness is high (Bäckman, 2001; O. Lundberg & Gonäs, 1998; The Work Environment 2007, 2008). Therefore, care must be taken in generalization to other sectors. However, although it represents a particular work sector, different educational levels are represented within dentistry (but not within elderly care). This suggests that generalization may be made across educational levels.

Ethical considerations
Doing research in the workplace means reaching potential participants through their employer, on whom the employees are more or less dependent. The employer’s decision to allow a research project to take place may
influence employee decision to participate, if they believe their employee-employer relationship would be affected by it. From this follows that particular care must be taken to ensure that participation or non-participation does not affect the employee’s situation in the workplace, in either a positive or negative way. An obvious first step is to guarantee employee anonymity, so that the employer has no knowledge about who has volunteered to participate in the research project and who has not. In the research presented in this thesis, care was taken to separate the participation in the WHP, which was a responsibility of the employer, from the participation in the data collection done to evaluate the interventions, for which the researchers were responsible. Hence, the employer decided that participating in the WHP was mandatory, while participation in the evaluation of the WHP was voluntary. This was communicated both orally and in writing. Secondly, the union was involved in the decision to allow the research project to take place. This means that the employee representatives supported the project, and that employees had a saying in the decision. Despite this, and despite efforts to keep the employers blind as to who participated in the research part of the project, the possibility cannot be eliminated that the awareness among employees that participating was encouraged by the employer still may have influenced their decision to participate.

Allowing a research project to take place at a workplace means investments from both an individual and an organizational perspective. For the individuals, time has to be allocated for receiving information, health checkups and questionnaires. They also have to withstand the discomfort associated with undergoing a physical exam (e.g. measuring blood pressure and taking blood samples). For the employer, the investment involves allowing health checkups and information meetings during work hours, hence decreasing productivity. To compensate for this in some way, an effort was made to reciprocate to both individuals and employers. This was done after the end of the project, by giving feedback on the results of the studies. Each individual received their results from the three health checkups, in writing, and each workplace was given a presentation of the results for that group as well as the overall results of the studies. Detailed, written reports on the group results were also produced and presented to the organizations involved.

Another ethical question concerns the WHP itself. Who bears the responsibility for individual health, the employee or the employer? Despite the obligations outlined in the Work Environment Act (Arbetsmiljöverket [Swedish Work Environment Authority], 2008), it is difficult to ignore the responsibility of each individual for his or her own health. One argument for the individual’s responsibility is that health is affected by, and affects, much more than work. Since the employer does not have an influence over these circumstances, it can be argued that they should not bear any responsibility for them either. In fact, only the individual has the potential to influence all
factors that are related to health. Another argument for health as an individual responsibility is that, although employers or others may influence individual behaviour, only the individual can change it.

A related question is what kind of demands an employer can put on employee health and employee health behaviours. This question may not have a given answer. First, it depends on the answer to the first question. If health is regarded as solely an individual responsibility, the employer may either set criteria for what they expect of their employees without providing any means, or take a “hands-off” approach and leave health-related issues exclusively to the individual. Both approaches may be argued to be ethically questionable. In Sweden, the employer is responsible for the work environment. This means that the organization is obligated not only to minimize risks but also to facilitate employee health and well-being from a broader perspective (Arbetsmiljöverket [Swedish Work Environment Authority], 2008). As such, it can be argued that in order to fulfil the legal requirements, WHP is appropriate. Moreover, the work environment-health relationship is dependent not only on the work environment per se, but also on the employee-work environment fit. No matter what measures are taken to improve the ergonomic situation, for example, it still depends on how well equipped the individual is to meet the demands of the workplace. That is, having employees who are fit or strong enough to meet the demands of their workplace may be a necessity for employers to meet their legal obligations. From this perspective, putting demands on employee fitness may be reasonable, particularly if work time is allocated for these activities. This is also the case within some occupations, such as among fire-fighters and policemen, where physical exercise has traditionally been an integrated part of work.

Practical implications

Consequences of UED and reasons for action

Since working adults spend so many of their waking hours at their workplaces, the conditions there are important for employee health and well-being. For most people, the benefits of paid work override the costs: not only financially but by providing goal-directed activity and a daily structure, along with social contacts. Paid employment has been related to better social support, increased creativity and control and increased intrinsic and extrinsic gratification, including income (Barnett & Hyde, 2001; Bird & Ross, 1993; Hibbard & Pope, 1992; Mirowsky & Ross, 2007; Repetti et al., 1989; Yoshii & Yamazaki, 1999). However, it is undisputed that poor work conditions have the potential of causing ill health and sickness. In dentistry, this includes UED, which is a very common problem. The negative
consequences this has for the individual are obvious, in terms of pain and the long-term increased risk for sickness absence, decreased productivity and early exit from the work force (Hagberg, Vilhemsson, Tornqvist, & Toominaas, 2007; Huissdette et al., 2008; Wiitavaara, Barnekow Berkvist, & Brulin, 2007). From this follows that for the individual, there is an increased risk not only of losing his or hers health, but also of losing the benefits of having a paid work. For the individual, increasing one’s knowledge about what factors are related to UED may increase the possibility for the individual to notice, and make changes to, a potentially harmful situation. For example, being aware of the risks associated with being exposed to high physical load may increase the individual’s motivation for utilizing the ergonomical equipment that the employer supplies.

However, work-related ill health is a problem not only for those individuals who suffer, but also for their employer. Many of the consequences that affect the individual also affect the employer. Factors like reduced work ability, sickness absence, high turnover and early retirement all have financial implications for the organization. First, there are direct costs related to sickness absence and high turnover (sickness salaries during early sickness absence, the cost of rehabilitation, recruitment costs, etc.). Second, the indirect costs are high. One of the highest is productivity costs, that is the productivity losses due to the values lost when the employee is not present doing his or her job, and replacement costs, that is the cost of replacing the absent employee. Productivity costs may also include losses associated with poor performance among employees who have impaired health and/or functioning, but still are part of the work force. Also, indirect costs may include legal sanctions, fines, etc. Organizations may therefore be motivated not only by moral and/or legal obligations to intervene, but by economic reasons as well.

Possible interventions — PE and RWH

The fact that many adults spend so much time at work does not only poses a potential problem in terms of exposure to harmful environments. It also makes the workplace a suitable arena for health interventions and health promotion. Even small improvements in working conditions or employee health habits may be effective in improving employee health. In Study II, it is shown that PE during work hours may be related to improved physical health, whereas RWH cannot be recommended as a general intervention to improve health. As explained above, one reason for this may be that the effect of RWH may be dependent on how the reduced working hours are spent. What individuals do during their free time is a factor that few organizations have influence over. PE, particularly when scheduled during working hours, on the other hand, may be less dependent on individual
factors and may therefore be better suited as an “all-for-one” intervention (that is, general rather than adapted to individual needs). Another option for employers is WHP that is adapted to individual needs, giving the individual a choice between different interventions or targeting different interventions to employees at different stages of change. This has yielded support in previous research (Marshall, 2004).

PE during working hours seems particularly appropriate when the goal is to improve physical health and/or when physical fitness is important for fulfilling job requirements. The challenge for organizations wishing to gain the positive effects related to PE interventions lies in reaching all employees. Previous research has shown that almost inevitably, physical activity interventions are more successful in attracting employees who are already physical active, whereas sedentary employees and those with health problems seldom participate (Alexy, 1991). Reaching blue-collar workers has been particularly challenging (Gebhardt & Crump, 1990). This is particularly troublesome since it is among those who are less likely to participate that the need is greatest and the most pronounced effects can be expected. If physically inactive employees do not participate, it may even be questionable whether physical exercise is an effective intervention, particularly if the exercise is scheduled during work hours and hence involves a cost in terms of fewer productive hours. However, Study II shows that it is possible to achieve a high participation rate. This is in line with previous research showing considerably higher participation rates when the PA takes place during work hours (H R. Eriksen et al., 2002; Pohjonen & Ranta, 2001; Yancey et al., 2004).

Since attracting participators to initiate and maintain a PA program is one of the great challenges in health promotion, much of the literature on PA focuses on motivation: what makes people start and sustain an exercise regime? (see for example Armitage & Conner, 2000). The PA initiative in this thesis was mandatory. This means that the initiation of PE was externally regulated and motivated and negatively reinforced. According to the self-termination theory (Ryan & Deci, 2000), this kind of motivation is less likely to maintain the behaviour, and more likely to produced negative affect than intrinsic motivation, that is when the behaviour in itself is rewarding (Deci & Ryan, 2008). Also, mandatory PA may interfere with autonomy, to act volitionally, which frequently has been described as an important part of intrinsic motivation (Deci & Ryan, 2008; Ryan & Deci, 2000). Hence, a mandatory PA initiative may counteract factors associated with maintenance of behaviour and positive affect. However, although intrinsic motivation is important in order to increase long-term engagement, externally regulated behaviours may be appropriate in initiating activities. By making the PE mandatory, individuals will have the opportunity of directly experiencing the effects of PE, as well as directly testing his or hers abilities to perform the activity. According to the theory of planned
behaviour, this will increase the likelihood for a positive attitude towards the behaviour and a sustained engagement in the activity, given that that experience is more positive than negative and that the individual succeeds in doing the behaviour (Ajzen, 1991). Also, regardless of what motivates the PE, doing it regularly may transform the behaviour into a habit, which requires less cognitive and motivational effort to perform (Aarts, Paulussen, & Schaalma, 1997). Nevertheless, it may be appropriate for organisations to help individuals in the transformation from being primarily externally motivated to being internally motivated and experience greater autonomy, for example by encourage the individual to set achievable goals with the PE, by providing opportunity to get individual feedback on the effects (e.g. health checkups) and by discussing the positive affects related to the training experience.

Although the PA in Study II was mandatory, it was of great importance to motivate and inspire employees to approve of the intervention, so that they chose to stay at the workplace, complied with the intervention and participated in the scientific evaluation. The experience from this project suggests that including employees at an early stage in the decision process, facilitating interaction and discussion among employees regarding all aspects of the intervention, having highly visible support from upper management and providing the opportunity to assess improvements and giving feedback may contribute to a high participation rate. This is in line with previous research showing that being clear about the goals of the initiative, having long-term management support and evaluating and giving feedback on the results to employees are important for employee commitment (Gebhardt & Crump, 1990). To summarize, PE may be recommended to organizations wishing to increase employee health, particularly if care is taken to reach those who are not already active. Although not investigated in this thesis, PE interventions may also be motivated by other goals: decreased turnover and early exit from the workplace (that is, support a sustainable work life), positive financial returns, increased goodwill and ease of recruitment by being considered an attractive and sought-after employer, etc. (for example, see Golaszewski, 2001).

From a public health perspective, the results from this thesis support the notion of the workplace as a promising arena for health promotion targeting adults. However, from this perspective it should also be noted that choosing the workplace as an arena for health promotion and health interventions means targeting a population that in many aspects is already blessed: healthier and richer, with a greater social network and longer life expectancy, etc. (Alexy, 1991; Conrad, 1987; Marshall, 2004). As such, workplace interventions may be less appropriate from a public health perspective. However, WHP and other public health initiatives are not mutually exclusive – that is, one does not disqualify the other. In fact, if
some public health initiatives are taken care of by employers instead of public health organizations or governments, more of their means may be available to less fortunate groups.

Withdraw from work – what can be done?

Study III shows that OC is important in understanding recovery between workdays and work-related fatigue. From this follows that it is not only factors associated with the workplace that need to be considered in interventions aimed at decreasing stress-related ill health. For organizations, this means providing employees with the tools to handle or prevent perseverative cognitions and may include interventions focusing on the individual as well as those focusing on the work situation and organization. As an intervention targeting the individual, cognitive behavioural therapy has been promising in treating rumination and worry within a clinical context (Borkovec, Newman, & Castonguay, 2003; Kehle, 2008), and may prove valuable within the context of work stress as well. However, this needs to be investigated in future research. For interventions targeting the work situation, it may be speculated whether minimizing unclarities and insecurities associated with work are appropriate. Research has shown that in the working life of today, it is becoming increasingly common to be uncertain of when one’s work is done and against what standards the work is being evaluated (Hellgren et al., 2008). These factors may increase rumination. From this follows that clarifying goals, providing feedback (e.g. being able to observe the result of one’s job or receiving oral feedback from supervisors), etc. may aid the employees in detaching from work and decreasing rumination. These kinds of initiatives are taken within the framework of organizational behaviour management and have been successful in other aspects, such as increasing employee motivation and commitment and in improving productivity (Daniels, 2000). However, the effects on rumination and the ability to withdraw from work need further investigation.

Negative effects of fatigue and lack of recovery

Although there is an agreement on stress as being related to various negative effects on health, less is known about the relationships between lack of recovery and fatigue and ill health. Study IV provides evidence that individuals with a recovery profile characterized by mental and physical fatigue during and after the workday, disturbed sleep and not being fully rested after a nights sleep have an increased risk of AL, a cumulative biological load. This shows that lack of recovery and fatigue may have health-damaging effects even among women who are still working and considered part of a healthy population. This implies that lack of recovery
and fatigue may be an early warning sign of a potentially health harming process. As such, recovery and fatigue should be part of workplace assessment of work environment and employee health. It seems likely that monitoring factors that act as early warning signs would make it possible for organizations to act preventively rather than rehabilitatively, or after-the-fact. Such initiatives may be more powerful since the ill health process is at an earlier stage and as such may be more easily reversed, thereby preventing the loss of workforce to sickness absence, early retirement or turnover.

Conclusions

The public health care in general, and dentistry in particular, involves demanding work conditions, both psychosocial and ergonomically. The risk of work-related ill health is high, particularly when efforts at work are not balanced with sufficient recovery from work as proposed by stress theory. This thesis shows that UED is particularly common. Finding interventions that may improve employee health is therefore important. However, simply decreasing the number of hours spent at work, thereby decreasing exposure to the work environment and allowing more time for leisure activities, did not lead to positive health effects. It is concluded that it is an oversimplification to believe that whatever you do outside work will prove more beneficial to your health than what you experience during work. The effect on physical health among women who took part in physical exercise during working hours, on the other hand, was promising, and this may be an appropriate intervention to improve physical health, including decreasing UED. Neither decreased work hours nor physical exercise had any effect on recovery or fatigue. It is suggested that factors outside work that prolong or sustain the stress-related activity in the body may contribute to this. It was shown that being overcommitted to work was associated with poorer next-day recovery and increased fatigue and that this factor was a more important predictor of lack of recovery and fatigue than were psychosocial work characteristics. Therefore, it is suggested that factors that affect the ability to let go of work need to be considered in relation to work-related ill health, whether in terms of direct interventions aimed at the individual or organizational efforts that would reduce uncertainties associated with work. The importance of intervening when individuals experience lack of recovery and fatigue was demonstrated in the increased risk for a cumulative biological load, in terms of allostatic load, among fatigued and non-recovered women. This also highlights the importance of assessing recovery from work as an early risk factor for stress-related disease.
Även om förvärvsarbete generellt är hälsofrämjande så kan krävande psykosociala och ergonomiska arbetsförhållande öka riskerna för arbetsrelaterad ohälsa. Syftet med den här avhandlingen var att studera olika aspekter av arbetsrelaterad hälsa och ohälsa bland kvinnliga anställda inom offentlig sektor i allmänhet och tandvård i synnerhet. Detta gjordes utifrån en stresssteoretisk referensram med särskilt fokus på återhämtning från arbetet. Den här avhandlingen inkluderar 1) en deskriptiv studie av smärtproblematik i de så kallade övre extremiteterna (s.k. UED, från engelskans Upper Extremity Disorder) inom tandvården, 2) en undersökning av effekten av två arbetsplatsförlagda interventioner samt 3) två studier som fokuserar på hur återhämtning från arbetet är relaterat till psykosociala arbetsplatsförhållandena, oförmåga att släppa tankarna på arbetet och till kumulativ biologisk belastning, s.k. allostatisk belastning (AL). Den första studien visade att en anmärkningsvärd stor andel av kvinnlig tandvårdspersonal led av UED: 81 % av 945 deltagare rapporterade sådan problematik. Dessa personer upplevde både den psykosociala och den fysiska arbetsmiljön som sämre än anställda utan UED. Signifikanta skillnader återfanns också mellan tandläkare och tandläkare, där tandläkare rapporterade högre fysisk belastning och mer utmattning medan tandläkare rapporterade lägre grad av inflytande över arbetet. En hierarkisk regressionsanalyser visade att en hög fysisk belastning var den viktigaste prediktorn för UED, följt av antalet allmänna hälsoproblem, högre ålder och sämre fysisk arbetsmiljö. Slutsatsen var att förekomsten av UED var mycket hög, i synnerhet med tanke på att arbetsplatserna hade hög ergonomisk standard. Det noterades också att psykosociala arbetsförhållanden, något förvånande, inte predicerade UED och detta antogs bero på att den höga fysiska belastningen överskuggade eventuella effekter av den psykosociala miljön. Sammanfattningsvis konstaterades att kvinnlig tandvårdspersonal riskerar att utveckla muskelbesvär och att det därför att angeläget att hitta interventioner som förbättrar hälsan för anställda inom detta arbetsfält.

Syftet med den andra studien var att undersöka de hälsorelaterade effekterna av två arbetsplatsförlagda interventioner: fysisk träning respektive förkortad arbetstid. I båda interventionsgrupperna förkortades veckotidstiden med 2,5 timmar, från 40 till 37,5 timmar. I arbetstidsförkortningsgruppen fick tiden användas till vad som helst, medan
tiden i träningsgruppen var avsedd för medel- till högintensiv fysisk träning fördelat på två tillfällen per vecka. Arbetstidsförkortningsgruppen omfattade 50 kvinnor, träningsgruppen inkluderade 62 kvinnor, och referensgruppen, där ingen förändring skedde, bestod av 65 kvinnor. Resultaten visade på signifikanta skillnader mellan grupperna över tid i glukos \((p = .04)\), midje/höft-kvot \((p = .036)\) och självskattad arbetsförmåga \((p = .01)\). Post hoc analyser visade att glukosnivåerna minskade signifikant i träningsgruppen \((p = .036)\), att midje/höft-kvoten ökade i arbetstidsförkortningsgruppen \((p < .001)\) och att arbetsförmågan minskade i referensgruppen \((p = .005)\). Skillnaderna mellan grupperna över tid närmade sig också signifikans för generella symptom \((p = .063)\) och UED \((p = .062)\), då antalet symptom ökade i referensgruppen och UED minskade i träningsgruppen. Andra resultat pekade på ökade nivåer av det anabola hormonet DHEAS, HDL och totalkolesterol i arbetstidsförkortningsgruppen, ökade nivåer av totalkolesterol i träningsgruppen och generellt ökade nivåer av blodfetter i referensgruppen. Således tycks effekterna av interventionerna skilja sig åt. Tydligast var de positiva effekterna i träningsgruppen, där några av de traditionella riskfaktorerna för ohälsa påverkades i positiv riktning. Slutsatsen är att träning på arbetstid ger lovande resultat, och att det kan vara en lämplig intervention för att förbättra den fysiska hälsan samt för att minska förekomsten av UED.


Resultaten av Studie III indikerade också att trötthet både kan ses som en stressreaktion, och följaktligen föregå återhämtning, och som en konsekvens av bristade återhämtning. Implikationerna av detta för framtida forskning diskuteras, och en konceptuell modell för återhämtning presenteras. I modellen visas hur återhämtning är relaterat till såväl stressorer, stressreaktivitet, återhämtningens förläggning i tiden och faktorer som påverkar återhämtningsprocessen.

I Studie IV undersökes risken för framtidshälsa bland kvinnor som upplever en brist på återhämtning och arbetsrelaterad trötthet. Genom en kombination av personorienterade och variabelorienterade metoder framkom
tre olika återhämtningsprofiler, där profilen som karaktäriserades av trötthet, sömnsvårigheter och bristande korttidsåterhämtning hade en 2.86 gånger högre risk för hög allostatisk belastning, d.v.s. en kumulativ biologisk belastning. Resultaten visade också att även om självskattad återhämtning var kopplad till allostatisk belastning så fanns det inga skillnader i de biologiska markörerna när de analyserades var för sig. Vidare framkom att de två profilerna som uppvisade bristande återhämtning skiljde sig åt i risk för allostatisk belastning, vilket har betydelse när återhämtning och trötthet ska studeras vetenskapligt. För att summera ger resultaten från Studie IV stöd för att fokusera på kumulativ biologisk belastning för att förstå mekanismerna mellan bristande återhämtning och framtida ohälsa. Studien visar också på vikten av att följa upp bristande återhämtning och trötthet som en tidig riskfaktor för stressrelaterad ohälsa.

Sammanfattningsvis visar den här avhandlingen att det är viktigt att ta hänsyn till återhämtning från arbetet för att förstå kopplingen mellan stress på arbetet och ohälsa. Begreppet återhämtning behöver utvecklas ytterligare, och det är angeläget att särskilja bristande återhämtning från arbetsrelaterad trötthet och att vara noggrann med den tidsmässiga aspekten av återhämtning. De praktiska implikationerna av avhandlingen är att det finns stöd för att organisationer kan genomföra åtgärder som förbättrar hälsan och minskar risken för ohälsa hos medarbetarna genom fysisk träning på arbetstid. För att tidigt kunna ingripa vid framtida ohälsa rekommenderas att bristande återhämtning och arbetsrelaterad trötthet inkluderas i arbetsmiljökartläggningar och att man i högre grad fokuserar på kumulativ biologisk belastning, alltså gör en sammanvägning av flera enskilda biologiska indikatorer.

Ahmad, N., Pollard, T. M., & Unwin, N. (2002). The optimal timing of blood collection during the menstrual cycle for the assessment of endogenous sex hormones: can interindividual differences in levels over the whole cycle be assessed on a single day? *Cancer Epidemiology, Biomarkers & Prevention, 11*(1), 147-151.


non-occupational sedentary behaviour of adults: a review. Obesity Reviews, Electronic publication available online 9th July.


Garde, A. H., Hansen, A. M., Skovgaard, L. T., & Christensen, J. M. (2000). Seasonal and biological variation of blood concentrations of total cholesterol,


occupational cohort in France. *Journal of Epidemiology and Community Health, 52*(2), 93-100.


Sonnentag, S., & Kruel, U. (2006). Psychological detachment from work during off-job time: The role of job stressors, job involvement, and recovery-related self-


