How to work for a good night's sleep
Helena Schiller

Academic dissertation for the Degree of Doctor of Philosophy in Public Health Sciences at Stockholm University to be publicly defended on Friday 15 December 2017 at 10.00 in rum 207, Stressforskningsinstitutet, Frescati Hagväg 16 A.

Abstract
Stress and sleep problems are common in the working population and cause considerable costs for society. Sleep is the most important part of recovery, and poor sleep has a negative impact on overall functioning, which might have important consequences for both the employee, the employer and society. In order to find strategies to alleviate this contemporary public health concern of stress and poor sleep in the working population, this thesis evaluated interventions performed at the workplace to target these issues.

The first intervention is a randomized controlled trial of a 25% work time reduction for full-time workers within the public sector in Sweden. Study I evaluated the impact of work time reduction on subjective sleep quality, sleep duration, sleepiness, perceived stress, and bedtime worries. Assessments included diary data from one week at three occasions over 18 months. Study II investigated time-use patterns through activity reporting sheets used during the work time reduction by evaluating the amount of total workload, paid work, non-paid work and recovery activities. Both studies investigated workdays and days off separately as well as the importance of gender, family status and work situation (only Study II). The second randomized controlled intervention of the thesis is a group cognitive behavioral therapy (CBT) intervention at the workplace targeting sleep disturbances among employees within the retail sector in Sweden (Study III). Data were collected through questionnaires, diaries and objective sleep measurement (actigraphy) over a period of ten days before and after the intervention, as well as at a three-month follow up. The study evaluated the effects of the intervention on sleep and explored the moderating effect of burnout-levels at baseline.

In our studies, an economically fully compensated reduction of work hours for full-time workers lead to long-term positive effects on sleep duration and sleep quality, sleepiness and levels of perceived stress. During this work time reduction, the total workload of both paid and non-paid work was reduced and time spent in recovery activities increased. The results indicate that a more balanced relation between effort and recovery was established. The second intervention, which targets the individual through a group CBT-intervention for insomnia at the workplace, was shown to improve insomnia symptoms in daytime workers who did not suffer from concurrent burnout. Such an intervention could support the individual in handling sleep problems and preventing the development of more severe and chronic sleep disorders, as opposed to interventions aimed at making environmental changes at the workplace. However, the CBT-intervention evaluated within this thesis will need to be further developed in order to be beneficial for more groups of employees. The positive effects of these interventions might be beneficial for public health and help improve employee’s life satisfaction, daily functioning and health development.

Keywords: Intervention studies, Sleep, Insomnia, CBT, Work time reduction, Interventionsstudier, Sömn, Insomni, KBT, Arbetsstidsreduktion.

Stockholm 2017
http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-148576

ISBN 978-91-7797-059-0

Centre for Health Equity Studies (CHESS)
Stockholm University, 106 91 Stockholm
How to work for a good night's sleep

Helena Schiller
“It is not the work that drains me, but the work I have not completed.”

Quote from my grandfather
Carl Mannerfelt
ABSTRACT

Stress and sleep problems are common in the working population and cause considerable costs for society. Sleep is the most important part of recovery, and poor sleep has a negative impact on overall functioning, which might have important consequences for both the employee, the employer and society. In order to find strategies to alleviate this contemporary public health concern of stress and poor sleep in the working population, this thesis evaluated interventions performed at the workplace to target these issues.

The first intervention is a randomized controlled trial of a 25% work time reduction for full-time workers within the public sector in Sweden. Study I evaluated the impact of work time reduction on subjective sleep quality, sleep duration, sleepiness, perceived stress, and bedtime worries. Assessments included diary data from one week at three occasions over 18 months. Study II investigated time-use patterns through activity reporting sheets used during the work time reduction by evaluating the amount of total workload, paid work, non-paid work and recovery activities. Both studies investigated workdays and days off separately as well as the importance of gender, family status and work situation (only Study II). The second randomized controlled intervention of the thesis is a group cognitive behavioral therapy (CBT) intervention at the workplace targeting sleep disturbances among employees within the retail sector in Sweden (Study III). Data were collected through questionnaires, diaries and objective sleep measurement (actigraphy) over a period of ten days before and after the intervention, as well as at a three-month follow up. The study evaluated the effects of the intervention on sleep and explored the moderating effect of burnout-levels at baseline.

In our studies, an economically fully compensated reduction of work hours for full-time workers lead to long-term positive effects on sleep duration and sleep quality, sleepiness and levels of perceived stress. During this work
time reduction, the total workload of both paid and non-paid work was reduced and time spent in recovery activities increased. The results indicate that a more balanced relation between effort and recovery was established. The second intervention, which targets the individual through a group CBT-intervention for insomnia at the workplace, was shown to improve insomnia symptoms in daytime workers who did not suffer from concurrent burnout. Such an intervention could support the individual in handling sleep problems and preventing the development of more severe and chronic sleep disorders, as opposed to interventions aimed at making environmental changes at the workplace. However, the CBT-intervention evaluated within this thesis will need to be further developed in order to be beneficial for more groups of employees. The positive effects of these interventions might be beneficial for public health and help improve employee’s life satisfaction, daily functioning and health development.
SVENSK SAMMANFATTNING

Sömnen är den viktigaste delen av vår återhämtning, men tyvärr rapporteras det både om bristande återhämtningsmöjligheter och dålig sömn i flertalet arbetsmiljöundersökningar. Sömnstörningar har en negativ inverkan både på vårt välmående och vår funktion, vilket i sin tur kan få stora konsekvenser inte bara för den anstälde och arbetsgivaren utan i förlängningen även för folkhälsan och samhället. Risken att hamna i en ond cirkel av dålig sömn och hög stress är överhängande, eftersom stress och sömn påverkar varandra negativt över tid. I syfte att hitta effektiva verktyg för att lindra stress och störd sömn hos de anställda, utvärderas två organisatoriska interventioner i denna avhandling genom tre olika studier.

dagar före och efter interventionen samt vid en uppföljning tre månader senare. I denna studie undersöktes även graden av utbrändhet vid baslinjemätningen som en möjlig moderator.

LIST OF SCIENTIFIC PAPERS

The following studies aim to answer the research questions of this thesis and add new important knowledge in the field of organizational health interventions. These findings could be of broad interest for many occupational health specialists and work- and organizational psychologists in a much-needed area.

Study I


New analyses of the subgroup “Individuals having children living at home” was effectuated, and the manuscript as well as the supplementary file were updated online in June 2017. In November 2017, one sentence with regards to the reference Bark-Holst (2015) was amended in the online version of the article.

Study II


Study III

# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBT</td>
<td>Cognitive Behavioral Therapy</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>COEFF</td>
<td>Coefficient</td>
</tr>
<tr>
<td>EEG</td>
<td>Electroencephalography</td>
</tr>
<tr>
<td>EOG</td>
<td>Electrooculography</td>
</tr>
<tr>
<td>HADS</td>
<td>Hospital Anxiety and Depression Scale</td>
</tr>
<tr>
<td>HPA</td>
<td>Hypothalamic-pituitary-adrenal</td>
</tr>
<tr>
<td>ICC</td>
<td>Intra-class correlation</td>
</tr>
<tr>
<td>ISI</td>
<td>Insomnia Severity Index</td>
</tr>
<tr>
<td>KBT</td>
<td>Kognitiv Betteendeterapi</td>
</tr>
<tr>
<td>KSS</td>
<td>Karolinska Sleepiness Scale</td>
</tr>
<tr>
<td>M</td>
<td>Mean</td>
</tr>
<tr>
<td>PSG</td>
<td>Polysomnography</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomized controlled trial</td>
</tr>
<tr>
<td>SAM</td>
<td>Sympathetic-adrenal-medulla</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>SE</td>
<td>Sleep efficiency</td>
</tr>
<tr>
<td>SMBQ</td>
<td>Shirom-Melamed Burnout Questionnaire</td>
</tr>
<tr>
<td>SSQ</td>
<td>Subjective sleep quality</td>
</tr>
<tr>
<td>TST</td>
<td>Total sleep time</td>
</tr>
<tr>
<td>WASO</td>
<td>Wake after sleep onset</td>
</tr>
</tbody>
</table>
## CONTENTS

1 INTRODUCTION 11

2 BACKGROUND 15

2.1 Stress 15
   2.1.1 Physiological aspects of stress 15
   2.1.2 Stress models 16

2.2 Sleep 17
   2.2.2 Sleep regulation 17

2.3 The interplay between stress and sleep 19
   2.3.1 The impact of stress on sleep 19
   2.3.1.1 Perseverative cognitions 20
   2.3.2 Sleep as recovery 21
   2.3.3 The impact of poor sleep on stress 22

2.4 Recovery 22
   2.4.1 Factors that enhance recovery 22
   2.4.2 Factors that hinder recovery 23
   2.4.3 Passive and active recovery activities 23
   2.4.3.1 Household work and child care 24
   2.4.4 Work hours 25

2.5 Interventions in the working population targeting stress and sleep 26
   2.5.1 Interventions at the workplace level 27
   2.5.1.1 Work time reduction to improve stress and recovery 28
2.5.1.2 Earlier findings of reduced work time, stress and sleep 29
2.5.1.3 Time-use and gender aspects in relation to work time 33
2.5.2 Interventions at the individual level 34
2.5.2.1 Earlier findings of psychological treatment for sleep problems 35

2.6 Identification of knowledge gap 36

3 AIM AND RESEARCH QUESTIONS 39

4 MATERIAL AND METHODS 41

4.1 Project design 41
4.1.1 Work time reduction - Study I & II 41
4.1.2 Group CBT for insomnia - Study III 43

4.2 Study population 45
4.2.1 Work time reduction - Study I & II 45
4.2.2 Group CBT for insomnia - Study III 47

4.3 Methods of data collection 49
4.3.1 Diary data 50
4.3.2 Time-use data 51
4.3.3 Questionnaires 52
4.3.4 Actigraphy 55

4.4 Statistical analyses 56

4.5 Summary of material and methods 60

5 ETHICAL CONSIDERATIONS 63

6 RESULTS 65
1 INTRODUCTION

Sleep is a key component of recovery, and good sleep is essential for psychological and physiological health (Sivertsen et al., 2014). Disturbed sleep will not only affect the individual, but also employers and society at large (Metlaine, Leger & Choudat, 2005). Sleep has become an important issue within the field of public health (Williams, Meadows & Arber, 2010). Barnes and Drake (2015) claim that the United State is facing a public health crisis due to the increasing sleep problems in the population. Moreover, in the most recent survey from the Swedish work environment institute (Arbetsmiljöverket, 2016) it was shown that almost half of all employees in Sweden (47%) report problems with psychologically detaching from work during leisure time, and 36% report experiencing sleep difficulties at least once a week.

A recent review (Wickwire, Shaya & Scharf, 2016) has evaluated the economic consequences of insomnia and concluded that the indirect and direct costs of insomnia are highly considerable (over 100 billion USD in the US per year). It was also concluded that the costs of treating insomnia (both through pharmacological and psychological treatment) were lower than leaving insomnia untreated. Barnes and Drake (2015) recommend a variety of actions for policy makers to consider in the future regarding this growing public health issue (e.g. regulation of work hours and work schedules, and public education of sleep). These facts underscore the importance of finding strategies and developing interventions in occupational settings to reduce work-stress and enhance sleep and recovery opportunities.

The underlying causes of disturbed sleep are today commonly discussed in terms of occupational characteristics and imbalance between work and other domains in life. Notably, we live and work in a society that enables activity 24 hours a day. Thanks to globalization and new technologies, many
employees can work or be active in leisure activities whenever they want (Rajaratnam, 2001), even during nighttime. The natural boundaries between night and day, as well as between work and leisure time, are weakened. Indeed, work-related stress is believed to be an important contributing factor to sleep problems (Hall et al., 2015; Hanson et al., 2011; Linton, 2004; Riemann et al., 2010). However, stress in private life and a poor work-life balance can also disrupt sleep and diminish recovery opportunities (Burgard & Ailshire, 2009; Hammer & Sauter, 2013; Johnson, 2016; Kompier, Taris & van Veldhoven, 2012; Lallukka et al., 2010; Nixon et al., 2011; Nylén, Melin & Laflamme, 2007; Sims et al., 2016; Åkerstedt, 2006).

Van Laethem et al. (2017) found that job demands, work-related perseverative cognition and poor sleep quality were reciprocally related, and that perseverative cognition had a mediating role in the relationship between high job demands and poor sleep quality. Moreover, Kompier, Taris & van Veldhoven (2012) describe the associations between occupational stress, perseverative thoughts, poor sleep quality, fatigue and less pleasure at work as a kind of circular process. Based on their findings, they underline the need to create a balance between effort and recovery in the working population. I have chosen to summarize and illustrate the interplay between work, stress and sleep in terms of a vicious circle (see Figure 1). This visualization clarifies the importance of implementing effective and well-targeted occupational interventions in order to break the vicious circle and optimize recovery opportunities. Such interventions could target the work environment by implementing organizational changes that reduce stress and/or improve recovery opportunities. However, they could also target the individual directly, by education and behavioral changes.
Figure 1. Summary of the interplay between work, stress and sleep.

The overall aim of the present thesis is to evaluate two different interventions targeting the working population in Sweden. The first is an organizational intervention within the public sector, namely a reduction in weekly work hours with a preserved salary, where the impact on sleep, sleepiness, perceived stress and time-use is evaluated (Study I and II). The second intervention targets the individual employee within the retail sector through an evaluation of a workplace-based group CBT-program for insomnia during work hours (Study III).

As a background to these studies, stress and sleep and the interplay between the two will briefly be described. Further on, there will be a discussion on the term recovery and how to optimize recovery opportunities during working life. Finally, a literature review on earlier studies made within the field of work time reduction and group CBT for insomnia will be presented in order to give a broader background to the origins of the thesis.
2 BACKGROUND

The following section concerns some central theories and studies within the stress- and sleep literature, of relevance for this thesis. The aim of this section is to briefly present the physiological processes and mechanisms involved in the stress reaction and sleep regulation. Another aim is to underscore the importance of sleep and recovery from stress and effort expenditure.

2.1 Stress

In behavioral sciences, stress is generally defined as the bodily processes that follow a physical or a psychological demand (Seyle, 1976), demands that are typically referred to as stressors (Mc Grath, 1982). Stress is also a relationship between the individual and the environment, implying an individual appraisal of the stressor and a coping behavior (Lazarus, 1966). The physiological bodily activation is described here as the physiological aspects of stress, whereas the relationship between the individual and the environment is described through conceptual stress models.

2.1.1 Physiological aspects of stress

Allostasis refers to the bodily process by which the organisms aim to maintain homeostasis in the body following physiological or environmental threats or challenges (McEwen, 1998; 2007). The activation of the allostatic system involves the physiological stress-response, thus the sympathetic-adrenal-medullary (SAM) system and the hypothalamic-pituitary-adrenal (HPA) axis. The allostatic system, which is also called the adaptive system constantly acts in
order to adapt to environmental changes to adjust homeostasis and increase the chances for survival.

Allostatic load is a theoretical framework, conceptualized by Mc Ewen and Stellar (1993). The term is used to explain how repeated and chronic activation of the stress-system might lead to physiological damage with serious consequences for bodily function and health as a result. This is explained by the fact that even though hormones that are involved in the acute stress response act to protect the body and promote adaptation, the burden of chronic stress will cause changes in the brain and in the bodily systems (McEwen, 2012). One of the functions of sleep is to suppress biological activation in order to avoid chronic or constant maladaptive stress responses, and McEwen (2006) points out the fact that disturbed sleep may be a contributing factor to allostatic load.

### 2.1.2 Stress models

As allostatic load is a theoretical framework used to explain the relationship between chronic stress and ill-health through physiological aspects, psychological stress models intend to clarify the relationship between the individual’s perception of environmental stressors, health and disease. The psychosocial work environment is often of great importance, and one model that is commonly used within the field of work-related stress is the Demand-Control Model. It was developed by Karasek in 1979 and focuses on the individual perception of organizational structure in terms of psychological demands and decision latitude. Examples of other stress models are the Effort-Reward Imbalance Model (Siegrist, 1996), the Job Demands-Resources Model (Bakker & Demerouti, 2007) and Organizational (In)justice (Greenberg, 1987).

However, within the framework of this thesis, the stress model in focus will be the Effort-Recovery Model, which was developed by Meijman and Mulder in 1998. According to the model, recovery has an important role in the
causal pathway between exposure to stressful situations and both acute and chronic load reactions. Prolonged exposure to high work demands and stress-induced cognitive processes, such as worries and rumination, might lead to sustained psychophysiological activation and arousal that may disrupt sleep, which in turn impedes the recovery processes (Geurts & Sonnentag, 2006). The model is based on the theoretical framework of the allostatic load theory (Clow, 2001; Mc Ewen, 1998; Sterling & Eyer, 1990) and postulates that recovery is a process of psychophysiological unwinding.

In order to avoid chronic load reactions turning into ill-health, the presence of conditions that foster recovery is vital, since recovery facilitates the re-establishment of depleted resources in the body. This conceptual model fits very well within the background of this thesis, since the aim is to find ways that could optimize recovery opportunities and sleep in the working population.

2.2 Sleep

Sleep is essential in the process of recovery and necessary for survival (Eversson, Bergmann & Rechtschaffen, 1989). The main function of sleep is to restore daily energy expenditure both in the brain and in the body. In that sense, sleep ensures optimal emotional, mental and physical functioning. In order to be able to manage both psychological and physiological factors that might interfere with sleep, it is of great importance to understand the mechanisms of sleep and how it is regulated by nature.

2.2.2 Sleep regulation

Since sleep is vital to the organism, there are solid bodily systems that regulate sleep. The duration and quality of sleep is determined by the circadian rhythm,
prior time awake and prior sleep duration (Borbély, 1982). For example, sleep during the day will be shorter as compared to sleep during the night, and a nap will affect the sleep quality of the subsequent sleep episode since the sleep drive will be lower (Dijk & Czeisler, 1994; Åkerstedt & Gillberg, 1981; 1986). Sleep drive refers to the fact that the longer you are awake, the higher the need for sleep. When sleep deficiency occurs, there will be a compensatory increase in both sleep length and sleep depth, resulting in a more consolidated sleep the next night. Conversely, after excessive sleep, the effect will be the opposite – all due to the homeostatic rebound effect (Mezick et al., 2009). We can thus buffer and recoup sleep.

However, even though we have a natural and robust bodily regulation of sleep, there are several factors both within and outside of working life - external (e.g. noise) or internal (e.g. perseverative thoughts) - that might have a negative impact on sleep and contribute to the development of sleep disorders. These factors may be sociocultural, but they may also be related to technology and lifestyle (Shochat, 2012). The technological development has contributed to the possibility of alternative work schedules, jetlag, the use of electronic media and new patterns of light exposure, all of which contribute to circadian desynchrony. Moreover, lifestyle factors such as dietary habits and participation in physical activity as well as intake of caffeine, nicotine and alcohol will have an impact on sleep. Shochat (2012) presents in a review on lifestyle factors and sleep a hypothetical model conceptualizing factors that interfere with sleep patterns. The model divides those factors into behavioral factors (e.g. weight gain, caffeine) and environmental factors (e.g. irregular work hours, 24/7 society), and they are important to consider in order to optimize sleep and recovery. However, within the framework of this thesis the factor in focus will be stress, since stress is believed to be an important factor in the development of sleep disorders.
2.3 The interplay between stress and sleep

A relationship between high psychosocial work stress and an increased risk of sleep disturbances has been confirmed in two recent systematic reviews based on prospective studies (Linton et al., 2015; Van Laethem et al., 2013). The bodily stress systems might interfere with both sleep duration, sleep fragmentation (Mezick et al., 2009) and subjective sleep experience (Drake, Pillai & Roth 2014; Morin, Rodrigue & Ivers, 2003). However, the way in which sleep regulation and the activation of the stress system affect each other is complex, and the interplay between the two is believed to be bi-directional (Buckley & Schatzberg, 2005; Steiger, 2002). These relationships and the negative consequences they imply in working life will be described more thoroughly in the following paragraphs.

2.3.1 The impact of stress on sleep

Stress induces a rise in several markers of physiological arousal that are known to affect sleep (Vgontzas & Crouzos, 2002; Han, Kim & Shim, 2012; Pirrera, De Valck & Cluydts, 2010; Riemann et al., 2010). Indeed, there is robust evidence showing that psychosocial work stress is associated with self-reported sleep quality in large scale epidemiological studies (see Linton et al., 2015 and Van Laethem et al., 2013). However, studies using objective sleep measures to evaluate psychosocial stress and its’ impact on sleep are few, and they show inconsistent findings (e.g. Kim &Dimsdale, 2007; Åkerstedt, Perski & Kecklund, 2017). One study on work-related stress including physiological sleep measurements have shown emotional stress, such as worrying about going to work the next day to be related to less deep sleep (Kecklund & Åkerstedt, 2004). High job burnout has been shown to interfere with sleep architecture and cause highly disturbed sleep with many awakenings and a reduced amount of deep sleep (Ekstedt, Söderström & Åkerstedt, 2009). Moreover, in a study on middle-aged women a high chronic stress burden over
several years has been related to poor subjective sleep quality, insomnia symptoms and sleep fragmentations (Hall et al., 2015). Altogether it seems that objectively-verified number of awakenings and micro-arousals are the physiological sleep quality parameters most negatively affected by psychosocial stress.

However, stress will not always have a negative impact on sleep, as stress during the day, if returning to low levels in the evening might have positive effects on sleep due to increased fatigue, which might facilitate sleep onset.

2.3.1.1 Perseverative cognitions

Stress before bedtime, in particular perseverative cognition, has been proposed to be a key component in the relationship between high psychosocial stress and poor sleep (Åkerstedt et al., 2017). Perseverative cognition, which refers to rumination over past stressors as well as worry about potential future stressors, has been related to activation of bodily stress systems both during sleep and waking. Such sustained activation of the stress systems might eventually lead to the prolonged effects of the stressor and negatively impact on sleep (Brosschot, 2010). Since prolonged stress reactions might lead to health problems, it is important to be able to detach psychologically from work during free-time. Emotional exhaustion and burnout has been predicted by the disability to detach from work (Sonnentag, Binnewies & Mojza, 2010; Söderström et al., 2012). Söderström et al. (2012) even found that sustained cognitive activation was a stronger predictor of clinical burnout than the stressful work demands per se. Conversely, psychological detachment has been related to positive mood and less fatigue (Sonnentag & Bayer, 2005), and it seems that being able to detach from work buffers the relation between job demands and psychosomatic complaints (Sonnentag, Binnewies & Mojza, 2010). Notably, high job demands might make it difficult to cognitively detach from work. Periods of high workload have been related to impaired sleep and higher
stress-levels at bedtime despite increased sleepiness (Dahlgren, Kecklund & Åkerstedt, 2005). In sum, stress-related cognitive processes are important to consider in order to properly recover from stress (Geurts & Sonnentag, 2006) and achieve optimal sleep for the next day at work.

2.3.2 Sleep as recovery

Sleep is essential in the process of recovery, not only in terms of physiological balance, mental functioning and health, but also restoration of mood, alertness and performance capacity (Åkerstedt et al., 2007; Åkerstedt, Nilsson & Kecklund, 2009). Insufficient sleep is a contributing factor to suboptimal recovery and when recovery is compromised, our functioning and well-being is affected. Impaired recovery due to poor sleep will affect the metabolic system, the cardiovascular system, the endocrine system, the cerebral nervous system and the immune system, which in the long run will increase the risk of developing depression, burnout, fatigue, cardiovascular diseases or metabolic diseases (Ayas et al., 2003; Bonnet & Arand, 2001; Ekstedt et al., 2006; Gangwisch et al., 2006; Juster, McEwen & Lupien, 2010; McEwen, 2006; Söderström et al., 2012; Åkerstedt, Nilsson & Kecklund, 2009). Sleep disturbances can lead to many kinds of deteriorations of daily functioning, such as excessive sleepiness and impaired cognitive functioning (Shekleton, Rogers & Rajaratnam, 2010; Van Dongen et al., 2003). From an extensive body of experimental research, it is shown that restricted or disturbed sleep impairs memory and attention (Lim & Dinges, 2010). Sleep deprivation also affects emotional regulations and perception of stressors (Minkel et al., 2014), which could lead to emotional overreactions in social interactions and increased involvement in conflicts (Kamphuis et al., 2012). In a recent study by Åkerstedt et al., (2015) it was hypothesized that individuals with chronic sleep problems could be more sensitive to stress.
2.3.3 The impact of poor sleep on stress

As the stress-systems enable us to cope with daily stressors and challenges, it is important to illuminate how sleep loss might affect these systems. In a literature review by Meerlo, Sgoifo and Sucheki (2008) it is suggested that sleep deprivation may be thought of as a stressor, since it is followed by a mild activation of both the SAM system and the HPA-axis. Minkel et al (2014) found that sleep deprivation was associated with elevated stress reactions the subsequent day, but poor sleep as it might appear in the general population showed no impact on emotional responses (Minkel et al., 2012). Since few studies have examined how poor sleep affects stress, it is not possible to conclude how sleep actually influence biological stress regulation in real life.

2.4 Recovery

Recovery refers to activities that might reduce strain and restore depleted energy in the body, making the individual psychologically and physiologically ready for performance (Sonnentag & Natter, 2004). Notably, it is important to foster situations that reduce stress and enhance sleep in the working population. On the basis of the effort-recovery model (Meijman & Mulder, 1998) which underscores the importance of proper recovery, the next section will discuss how to optimize recovery opportunities in working life.

2.4.1 Factors that enhance recovery

Many researchers have investigated different factors that might hinder or enhance recovery. Sonnentag (2001) identifies four factors based on the effort-recovery model that will enhance recovery, namely feelings of mastery; feelings of control; relaxation; and psychological detachment from work. Indeed,
earlier studies have found that feelings of mastery at work and control over the situation outside work, enhance recovery (Sonnentag, Bennewies & Mojza, 2008; Sonnentag & Fritz, 2007). Relaxation diminishes the negative effects of work-related worry and enhances the psychological detachment from work (Sonnentag, Binnewies & Mojza, 2008), and being able to detach from work has shown many positive effects on fatigue and negative affect (Brosschot, Gerin & Thayer, 2006; Sonnentag, Binnewies & Mojza, 2008), especially when time pressure is high (Sonnentag & Bayer, 2005).

2.4.2 Factors that hinder recovery

Other factors, such as workload and conflict between work and life responsibilities, have been shown to hinder recovery. The level of workload might affect the possibilities of recovery in many ways. Higher workload leads to impede psychological detachment (Sonnentag & Bayer, 2005), which in turn is associated with sleep problems and poor recovery possibilities. Furthermore, workload in terms of high work demands may increase the conflict between work and private life. The feeling of not being able to fulfill duties at home will result in a loss of recovery, which in turn could lead to depression, anxiety and health complaints (Ilies et al., 2007). A meta-analysis showed that interference of work and private life predicted both family-related and work-related negative outcomes, as well as diverse health problems (Amstad et al., 2011). Poor health has also been associated with effort-demanding activities outside work and overtime work as well as to sleep problems and fatigue (Van Hooff et al., 2006).

2.4.3 Passive and active recovery activities

Demerouti and colleagues (2009) distinguish between activities that have the potential for recovery (e.g. sleep, low-effort activities, relaxation activities,
social activities, physical activities, creative activities), psychological experiences that will enhance recovery (e.g. psychological detachment and humor) and activities that potentially inhibit recovery (work-related activities, household activities and child care activities). Recovery activities can thus be both passive and active.

Empirical findings on the effect of passive activities (e.g. low-effort activities) on recovery and well-being show mixed results, although relaxation has been shown to have positive impact on recovery (Demerouti et al., 2009). Since sleep has a direct restorative function, it is the key component of passive recovery. Physical activity, which is an active form of recovery activity is well known for its positive effects on both physical and mental health (McAuley, Kramer & Colecombe, 2004). Indeed, physical activity has a positive impact on mood and vigor, it reduces symptoms of depression, but it has been shown to have no effects on fatigue (Demerouti et al., 2009). However, sports and exercise might stimulate recovery since those activities are often agreeable and imply some sort of distraction (Lox, Martin Ginis & Petruzzello, 2010).

2.4.3.1 Household work and child care
The detrimental effects of activities including household work and child care are often pronounced in relation to workload and recovery deficiency, but these effects have, according to Demerouti et al., (2009) not been empirically proven. However, activities that are of an obligatory character are believed to have a negative effect on recovery. Indeed, household work may impede recovery, whereas childcare may be a combination of chores and social interaction that may actually enable recovery and buffer the effects of stress (Demerouti et al., 2009). Another perspective is that the experience of these activities is highly individual (Sonnentag, 2001).

When studying total workload among individuals in the working population, this typically includes paid and non-paid work altogether, where non-paid work refers to domestic duties and care for one’s own children or others
(SCB, 2012). These are consequently activities that are seen as effort expenditure activities and not as recovery. Time spent outside paid and non-paid work is seen as leisure time and is typically thought upon as recovery activity.

2.4.4 Work hours

Naturally, work hours have a pivotal position in the balance between work and private life and between effort and recovery. Long work hours might hinder proper recovery between workdays, and the relationship between work hours and health has been widely investigated. There is a growing evidence from both longitudinal studies, meta-analyses and reviews that longer work hours are associated with different aspects of negative health outcomes (Artazcoz et al. 2009; Caruso et al., 2004; van der Hulst, 2003; Kivimäki et al., 2017; Nixon et al. 2011; Song et al. 2014; Sparks et al., 2013; Taris et al., 2011; Virtanen et al., 2011). Moreover, sleep time gets shorter when work hours are prolonged due to over-time work. This relationship is probably partly due to increased stress-levels (Dahlgren et al., 2006).

Working part-time implies shorter work hours, which theoretically should be better for long term health aspects. One study on part-time employees in five western European countries (Beham, Präg & Drobnic, 2012) reveals that those who work part-time report more satisfaction with work-family balance in comparison to full-time employees. Marginal part-time workers (working <20h/week) seem to be the most satisfied, whereas professionals (in high-level part-time jobs) seem to be less satisfied. One explanation could be that professionals are often expected to be available to the employer, even though they are not present at work (Beham et al. 2012).

Importantly, part-time work also means a corresponding decrease in salary. In a recent British study by Conway and Sturges (2014) it was shown that part-time workers do more unpaid overtime hours as compared to those who work full-time. The fact of working overtime without being paid, is not
only a question of dissatisfaction; it will also increase the risk of fatigue and exhaustion (according to the effort-reward model (Siegrist, 1996) and the demand-control model (Karasek, 1979)).

Shift work, which is characterized by work time distributed across hours that are outside normal daytime hours, typically interferes with the normal sleep-wake cycle. This makes shift workers a relevant population to investigate in relation to recovery and health outcomes. In a recent clinical review, shift work was linked to both sleep loss, accidents and disease (Kecklund & Axelsson, 2016). Working long or non-regular work hours as well as working during unsocial hours have been shown to negatively affect the perception of work-life balance (Chung, 2011; Fagan & Walthery, 2011; Fahlén, 2014; Grönlund, 2007; McGinnity & Calvert, 2009). Moreover, several studies have shown that the start hour of the workday has an impact on sleep length and sleepiness (Bildt et al., 2007; Härma et al., 2002; Ingre et al., 2004; Sallinen et al., 2003), where an earlier start hour will lead to shorter sleep and more sleepiness during the day. In sum, work hours are important because of the effects on the possibility to gain enough time daily to unwind for proper recovery from work-related effort during non-work time.

2.5 Interventions in the working population targeting stress and sleep

On the basis of the theories behind the effort-recovery model (Meijman & Mulder, 1998) and with regard to the vicious circle of stress and poor sleep in working life (see Figure 1, p.13), it is obvious that it is of great importance to find strategies and develop interventions in occupational settings with the aim to reduce work-stress and enhance sleep and recovery opportunities. The interventions could be at an organizational level (e.g. restructuring of workload or work hours), but they could also target the individual (e.g. stress management or sleep education). The possibility to implement organizational changes
might not always be feasible, and it would sometimes be easier to target the individual. However, the optimal situation might be to combine organizational- and individual-level interventions to prevent problems with work-related sleep and stress (Ruotsalainen et al., 2014).

2.5.1 Interventions at the workplace level

An intervention at the organizational level could aim at decreasing work strain, which in turn would lead to decreased levels of stress and physiological activity and consequently also to better sleep and daily functioning. Work conditions, such as long work hours and high workload, are factors among others that often have a negative impact on work-related stress reactions, impaired sleep and sleepiness. Occupational interventions are typically related to organizational factors such as work time (e.g. work time control, reduced work time or changed schedules) or the balance of, for example, job demands, job control and social support. The aim of these interventions is to implement changes in the work environment that would support employees in creating a better balance between paid work and other domains in life and help them cope with psychosocial stress. One way would be to educate supervisors in work-family conflict matters and provide them with tools in order to support employees in these issues (Olson et al., 2015). Another way would be to diminish job demands or reduce work hours.

The conceptualizations of the balance between effort and recovery is the framework applied in this thesis, that serves as a background to the idea that reduced work time could be an effective way of diminishing stress and ameliorating sleep in the working population. A work time reduction, without an increase in work demands, would imply a lower workload, and more time for non-work activities. Improved recovery opportunities and a lower workload can in turn lead to reduced stress, longer sleep and better sleep quality, which would mean higher daytime alertness.
2.5.1.1 Work time reduction to improve stress and recovery

The discussion concerning reduced work time has been part of the Swedish political debate since the legislation of the 40-hour workweek in 1974 (Isidorsson, 2001). At that time, the discussion was more oriented towards issues related to the labor market (such as levels of unemployment). During the 1990s there were new health-related problems in society to cope with and stress became one of the largest work environment issues (Miller & Åkerstedt, 1998). Thus, the debate on work time reduction turned towards a more health-related focus.

In recent years, due to the increasing and alarming rates of sick-leave related to stress (Försäkringskassan, 2016), the debate has again escalated. The discussion in Sweden (and in other European countries) has treated the possibility that reduced weekly work time could be beneficial for employee health in some exposed sectors and in the long run for the employer and society. Those who advocate shortening work hours emphasize the beneficial effects on health and well-being. They argue that with a lower workload, employees will be more efficient while at work, and with shorter workdays the balance between work and other life domains will lead to better recovery opportunities between workdays. There is some empirical support for these arguments (Anttila, Nätti & Väsiänen, 2005; Lorentzon, 2017; Nätti & Anttila, 1999; Åkerstedt et al., 2001)

However, there are opponents, who mainly point out that reduced work hours with retained salary is very costly and that there is still no evidence that the rates of sick-leave or an increase in productivity would take place. One negative aspect could also be that the actual workload does not diminish and that a shortening of work hours would only lead to more stress and time strain at work (Roll et al., 2012). Another argument is that a workday that is less fragmented by shorter work hours could actually have beneficial effects on well-being (Erlandsson & Eklund, 2006).
2.5.1.2 Earlier findings of reduced work time, stress and sleep

Although shortening work hours might be a way of ameliorating recovery opportunities and enhancing sleep, there is an apparent scarcity of longitudinal research and intervention studies in this area. Some studies focus on health and well-being, although leaving the question on stress and sleep untreated. One study shows that a reduction from an 8h/day to 6h/day had positive effects through reduced pain in the neck- and shoulder area for employees with physically demanding professions (Wergeland et al., 2003). A minor reduction (2.5 hours) of weekly work time has shown small effects on health in female dentists (von Thiele Schwarz, Lindfors & Lundberg, 2008), which seemed to be related to increased physical exercise. Moreover, four Swedish reports have found reduced work time to improve general well-being, yield increased energy, and lead to less overall stress (Bildt et al, 2007; Lorentzon, 2017; Olsson, 1994; 1999). Only one scientific paper has evaluated a reduced weekly work time of 25% with retained salary and its consequences for perceived stress, sleep and sleepiness over time (Åkerstedt et al., 2001). That study showed a slight improvement in sleep quality and mental fatigue. Moreover, other studies on work time reduction have shown that shorter workdays lead to a reduction of job exhaustion (Nätti & Anttila, 1999) and had a positive impact on work-family interaction (Anttila, Nättä & Väsiänen, 2005; Åkerstedt et al., 2001). See Table 1 for a summary of these studies.
Table 1. Overview of earlier literature on work time reduction and its impact on health.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Population</th>
<th>Main outcomes</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nätti &amp; Anttila 1999</td>
<td>-Control group</td>
<td>-Three municipalities</td>
<td>-Job exhaustion (work ability)</td>
<td>-Decreased job exhaustion</td>
</tr>
<tr>
<td>Part I</td>
<td>-No randomization</td>
<td>-Intervention group: N=110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data collected in</td>
<td>-Partial compensation of</td>
<td>-Control group: N=116</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finland, 1996-1998</td>
<td>wage loss</td>
<td>-96% women</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-17-22% reduction during</td>
<td>-14 municipalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 months</td>
<td>-N=567</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-New staff employed</td>
<td>-96% women</td>
<td>-Job exhaustion (work ability)</td>
<td>-Decreased job exhaustion</td>
</tr>
<tr>
<td></td>
<td>-Data collected at baseline</td>
<td>-40% 6h-workday</td>
<td>-Quality of services</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&amp; 18 months</td>
<td>-35% extra days off</td>
<td>-Work efficiency</td>
<td>-35% thought quality of service improved - better quality when working 6h</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-21% extra weeks off</td>
<td></td>
<td>-73% thought work efficiency increased</td>
</tr>
<tr>
<td>Nätti &amp; Anttila 1999</td>
<td>-No control group</td>
<td>-9 units in health care</td>
<td>-Time for family, friends and social</td>
<td>-Less mental fatigue</td>
</tr>
<tr>
<td>Part II</td>
<td>-Partial compensation of</td>
<td>-Intervention group: N=41</td>
<td>activities</td>
<td>-Better sleep quality</td>
</tr>
<tr>
<td>Data collected in</td>
<td>wage loss</td>
<td>-Control group: N=22</td>
<td></td>
<td>-More time for social activities</td>
</tr>
<tr>
<td>Finland, 1996-1998</td>
<td>-17-22% reduction during</td>
<td>-82% women</td>
<td></td>
<td>-More time for family/friends</td>
</tr>
<tr>
<td></td>
<td>18 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-New staff employed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Data collected at baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&amp; 32 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Åkerstedt et al. 2001</td>
<td>-Control group</td>
<td>-9 units in health care</td>
<td>-Time for family, friends and social</td>
<td>-Less mental fatigue</td>
</tr>
<tr>
<td>Data collected in</td>
<td>-No randomization</td>
<td>-Intervention group: N=41</td>
<td>activities</td>
<td>-Better sleep quality</td>
</tr>
<tr>
<td>Sweden, 1996-1998</td>
<td>-Retained salary</td>
<td>-Control group: N=22</td>
<td></td>
<td>-More time for social activities</td>
</tr>
<tr>
<td></td>
<td>-From 8h/day to</td>
<td>-82% women</td>
<td></td>
<td>-More time for family/friends</td>
</tr>
<tr>
<td></td>
<td>6h/day during 32 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-New staff employed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Data collected at baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&amp; 24 months</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Continuing of Table 1.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Population</th>
<th>Main outcomes</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wergeland et al. 2003</td>
<td>-Control group</td>
<td>-Data from three projects in Oslo, Helsingborg and Stockholm (health care services)</td>
<td>-Neck/shoulder or back pain</td>
<td>-Less pain in neck/shoulder -Less physical exhaustion</td>
</tr>
<tr>
<td>Data collected in</td>
<td>-No randomization</td>
<td></td>
<td>-Physical exhaustion</td>
<td></td>
</tr>
<tr>
<td>Norway and Sweden, 1995-1998</td>
<td>-Retained salary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-From ≥7h/day to 6h/day during 22-32 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-New staff employed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Data collected at baseline, 12 months and 18 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anttila, Nätti &amp;</td>
<td>-Control group</td>
<td>-Three municipalities</td>
<td>-Work-family conflict</td>
<td>-Positive effects on work-family conflict</td>
</tr>
<tr>
<td>Väisänen 2005 Part I</td>
<td>-No randomization</td>
<td></td>
<td>-Family-work conflict</td>
<td></td>
</tr>
<tr>
<td>Data collected in</td>
<td>-Partial compensation of wage loss</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finland, 1996-1998</td>
<td>-17-22% reduction during 18 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-New staff employed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Data collected at baseline, 6 months &amp; 18 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anttila, Nätti &amp;</td>
<td>-No control group</td>
<td>-14 municipalities</td>
<td>-Work-family conflict</td>
<td>-Positive effects in all types of reduced work time</td>
</tr>
<tr>
<td>Väisänen 2005 Part II</td>
<td>-Partial compensation of wage loss</td>
<td>-N=567</td>
<td>-Family-work conflict</td>
<td></td>
</tr>
<tr>
<td>Data collected in</td>
<td>-17-22% reduction during 18 months</td>
<td>-96% women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finland, 1996-1998</td>
<td>-New staff employed</td>
<td>-40% 6h-workday</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Data collected at baseline and 18 months</td>
<td>-35% extra days off</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-21% extra weeks off</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To my knowledge, there are only five published scientific papers within the field of reduced work time and its impact on health. Among the four studies that evaluate 22-25% reductions of work time, none employ randomization. Moreover, the studies are based on relatively small samples, which are almost exclusively represented by women. Interestingly, three studies investigate the impact of reduced work time on the balance between work and family life and they all reveal positive results. Åkerstedt et al. (2001) suggested that the beneficial effects of reduced work time could be explained by the increased time for recovery and social activities, whereas von Thiele Schwarz et al. (2008) speculated physical exercise to be the mediator to better health outcomes.

Therefore, the investigation of time-use during a work time reduction is an interesting sequel in the evaluation process of shorter workdays. However, in order to investigate if time-use patterns actually reflect a better work-life balance, and if reduced work-time is related to increased time for recovery activities, it would be more appropriate to adopt intensive time-use measures instead of questionnaires (as were used in Anttila, Nättä & Väsiänen, 2005 and in Åkerstedt et al., 2001). This is because retrospective estimates of time

### Table 1 (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Population</th>
<th>Main outcomes</th>
<th>Main results</th>
</tr>
</thead>
</table>
| Von Thiele Schwarz et al. 2008 | -Control group  
-Randomization  
-Retained salary  
-2.5h reduction from full-time  
-No staff employed  
-Data collected at baseline, 6 months  
and 12 months | -Six workplaces in dentistry  
-N=177  
-100% women  
-2.5h exercise during work N=62  
-2.5h reduced work time N=50  
-Work as usual N=65 | -Physical activity  
-Biological markers  
-Work-home interference  
-Recovery  
-Work ability  
-General symptoms | -More physical activity in both groups compared to control  
-Improvements of some biomarkers  
-Improved work ability |
spent in specific activities in questionnaires may give inaccurate estimates due to, for example recall bias.

2.5.1.3 Time-use and gender aspects in relation to work time

Two hours of extra time off per day could emancipate more time for rest, relaxation and recovery. However, if the extra time is used for non-paid work, total workload and recovery time will probably not change as compared to before the reduction of work time. In that sense, there may be differences between subgroups when it comes to how the additional free-time is used during a work time reduction. Type of work is an interesting aspect to consider in relation to time-use during a work time reduction. Due to their specific situation related to work hours, shift workers represent a particularly interesting group to investigate. Moreover, since women still have the main responsibility for the family while simultaneously trying to handle a career (Lunau et al., 2014), differences in relation to, for example, gender and family situation are important to consider when investigating time-use.

The social structure of work life is characterized by the fact that men generally spend more time in paid work as compared to women, and women spend more time in non-paid work as compared to men (Bianchi & Milkie, 2010; Hagqvist, Toivanen & Vinberg, 2015). When looking at the total workload, which includes both paid and non-paid work (e.g. in household), there is a higher load for women than for men (Eurofound, 2016; McElwain, Korabik & Rosin, 2005). However, there seem to be no gender differences in the experience of work-family conflict (Byron, 2005; Lallukka et al., 2010), which may be due to the fact that women to a greater extent than men work part-time. One study on part-time employees in five western European countries (Beham, Prüg & Drobnic, 2012) reveals that those who work part-time report more satisfaction with work-family balance in comparison to full-time employees. Notably, Leineweber and colleagues (2012) found that especially
among full-time workers, more women than men reported work-family conflict. Interestingly, Hagqvist and colleagues (2012) state that the perception of a work-family conflict have a stronger negative impact on well-being as compared to the amount of time spent on paid and non-paid work.

In sum, a work time reduction might have beneficial effects on recovery opportunities and work family conflict and thereby prevent stress reactions and disturbed sleep. However, another way of diminishing sleep problems and perceived stress in working life could be to target the individual directly.

### 2.5.2 Interventions at the individual level

An intervention at the individual level could aim at learning how to handle stress or sleep problems. When the aim is to introduce behavioral changes, or handle intrusive thoughts, methods based on Cognitive Behavioral Therapy (CBT) are of great use. Cognitive behavioral therapy is based on research from both behavioral and cognitive psychology (Beck, 2011), where the role of the therapist is to help the patient to develop and use effective strategies in order to reach identified goals and to cope with symptoms of the disorder. Systematic reviews indicate that CBT is effective in reducing depressive symptoms (Butler et al., 2006; Hollon & Ponniah, 2010), and to some extent even exhaustion (Kaschka, Korczak, & Broich, 2011).

When it comes to sleep treatments, however, most commonly physicians give general sleep advice, often in combination with a prescription of sleep medicine (Mitchell, 2012; SBU, 2010). Even psychological methods are used as treatment against insomnia, and CBT has been especially proven to be an effective method (Ishak et al., 2012; Morin & Espie, 2003; Trauer et al., 2015). According to several studies, CBT-treatments have had stronger beneficial long-term effects on sleep than pharmacological treatment alone (Morin et al., 1999; Wickwire, Shaya & Scharf, 2016).

Importantly, improved sleep would mean better daytime functioning
and more energy to cope with stressful situations at work. Moreover, reduced sleep disturbance has, for example, been related to an accelerating healing process from depression (Smith & Perlis, 2006) and has been shown to have a buffering effect of the negative impact of work strain on fatigue (Winwood, Bakker & Winefield, 2007). Further on, extended sleep seems to lead to substantial improvements in daytime alertness, reaction time, and mood (Kamdar et al., 2004). In sum, an intervention at the individual level could be of great help for employees struggling with a stressful life and problems with sleep.

2.5.2.1 Earlier findings of psychological treatment for sleep problems

This literature review is primarily based on systematic reviews and meta-analyses that are relevant for the alignment of this thesis. They thus include studies that focus on psychological sleep treatments, preferably in group settings.

One systematic review indicates that CBT is highly effective in reducing insomnia (Ishak et al., 2012). Moreover, recent research suggests that psychological sleep treatments can be delivered through self-help programs on the internet or through self-help books. In two very recent meta-analyses (Yan-Yee-Ho et al., 2015; Zachariae et al., 2016) it was concluded that internet-delivered CBT for insomnia is efficient and practicable, whereas self-help programs (delivered by booklets, videotape and/or audio material) could be an effective first approach and a good compromise when face-to-face treatments are not possible to conduct. Cognitive behavioral therapy for insomnia could also be delivered as group therapy. In recent years, CBT-based sleep management in groups has become a common method. One study compared individual CBT (N=32) versus group CBT (N=74) in patients with chronic insomnia and found both methods to be effective since several sleep parameters improved and were maintained at follow-up (Verbeek et al. 2006).

In the research field of group CBT for insomnia, two meta-analyses have recently been published: Koffel, Koffel and Gehrman (2015) and Navarro-Bravo et al. (2015). Altogether 13 articles, based only on randomized
controlled trials (RCT), were included in these two meta-analyses, and four of them were included in both. According to Koffel et al. (2015) and Navarro-Bravo et al. (2015) there is evidence that group CBT for insomnia is an effective treatment, both when insomnia is evaluated through validated scales and with sleep diaries. Moreover, the effects of the treatment seem to be stable over time. However, only t-tests and analyses of variance were used in the included studies, and despite the fact that all studies are RCTs, three studies do not report the interaction effects of groups over time. Moreover, the meta-analyses show that very few studies have been carried out in a work context, and outcomes relevant for work are rarely evaluated.

Insomnia is commonly comorbid with other diagnoses, such as anxiety, depression and burnout (Bélanger et al., 2004; Ekstedt et al., 2009; Johnson et al., 2006; Lustberg & Reynolds, 2000; Riemann, 2007; Roth & Drake, 2004; Söderström et al., 2012). However, CBT for insomnia has been shown to be effective when comorbid with anxiety and depression (Lichstein et al., 2010; Manber et al., 2008; Rybarczyk et al., 2009; Smith et al., 2005; Stepanski & Rybarczyk, 2006), even when delivered in group format (Belleville et al., 2011; Blom et al., 2015; Edinger et al., 2009; Germain et al., 2006; Järnefelt et al., 2014; Okajima et al., 2011; Ye et al., 2015). Several studies also reflect upon the reciprocal relationship between mental health and sleep also in relation to treatment effects. However, to my knowledge, no study has investigated the moderating effect of level of burnout scores during a CBT-program for insomnia.

2.6 Identification of knowledge gap

On the basis of these literature reviews, it is clear that there is not much available research within the area of work time reduction. Moreover, intensive time-use data has not been evaluated before in relation to such an intervention.
Only one longitudinal study has investigated a reduced work time of 25% and the impact on stress, sleep and sleepiness (Åkerstedt et al., 2001). However, this study did not randomize participants into intervention and control groups, and the samples were small. Moreover, data on time-use only consisted of items in a questionnaire asking the participants to retrospectively indicate how much time they usually spent in certain activities. Due to the apparent scarcity of research in this area, there is a need for randomized controlled interventions, with large samples and several workplaces to evaluate the effects of a work time reduction on stress, sleep and sleepiness. In order to get more accurate data on time-use, data should preferably be collected with activity reporting sheets in diaries.

On the other hand, it is shown that group CBT for insomnia is a well-documented and effective method to diminish insomnia symptoms (Koffel et al., 2015; Navarro-Bravo et al., 2015). Ideally, in the working population, such a program should be adapted and implemented at the workplace in order to make it cost-effective and easily accessible for the participants. However, no study has specifically focused on working individuals and factors related to work and psychosocial stressors. Thus, there is a need for further evaluation of such adapted programs in workplace settings, and the moderating effects of level of burnout would be interesting to investigate due to the reciprocity between problems with stress and sleep.
3 AIM AND RESEARCH QUESTIONS

The aim of this thesis is to evaluate two different randomized controlled interventions performed at the workplace targeting stress and sleep problems. The specific aims, which are covered by three studies are as follows;

**Study I**  Evaluate the impact of a 25 % reduction of weekly work hours with preserved salary on subjective sleep quality (SSQ), sleep length, subjective sleepiness (based on repeated daytime ratings of Karolinska Sleepiness Scale, KSS) and perceived stress. The study also explores whether reduced weekly work hours affect sleep and stress during days off and if there are any differences between men and women in the effects of the reduced work time.

**Study II**  Explore time-use data with a focus on workload and recovery activities, in relation to reduced work time and investigate how employees use their extra leisure time on workdays and on days off during such an intervention. Subgroups of gender, family status and work situation are explored in relation to time-use patterns.

**Study III**  Evaluate a group intervention at work, based on CBT for insomnia among employees reporting moderate sleep problems. The moderating effects of level of burnout scores (high/low) at baseline are also investigated as an explorative aim.
These aims result in the following research questions:

**Study I**  Will work time reduction result in longer sleep duration, better subjective sleep quality, less sleepiness and lower levels of perceived stress, including worries and stress at bedtime on workdays? What are the effects on days off? Are there any gender differences in relation to the effects of the intervention?

**Study II**  Does total workload (paid and non-paid work put together) decrease, and recovery time increase when work hours are reduced? What are the effects on time-use patterns during days off? Are there any individual differences in the effects of the intervention depending on gender, family status or job situation?

**Study III**  Will a participation in a group intervention during work hours reduce insomnia symptoms and improve sleep parameters such as SSQ, sleep duration and quantitative sleep efficiency? What is the impact of level of burnout scores at baseline on the effect of the intervention?
4 MATERIAL AND METHODS

The following section concerns the methods used within the framework of this thesis. First of all, there is a presentation of the two interventions in terms of implementation and project design. Secondly, focus will be on the different study populations that participated in the two interventions and provided data for the three studies that are included in the thesis. Thereafter, all the different data collection methods will be presented together with a description of the statistical methods applied. A summary of material and methods including all three studies are presented in Table 2 under the section 4.5 “Overview of material and methods”.

4.1 Project design

This thesis consists of three studies based on two randomized controlled interventions, with data collections over time covering three time points. Participants have been randomized into intervention groups and control groups (in Study III the control group is a waiting list group). Subjective data through questionnaire and diary as well as objective data through actigraphy (wrist-watches that measure sleep, rest and wakefulness objectively) were collected (Study III).

4.1.1 Work time reduction - Study I & II

Study I and II were both made within a longitudinal controlled intervention study evaluating a 25% reduction of weekly work hours and its impact on health in the public sector. The project was carried out in 2005-2006 and the
period of work time reduction proceeded over 18 months. It was led by the Swedish National Institute of Working Life and commissioned by the government. Participants preserved their salary during the intervention and the workplaces obtained funding for employing more staff in order to avoid an increase in workload for employees having reduced work time. Participants were not constrained to allocate the reduced work time evenly for the five-day working week. Randomization was effectuated at the workplace level with the groups being balanced by geographic location, type of work and gender distribution. In total, 33 workplaces were included and randomized (17 to the intervention group and 16 to the control group). One workplace was allocated in the control group because of difficulties recruiting new staff.

Data were collected at baseline, in February-May 2005 and then in January/February and October/November 2006, see Figure 2 below. Since the intervention was introduced one to two months after baseline, participants were measured 9 months as well as 18 months after the introduction of the reduced work time before going back to full-time. At each data collection, participants filled out a questionnaire including questions on demographic data and work environment exposure. Participants also completed a sleep and wake diary including daily activity reporting sheets for one week during each measurement period.

Figure 2. Timeline of Study I and II.
In total, 580 individuals met the inclusion criteria of working full-time, having reduced work time by 25% according to the employers’ time recording data over 14 months (intervention group) and participated in the data collection at baseline, as well as the 9-month and/or the 18-month follow-up (Study I). In Study II an intention-to-treat approach was employed, including all subjects working full-time, having participated in baseline measurements, which resulted in N=636 participants.

An intention-to-treat approach is a statistical concept employed in clinical trials in order to treat the problem of for example noncompliance or withdrawal. By maintaining the balance that was created at randomization and accepting that noncompliance and deviations from protocol might appear during interventions, this approach will minimize the risk of overestimating the efficacy of an intervention (Gupta, 2011).

4.1.2 Group CBT for insomnia - Study III

Employees within the retail sector working at least 75% of full-time who reported moderate sleep problems were invited to participate in a group CBT-program for insomnia. They were informed that the program was free of charge and would take place at their own head-office during work hours over a period of ten to twelve weeks. In all, 64 employees from two workplaces were randomized into an intervention group and a waiting-list control group.

The intervention, which was a CBT-based program for insomnia, presented as a “sleep school”, was developed and led by a trained, certified clinical psychologist specialized in sleep. The program included both theory and practice and was carried out in groups (maximum eight participants in each group). There were five sessions of 2 hours during a period of approximately three months. The aim was to increase participants’ knowledge about sleep and to provide practical tools in order to improve sleep and decrease stress and worries about sleep. The program is based on methods that are empirically
proven to be efficient in cases of sleep problems (e.g. sleep hygiene; Stepanski & Wyatt, 2003; stimulus-control therapy, relaxation, sleep restriction; Morin et al., 2006) and all sessions included a psycho-educative lecture and group discussions.

The program involved five modules (one module per session):

1) Basic knowledge of sleep, circadian rhythm and sleep regulation
2) Stress, life style, evening routines and balance between activity and rest
3) Handling difficulties with falling asleep and restless sleep
4) Sleep schedules, sleep restriction and stimulus control
5) Relaxing (mindfulness) and acceptance strategies

Baseline measurements were made before the start of the intervention. Postmeasurements were made approximately three months later, directly after the intervention was finished, and follow-up measurements another three months later. When all measurement periods were completed, the control group started their participation in the group CBT-program, see Figure 3 below and Figure S1 in the supplement of Study III. No data was collected after the control group had ended the program. During data collections, participants filled out a sleep and wake diary and wore a wrist-actigraph for ten days. They also filled out a web-based questionnaire.

**Figure 3. Timeline of Study III**
4.2 Study population

Participants within this thesis are samples from the working population, employed full-time (Study I and II) or at least 75% of full-time (Study III). In Study I and II participants constitute a healthy sample from the public sector in Sweden, whereas in Study III, participants are employees within the retail sector reporting moderate sleeping problems. More detailed information of the study samples in each study is presented in the following paragraphs.

4.2.1 Work time reduction – Study I and II

Participants in the intervention of reduced work time were employees working full-time within the public sector in Sweden. Initially, 33 workplaces with 919 employees agreed to participate, of which 98 employees dropped out after randomization. The main reasons for this were changed job/workplace (N=29), parental leave (N=14), and long-term sickness absence (N=14). Out of the remaining 821 employees, 580 were included in the Study I; N=354 in the intervention group and N=226 in the control group, see Figure 1 in Study I. In Study II an intention-to-treat approach was employed, including all employees working full-time having participated in baseline measurements. This resulted in N=636 participants: N=370 in the intervention group and N=266 in the control group, see Figure A in the supplement of Study II. There is a Swedish report summarizing data and analyses on all 821 participants (Bildt et al., 2007): however, in these present studies data were reanalyzed on full-time workers only, using another statistical approach. See details of all study samples in Flow-chart, Figure 4.
Figure 4. Flow chart of Study I and II as well as Bildt et al., 2007. N=Number of workplaces; n=number of individuals

Participants worked in four different working sectors: Social services (e.g. managers, social workers or social assistants; N=152 in Study I and N=170 in Study II, from 8 workplaces), Technical services (e.g. administrators, airport workers or parking guards; N=214 in Study I and N=236 in Study II, from 9 workplaces), Care and welfare (e.g. caregivers at preschools, hospitals or retirement homes N=143 in Study I and N=159 in Study II, from 11 workplaces) and Call centers (e.g. managers or administrators; N=70 in Study I and N=71 in Study II, from 5 workplaces). Almost one third (25% in Study I and 30% in Study II) were shift workers, most of the participants were
women (76% in Study I and 75% in Study II) and the age range was 20-65 years (m=44.6 years; sd=10.6 years in Study I and m=44.2 years; sd=10.9 years in Study II). About half of the participants in both studies reported they had children living at home. Around 75% reported they lived with a partner and 13% were single parents living alone with children. See Table 1 in Schiller et al. (2017) and Table 1 in the manuscript of Study II.

4.2.2 Group CBT for insomnia – Study III

In Study III, 51 employees from two organizations within the retail sector were included. Initially, there were 72 individuals who showed interest in participating; however, two individuals chose to refrain before randomization. After the randomization, another six out of the 70 remaining participants chose to refrain (four from the intervention group and two from the control group). They declared they had too much to do, were going on a leave of absence or sick-leave, or were to change workplace.

Altogether 64 individuals were invited to participate in the first measurement. However, two participants dropped out before the baseline measurement, and another six from the control group chose to refrain after the first measurement period because of sick-leave, time pressure or diminishing interest in participating in the study. Four individuals from the intervention group were excluded from the statistical analyses, since only data from participants who fulfilled measurements at baseline and either the post-measurements or the follow-up measurements, or both, were used. Furthermore, one participant in the intervention group who reported a value of ISI at baseline lower than 8, was excluded from the analyses, since that indicated no presence of clinical insomnia. This resulted in a sample-size of N=51 (see flow-chart in Figure 5 and in Figure 1 in the manuscript of Study III). The a-priori power calculation indicated that 64 participants (32 in intervention group and 32 in control group) would be the threshold for detecting a large effect size of sleep-improvement.
Figure 5. Flow chart of Study III. N=Number of individuals.

The overall attrition rate for this study between randomization and follow-up was 27%, 29% in intervention group and 26% in control group. In comparison to the meta-analysis by Koffel et al. (2015) this appears to be a high number, since the average attrition from randomization to post-treatment was around 10%. Importantly, however, only two out of the six studies included in the meta-analysis used a waiting list control group. In one of these two studies the attrition rate from randomization to the 4-month follow-up was
31% in the intervention group and 29% in the waiting list control group (Rybarczyk et al., 2002), whereas in the other study (Morin et al., 1993), the rate between randomization and follow-up was only 8% in the control group and zero in the intervention group. However, the waiting period for the control group was 8 weeks and 71% of the sample were retired, which might have contributed to the low attrition rate. In Navarro-Bravo et al.’s meta-analysis (2015), the attrition rate was not discussed. However, when investigating the studies included that used a waiting list control group, it was shown that the attrition rate was 39% in Epstein et al.’s study (2012) and that 29% in both intervention and control group dropped out between randomization and 6-month follow-up (Espie et al., 2007). The corresponding numbers in Currie et al. (2000) between randomization and 3-month follow-up were 13% in the intervention group and 17% in the waiting list control group.

4.3 Methods of data collection

Within the framework of this thesis there are several different types of measurement methods. First of all, diaries are used in all three studies. They catch the individual’s immediate impression or observation in a given moment or during a short period of time. Time-use data, which is part of the diary and analyzed in Study II, is an activity reporting method allowing one to connect different kinds of activities or patterns of activities to the outcomes from psychosocial measures and sleep evaluations. Questionnaires were used in all three studies, and they are most efficient when samples are large and in cases where global judgments are asked for (Berkman & Kawachi, 2000).

Sleep could be measured both subjectively, through diary or questionnaire, and objectively, through electrophysiological techniques or actigraphy (a wristwatch measuring wakefulness, rest and sleep). Electrophysiological techniques are often seen as the gold standard in sleep research. However,
actigraphy is easier to use and less expensive (Sadeh, 2011). In comparison, self-report measures such as questionnaires and diaries are the tools that are the most practical and also the most used to determine sleep- and wake patterns. Consequently, sleep measures that are used in this thesis include diaries (all studies), questionnaires (Study III) and actigraphy (Study III).

4.3.1 Diary data

Diary data was collected on a daily basis throughout the data collections in all three studies. A modified and shorter version of Karolinska Sleep Diary (KSD; Åkerstedt et al., 1997) was filled out in the morning, and the wake diary was filled out before going to bed. Diary measurement of sleep provides psychometric strengths in terms of low risk of recall bias and high reliability when evaluating progress in relation to an intervention (Bolger, Davis & Rafaeli, 2003; Libman et al., 2000). According to Buysse et al. (2006), sleep-diaries should be included in insomnia research as a standard measure.

The sleep-diary consisted of questions on bedtime, time of awakening and sleep latency (the time it takes to fall asleep), as from which a measure of diary total sleep time (TST; hh:mm) was derived for each day. The diary also contained a question on feelings of worry and stress at bedtime (1 very worried/aroused– 5 very calm/relaxed) and questions on subjective sleep quality (SSQ). In Study I and II, subjective sleep quality was based on an index using four questions: Did you have difficulties falling asleep? (1 very much - 5 not at all); How did you sleep? (1 very poorly – 5 very well); Did you have a restless sleep? (1 very much – 5 not at all); and Did you wake up very early without being able to fall asleep? (1 very much too early – 5 no). The index, calculated as a mean of the four items has previously been validated against physiological sleep parameters, and it showed significant correlations with objective measures of sleep continuity (Kecskud & Åkerstedt, 1997). In Study III, subjective sleep quality was assessed through the following questions:
How did you sleep? (1 very poorly – 5 very well) and Did you feel refreshed in the morning after final awakening? (1 not at all – 5 completely). The method has also been shown to be useful for evaluating treatment effects.

The wake diary contained questions on work hours, work performance, sleepiness and perceived stress. Subjective sleepiness was measured through the Karolinska Sleepiness Scale (KSS), which is a nine-graded scale with values ranging from 1=very alert to 9=very sleepy, fighting sleep. KSS has been validated against both physiological and behavioral measures and electroencephalographic (EEG) and electrooculographic (EOG) changes, which are characteristics of sleepiness that generally occurs at a value of 7 (Åkerstedt & Gillberg, 1990). Moreover, KSS has been validated in several studies and shows robust correlations with physiological sleepiness parameters and objective performance measures (Åkerstedt et al., 2014). Perceived stress was rated from 1=very low stress to 9=very high stress. Sleepiness and stress were measured at six time points during the day in Study I and II and four times during the day in Study III. The stress scale has been used in several field studies (Dahlgren et al., 2005). A mean value of sleepiness and stress was calculated for each day. In Study I and II, all variables in the sleep- and wake diary were calculated as an average of the ratings on workdays and an average of the ratings on days off. Data from the wake-diary on daily functioning (e.g. work performance) and daily activities (e.g. physical activities) were not used in Study III, but represent important data for future studies.

4.3.2 Time-use data

Time-use data were analyzed in Study II. Time-use recordings were collected through paper and pen and were part of the diary that was filled out within the intervention of reduced work time. Data-collection through intensive diary measures enables the possibility to investigate time-use patterns in a very detailed manner. This way of collecting time-use data is extensively applied in
time-use surveys in many countries (Eurostat, 2009). The method used in this study was developed by Statistics Sweden and used in the Swedish Time Use Surveys (see SCB, 2012), where people are asked to report time-use every 10 minutes during one workday and one day off. In Study II however, some modifications were made to fit the design and the collection of data. The data collection proceeded during seven days and the activity reporting sheets were divided in intervals of 30 minutes, from 06 to 01 a.m. the next night.

There were 13 predefined activities, which were based on the categories originally developed by Statistic Sweden (see SCB, 2012): Paid work, Paid work performed at home, Household work, Care of own children, Care of others, Personal care, Meals, Sleep, Rest, Leisure time, Social activities, Own time and Other. Sleep reported during daytime (from 8:30 a.m. to 9:30 p.m.) was labelled Daytime sleep. The activity Other was not used in Study II, resulting in twelve categories that are defined and presented in Figure 6 and in Figure 1 in the manuscript of Study II. These predefined activities were then divided into four different groups based on the type of activity: 1) Paid work (including labor work at the office and/or at home); 2) Non-paid work (including domestic work, care of own children and care of others); 3) Total workload (the sum of paid and non-paid work); and 4) Recovery activities (including personal care, meals, rest, leisure time, social activities, own time and daytime sleep), see Figure 6. All groups of activities were mapped out and separately calculated in terms of the average number of hours per day on workdays and days off.

4.3.3 Questionnaires

The questionnaires, which were distributed at each data collection period in all three studies, included demographic factors, working parameters as well as questions on sleep, stress levels and mental health. In Study III, the questionnaires were web-based, whereas in Study I and II, the paper-and-pen method was adopted.
Work environment exposure in terms of job strain was evaluated through job demands (1 low demands – 4 high demands) and job control (1 low control – 4 high control) (Karasek & Theorell, 1990). In Study III, insomnia was measured through the Insomnia Severity Index (ISI; Bastien, Vallières & Morin, 2001), and burnout levels were measured through the Shirom Melamed Burnout Questionnaire (SMBQ, Melamed, Kushnir & Shirom, 1992). Depression and anxiety were evaluated through the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983; Sullivan et al., 1993).

ISI has robust psychometric properties (Bastien et al., 2001), even when administrated online (Thorndike et al., 2011) and in presence of comorbid insomnia (Geiger-Brown et al., 2015). The ratings of the seven questions in ISI, given on a 5-graded scale (0 good sleep – 4 very poor sleep) were summarized. Values between 0 and 7 correspond to No presence of insomnia, 8-14 = Sub-threshold clinical insomnia, 15-21 = Presence of clinical insomnia and 22-28 = Severe clinical insomnia (Bastien et al., 2001). ISI has been extensively used in CBT-research (Blom et al., 2015; Geiger-Brown et al., 2015; Yan-Yee Ho et al., 2015; Navarro-Bravo et al., 2015; Seyffert et al., 2016) and constitutes the primary sleep outcome in Study III.

In SMBQ, symptoms of burnout were rated on a 7-graded scale (1 almost never – 7 almost always). The mean of the 22 questions gives a measure of burnout scores with values of ≥3.75 indicating high level of burnout (Grossi et al., 2003). The seven items of each scale in HADS (anxiety and depression respectively) were rated on a 4-graded scale (from 0 to 3), giving global scorings of 0-7 = Non-cases, 8-10 = Possible cases and 11-21 = Probable cases.
<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
<th>TYPE OF ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work at workplace</td>
<td>Ordinary work, over time, other time spent at the office, work-related travelling</td>
<td>Paid work</td>
</tr>
<tr>
<td>Work from home</td>
<td>Ordinary work performed at home</td>
<td>Total workload</td>
</tr>
<tr>
<td>Domestic work</td>
<td>Cooking, baking; making the dishes/tables; domestic cleaning; washing clothes; gardening; taking care of domestic animals; maintenance of home and vehicles</td>
<td>Non-paid work</td>
</tr>
<tr>
<td>Child care</td>
<td>Supervision/support; homework; playing with/talking to/reading to children; meetings at school; presence during activities; other child-related activity</td>
<td>Recovery activities</td>
</tr>
<tr>
<td>Care of others</td>
<td>Supporting other adults or other children in their home; other help in other's home; visiting patients at hospital</td>
<td></td>
</tr>
<tr>
<td>Personal care</td>
<td>Personal hygiene/getting dressed; sauna/solarium; other personal care</td>
<td></td>
</tr>
<tr>
<td>Meals</td>
<td>Meals; coffee; refreshments</td>
<td></td>
</tr>
<tr>
<td>Free time</td>
<td>Traveling/excursions; hunting/fishing; sports/physical activity; outdoor life; religious activities; watching sport events/cinema/theater/concerts; museum</td>
<td></td>
</tr>
<tr>
<td>Own time</td>
<td>Watching TV/Films/computer; listening to radio/music etc.; reading; handicraft; technical hobbies; other hobbies</td>
<td></td>
</tr>
<tr>
<td>Socializing</td>
<td>Party/dinners; meeting friends and/or family; conversations (telephone or other); visiting restaurants, bars, cafés, night clubs; other social togetherness</td>
<td></td>
</tr>
<tr>
<td>Rest</td>
<td>Resting; meditating; doing nothing</td>
<td></td>
</tr>
<tr>
<td>Daytime sleep</td>
<td>Sleep during daytime between 7:30 and 21:30</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6. Activity categories in activity reporting sheets Study II.
4.3.4 Actigraphy

Actigraphy, which is a method of activity-based sleep-wake monitoring, was used only in Study III. It is cost-effective and very commonly used as an assessment tool in sleep research. Movements are measured through a sensitive accelerometer and the value, which is described as the amount of movements per minute, is saved in the memory of the actigraph. Preprogrammed algorithms make it possible to classify if the wearer has slept or not.

In a review by Sadeh (2011) it was shown that in comparison with polysomnography (PSG) in individuals with relatively normal sleep patterns, actigraphy has good validity and reliability. However, when used in special populations to evaluate sleep (e.g. children, individuals with insomnia or other sleep related disorders) the validity is less convincing, with rather low rates of specificity (ability to detect wakefulness) between 39-69%. In the case of insomnia patients, actigraphy overestimates sleep time in terms of shorter sleep onset latency and wake after sleep onset. This is due to the fact that patients with insomnia lay in bed motionless during long periods, trying to fall asleep. However, according to Sadeh (2011), when used for detecting insomnia cases, correlations have been satisfying; e.g. in Sanchez-Ortuno et al. (2010) correlations were WASO: r=0.78-0.85; TST: r=0.92-0.93; SE: r=0.77-0.81.

Importantly, actigraphy has been shown to be sensitive in detecting group differences between individuals with insomnia and controls. Moreover, there is high validity in the assessments of changes in sleep patterns related to both pharmacological and non-pharmacological interventions, such as behavioral treatments (Sadeh, 2011).

When compared to subjective sleep measures, actigraphy has good correspondence in measuring sleep-wake patterns and sleep periods, but not other indicators, such as wake after sleep onset or sleep efficiency. However, it is not established whether the discrepancy is due to inaccuracy of the subjective measures or the actigraphy. In order to provide reliable estimates of sleep,
actigraphy should preferably be used during at least one week, since there is a high variability from night to night (Van Someren, 2007; Sadeh, 2011). It is also recommended to use other assessment methods if possible, as a complement to actigraphy (Sadeh, 2011).

In Study III, actigraphy recordings were needed in order to measure outcomes related to quantity of sleep, such as sleep duration and sleep efficiency in parallel to sleep diaries. Consequently, participants in Study III wore a wrist-actigraph (Actiware Spectrum Pro by Philips Respironics) day and night, on the non-dominant hand, during all three measurement periods. Participants received the instruction to push an event button at lights out in the evening and at final wake-up time in the morning. Scorings and calculations were made in ActiWare Software version 6.0.2; www.actigraphy.com/solutions/actiware/.

4.4 Statistical analyses

The data in the present thesis have a hierarchical or clustered structure, where individuals are clustered into groups (intervention and control) and at the same time nested within workplaces (in Study I and II). Moreover, the longitudinal design implies repeated measures data where an individual’s values over time are correlated with each other. All three studies represent randomized controlled trials where the main statistical effect of interest is the interaction effect of groups and time.

The statistical framework applied throughout this thesis is based on multilevel mixed modeling: an approach that can handle clustered or grouped data (Quené & van den Bergh, 2004). Multilevel mixed modeling takes the clustering into account when modeling the variation between groups. By using random coefficients, slopes or intercepts are not constrained to be equal over
the different groups. This means that the intercept values (or the baseline values) of the dependent variable (e.g. sleep quality) are assumed to be a sample of intercepts from a larger population. In other words, we want to generalize to a larger group of employees, beyond the particular sample of the study when examining means (intercept) or the relationship between X and Y (slopes). Multilevel modeling can be extended to deal with more complex statistical situations, such as inclusion of predictors (e.g. Gender) at the group level or including multiple levels of grouping (see Figure 7 and 8). Multilevel models use full information maximum likelihood to deal with missing data in the repeated measure variables, thus utilizing all available information.

In Study I, a mean value for workdays and days off, respectively, was computed for the outcome variables of the sleep and wake diary. In Study II, time-use data was similarly calculated separately as a mean value for workdays and days off. In order to account for the nested structure of data in Study I and II, a value of the intraclass correlation (ICC) of workplace was calculated for each variable at baseline. Although the values of ICC were low (ranging from 0.005 to 0.065 in Study I and from 0.010 to 0.078 in Study II), they were taken into consideration in the statistical analyses, which were based on multilevel mixed models including random effects for workplace at level 2.

The model applied in all three studies included the outcome variable and the fixed effects of the between-group factor Group (Intervention vs. Control; level 2), the within-group factor Time (including three measurement periods; level 1) and the interaction between Group and Time. Time was treated as a linear factor and the model was fitted by modeling the autocorrelation, thus taking the nested data over time into account.

The sub-group analysis by gender was made by adding a second between-group factor (Gender) into the model (see Figure 7 an 8), resulting in several two-way interactions and one three-way interaction of Group x Time x Gender. Additional sub-group analyses by age, having children living at home and baseline-levels of sleep quality and worries and stress at bedtime
(weekly mean value dichotomized by median split) were also performed in Study I. For the analysis of sleepiness and perceived stress of the different time points of the day, an additional within-group factor was entered (Time of day), resulting in a three-way interaction of Group x Time x Time of day together with several two-way interactions. In Study II, sub-group analyses of working area (four different), working shift (yes/no), having children living at home (yes/no), living with a partner (yes/no) and living alone with children (yes/no) were performed. Whereas in Study III, the moderating effects of burnout at baseline (SMBQbl) was evaluated by adding a second between-group factor SMBQbl (High vs Low; cut-off 3.75) into the model, see Figure 8. Furthermore, analyses were made on the intervention group only, through a model where the between-group factor was SMBQ-bl (High vs Low) and the within-group factor was Time. Sensitivity analyses were performed in all three studies. See table 2, p.61.

Figure 7. The structure of the multilevel modeling in Study I and II. Time was treated as a linear factor.
Figure 8. The structure of the multilevel modeling in Study III. Time was treated as a linear factor.

A two-tailed alpha-level of 0.05 was used in Study I and III when testing for statistical significance. To reduce the risk for Type I errors in Study II due to the number of statistical tests included in the study, a two-tailed alpha-level of 0.01 was used. Effect sizes of the interaction effects were calculated through Cohen’s $f^2$, where multilevel modeling was used. They were evaluated on the threshold levels of 0.02 described as small, 0.15 medium and 0.35 large (Cohen, 1988; Seyla et al., 2012). Where t-tests were used, effect-sizes were evaluated through Cohen’s $d$. Values of 0.3-0.5 are considered small, 0.5-0.8 moderate and >0.8 is considered large (Cohen, 1988). Descriptives, Chronbach’s alpha, t-tests, Chi$^2$-tests and analyses of variance were carried out in SPSS 21 and 24, whereas multilevel analyses and calculation of ICCs and Cohens $f^2$ were made in STATA 14.
4.5 Summary of material and methods

In order to present a clearer picture of study design, study populations and methods that were used in each study respectively, all information is summarized and presented in Table 2.

Table 2. Overview of methods and material used in Study I, II and III, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Study I: Work time reduction and stress/sleep</th>
<th>Study II: Work time reduction and time-use</th>
<th>Study III: Group CBT for insomnia at the workplace</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design</strong></td>
<td>RCT</td>
<td>RCT</td>
<td>RCT</td>
</tr>
<tr>
<td><strong>Randomization</strong></td>
<td>Cluster randomization on workplace level</td>
<td>Cluster randomization on workplace level</td>
<td>Randomization on individual level</td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
<td>Work time reduction 25%</td>
<td>Work time reduction 25%</td>
<td>Group CBT for insomnia</td>
</tr>
<tr>
<td><strong>Control group</strong></td>
<td>Treatment as usual; working full-time</td>
<td>Treatment as usual; working full-time</td>
<td>Waiting-list</td>
</tr>
<tr>
<td><strong>Measurement periods</strong></td>
<td>Baseline, 9 months &amp; 18 months</td>
<td>Baseline, 9 months &amp; 18 months</td>
<td>Baseline, Post- &amp; 3-month follow-up</td>
</tr>
<tr>
<td><strong>Duration of measurement periods</strong></td>
<td>7 days, 7 nights</td>
<td>7 days, 7 nights</td>
<td>10 days, 10 nights</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Full-time workers in public sector</td>
<td>Full-time workers in public sector</td>
<td>Employees in retail sector working at least 75%</td>
</tr>
<tr>
<td><strong>N participating workplaces</strong></td>
<td>33</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td><strong>N participants</strong></td>
<td>580</td>
<td>636</td>
<td>51</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>20-65 years (m=44.6; sd=10.6)</td>
<td>20-65 years (m=44.2; sd=10.9)</td>
<td>22-60 years (m=43.0; sd=9.3)</td>
</tr>
<tr>
<td></td>
<td>Study I: Work time reduction and stress/sleep</td>
<td>Study II: Work time reduction and time-use</td>
<td>Study III: Group CBT for insomnia at the workplace</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------------------</td>
<td>-------------------------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td><strong>Proportion of women</strong></td>
<td>76%</td>
<td>75%</td>
<td>63%</td>
</tr>
<tr>
<td><strong>Proportion of shift-workers</strong></td>
<td>29%</td>
<td>30%</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Measurements</strong></td>
<td>Questionnaire and Diary</td>
<td>Questionnaire and Activity reporting sheets</td>
<td>Questionnaire, Diary and Actigraphy</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>Sleep duration, Subjective sleep quality, Sleepiness, Perceived stress during daytime, Stress and worries at bedtime - separately for workdays and days off</td>
<td>Time use in terms of 12 different categories, grouped into: Total workload, Paid work, Non-paid work and Recovery Activities - separately for workdays and days off</td>
<td>Level of insomnia (ISI), Level of burnout (SMBQ), Subjective sleep quality, Non-refreshing sleep, Stress and worries at bedtime, Sleep length and Sleep efficiency</td>
</tr>
<tr>
<td><strong>Statistical methods</strong></td>
<td>• Multilevel Mixed Modeling with random effects for workplace • Time is linear</td>
<td>• Intention-to-treat approach • Multilevel Mixed Modeling with random effects for workplace • Time is linear</td>
<td>• Multilevel Mixed Modeling • Time is linear</td>
</tr>
<tr>
<td><strong>Main statistical indicator</strong></td>
<td>Group x Time interaction</td>
<td>Group x Time interaction</td>
<td>Group x Time interaction</td>
</tr>
<tr>
<td><strong>Subgroup analyses</strong></td>
<td>Gender (man/woman), Age (median split=45y), Having children living at home (yes/no), Sleep quality at baseline (poor/good) and Bedtime worries at baseline (high/low).</td>
<td>Gender (man/woman), Working area (4 different), Shift work (yes/no), Having children living at home (yes/no), Sharing household with a partner (yes/no) and Living alone with children (yes/no).</td>
<td>Level of burnout scores at baseline (high/low), Level of anxiety (high/low) and Level of depression (high/low).</td>
</tr>
<tr>
<td><strong>Sensitivity analyses</strong></td>
<td>• Excluding the non-randomized workplace</td>
<td>• Excluding employees working shorter workweek (4 days) • Excluding the non-randomized workplace</td>
<td>• Excluding shift workers • Comparing completers vs non-completers</td>
</tr>
</tbody>
</table>
5 ETHICAL CONSIDERATIONS

When human subjects are involved in research, anonymity and/or confidentiality should be guaranteed and consent should be informed (Behi & Nolan, 1995). The latter means that the subjects should receive honest and thorough information about the project in order to make it possible for them to decide whether or not they wish to participate. In all three studies both confidentiality and informed consent was ensured. Moreover, applicants were informed that participation was voluntary and could at any time be withdrawn.

Another ethical aspect to consider is that the benefits for the subjects participating in a study should be estimated to exceed the risk of harm (Behi & Nolan, 1995). In some cases, however, the benefits are not apparent for the subject directly, but could generate positive effects for society in the long run. That is a relevant aspect to consider for the participants in the control group in Study I and II. They were asked to participate in extensive data collection procedures three times, without getting anything back personally for the effort of their participation. Similarly, in Study III, it is important to consider that individuals in a waiting list control group, suffering from sleeping problems, could be deeply disappointed if they do not receive help directly, but must first go through and participate in three data collection periods. However, participants in Study III were informed that the study comprised randomization into an intervention group or a control group and that the control group had to wait at least six months before participating in the group intervention. Participants also received two cinema tickets after completing measurements at baseline as well as after having fulfilled all three periods of data collection.

Due to the increasing interest in organizational interventions targeting sleep, not only as an outcome, but also as an independent variable, Barber (2017) has written a commentary on ethical considerations to take into account...
during such interventions. She distinguishes between positive and negative interventions, where positive interventions refer to situations where the aim is to improve sleep – either directly through sleep education or changes in the work environment and/or leisure time activities. Negative interventions, on the other hand, refer to situations where the aim is to withdraw or restrict sleep and consequently, ethical issues arise and should be considered. In this present thesis, the nature of the interventions could be considered positive, and no ethical issues are connected to the sleep intervention, except for one method used within the group CBT intervention in Study III called “sleep restriction”. Sleep restriction is a validated and efficacious method where the aim is to improve sleep efficiency by reducing time in bed so it corresponds to sleep time (Morin et al., 2006). Prolongations are made until the desired sleep duration is accomplished. This method might seem deterrent to someone who already has problems with sleep. Some studies have actually reported increased daytime sleepiness (Miller et al., 2013; Kyle et al., 2014) and impaired vigilance (Kyle et al., 2014) in relation to sleep restriction therapy. However, the method has been shown to be efficient in a meta-analysis by Morin et al. (2006) and importantly, in Study III participants could choose themselves if they wanted to try sleep restriction or not. This fact reduces the ethical issues related to this method.

The project involving Study I and II was approved by the Stockholm regional ethical review board (Reference no: 04-1059/5), and all participants gave their written consent. Participants signed legally binding documents agreeing not to engage in any other paid work in their free-time during the intervention period. Study III was approved by the regional ethical committee in Stockholm (Reference no: 2013/2043-31/2) and informed consent was obtained from all included individuals.
6 RESULTS

In this section, the main results from the three studies are summarized. Results that are not included in the published paper or in the manuscripts are presented under separate subheadings.

6.1 Study I – Work time reduction

The aim was to evaluate the effects of the intervention on sleep, sleepiness and stress, and the main results of this study are presented in terms of differences between groups over time. Attrition analyses, sensitivity analyses and sub-group analyses are also presented in the following paragraphs. The additional results include the main effects of group and time, as well as sensitivity analyses employing an intention-to-treat approach and contrast scores.

6.1.1 Results

The analyses in Study I were made for workdays and days off separately. On workdays, there was a beneficial effect of the intervention (over the whole period of 18 months) expressed by improved SSQ, 23 minutes extended sleep duration per night, decreased sleepiness and perceived stress and fewer feelings of worry and stress at bedtime. Similarly, the intervention had positive effects on all outcomes on days off, except for sleep duration, see results in Figure 9-10 (p.67-68), Table 3 (including main effects, p.69), and Table 4 in Schiller et al. (2017).

Age, educational level and level of job control at baseline were added as covariates, which did not impact the results of the unadjusted models (see
Analyses of subjective sleepiness (measured by KSS) and perceived stress for the different time points of the day were effectuated and showed no significant three-way interactions, neither for workdays nor days off (see Figure 2 and 3 in Schiller et al., 2017).

Women showed marginally less improvement in sleepiness during days off as compared to men. However sub-group analyses did not show statistically significant differences with respect to gender, age or having children living at home, except for those having children who experienced less stress on workdays after the introduction of reduced work hours compared to those who did not have children. Moreover, those who had poorer sleep quality at baseline benefited more from the intervention since they reported fewer feelings of worry and stress at bedtime on days off after the introduction of reduced work time. Baseline-levels of worries and stress at bedtime did not impact on the effect of the intervention. Mean values and effects of the three-way interactions are presented in the supplement (Tables b to f in Schiller et al., 2017).
Figure 9. Interaction effects of groups over time on workdays.
Figure 10. Interaction effects of groups over time on days off.
6.1.2 Additional results

These analyses were made in order to provide additional results that could help understand and interpret the effects of the intervention. Table 3 below shows the main effects of group (intervention vs control) and time (baseline, 9 months and 18 months), analyses that were not included in the published paper (Schiller et al., 2017). These results show that time and group allocation alone did not have any effects on stress, sleep and sleepiness, but the interaction between the two did. This supports the notion that the work time reduction was responsible for the effects. In Figure 9 and 10, all the lines indicate interaction effects by the fact that they cross each other over time.

Table 3. Main effects group and time in the multilevel mixed model.

<table>
<thead>
<tr>
<th></th>
<th>Effects of group</th>
<th></th>
<th>Effects of time</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeffb</td>
<td>p-value</td>
<td>C.I. (95%)</td>
<td>Coeff</td>
</tr>
<tr>
<td><strong>Workdays</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSQa</td>
<td>-0.04</td>
<td>0.432</td>
<td>-0.14 – 0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Sleep duration</td>
<td>-0.03</td>
<td>0.696</td>
<td>-0.20 – 0.14</td>
<td>-0.01</td>
</tr>
<tr>
<td>Sleepiness</td>
<td>-0.04</td>
<td>0.775</td>
<td>-0.28 – 0.21</td>
<td>-0.09</td>
</tr>
<tr>
<td>Stress</td>
<td>0.01</td>
<td>0.971</td>
<td>-0.30 – 0.32</td>
<td>-0.00</td>
</tr>
<tr>
<td>Bedtime worries</td>
<td>-0.10</td>
<td>0.187</td>
<td>-0.25 – 0.05</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Days off</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSQ</td>
<td>-0.05</td>
<td>0.422</td>
<td>-0.16 – 0.07</td>
<td>-0.01</td>
</tr>
<tr>
<td>Sleep duration</td>
<td>-0.02</td>
<td>0.814</td>
<td>-0.23 – 0.18</td>
<td>0.09</td>
</tr>
<tr>
<td>Sleepiness</td>
<td>0.15</td>
<td>0.253</td>
<td>-0.10 – 0.40</td>
<td>0.02</td>
</tr>
<tr>
<td>Stress</td>
<td>0.17</td>
<td>0.177</td>
<td>-0.08 – 0.41</td>
<td>0.06</td>
</tr>
<tr>
<td>Bedtime worries</td>
<td>-0.08</td>
<td>0.116</td>
<td>-0.19 – 0.02</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

a) SSQ=Subjective Sleep Quality
b) Coefficient refers to the time interval Baseline to 18-months follow-up.
c) Significant at the 0.05-level
A second additional analysis was an intention-to-treat approach, performed here as a sensitivity analysis. All individuals working full-time and having participated in baseline measurements were consequently included in the model, which resulted in N=636 individuals (see flow chart Figure 4, p.46).

Table 4. Intention-to-treat analysis with N=636 individuals included. Contrast scores are presented by group and by time period.

<table>
<thead>
<tr>
<th>Workdays</th>
<th>Interaction effect of Group*Time</th>
<th>Contrast scores</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Baseline vs 9 months</td>
<td>9 months vs 18 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>C</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>SSQ</td>
<td>0.09&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.04 - 0.14</td>
<td>0.148&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.002</td>
<td>0.080&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sleep length</td>
<td>0.20&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.14 - 0.27</td>
<td>0.333&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.045</td>
<td>0.034</td>
</tr>
<tr>
<td>Sleepiness</td>
<td>-0.20&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.29 - -0.11</td>
<td>-0.450&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.122&lt;sup&gt;d&lt;/sup&gt;</td>
<td>-0.117&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Stress</td>
<td>-0.25&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.36 - -0.14</td>
<td>-0.158&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.072</td>
<td>0.041</td>
</tr>
<tr>
<td>Sleep length worry</td>
<td>-0.21&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.32 - -0.10</td>
<td>0.179&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.008</td>
<td>0.049</td>
</tr>
<tr>
<td>Days off</td>
<td></td>
<td>Baseline vs 9 months</td>
<td>9 months vs 18 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>C</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>SSQ</td>
<td>0.12&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.05 - 0.19</td>
<td>0.135&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.027</td>
<td>0.073</td>
</tr>
<tr>
<td>Sleep length</td>
<td>0.04</td>
<td>-0.15 - 0.08</td>
<td>0.125&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.076</td>
<td>-0.043</td>
</tr>
<tr>
<td>Sleepiness</td>
<td>-0.21&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.32 - -0.10</td>
<td>-0.288&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.093</td>
<td>-0.116</td>
</tr>
<tr>
<td>Stress</td>
<td>0.08&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.02 - 0.15</td>
<td>-0.287&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-0.032</td>
<td>-0.029</td>
</tr>
<tr>
<td>Bedtime worries</td>
<td>0.10&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.03 - 0.16</td>
<td>0.192&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.037</td>
<td>0.080&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

a) SSQ=Subjective Sleep Quality
b) Coefficient refers to the time interval Baseline to 18-months follow-up.
c) Significant at the 0.01-level  d) p=0.056
d) Significant at the 0.05-level  e) I=Intervention group, C=Control group

As can be seen in Table 4, there are no differences in significance of the interaction effects as compared to the original analyses of the study. Moreover, since time was modeled as a linear variable, contrast scores were additionally
calculated in order to detect the effects between baseline and 9 months as well as between 9 months and 18 months. Interestingly, it is shown that participants in the intervention group continued to improve in sleep quality and sleepiness on workdays as well as bedtime worries on days off, even after 9 months, although most of the positive effects were found between baseline and the 9-month measurement.

6.2 Study II – Time-use

In this study, which is completely based on an intention-to-treat approach, analyses were made to reveal changes in time-use patterns in relation to the intervention. Consequently, the main results of this study are presented in terms of differences between groups over time. The activities are clustered as total workload (paid work and non-paid work) and recovery activities, in addition to those twelve predefined activities from the activity-reporting sheet (see Figure 6, p.54). The main effects of group and time, not included in the manuscript are presented in the separate subheading “Additional results”.

6.2.1 Results

On workdays, there was an effect of the intervention in time-use patterns. The intervention group as compared to the control group increased the amount of time spent on own time activities and domestic work after the introduction of reduced work time. Although the total amount of non-paid work increased over time in the intervention group as compared to the control group, total workload decreased and the total amount of recovery activities increased. Total workload decreased by 65 minutes for the intervention group (15 minutes for control group) when baseline and 18-months follow-up was compared. See Figure 11, p.71.
Figure 11. Interaction effects of group over time on workdays.
On days off, the intervention group spent more time on free-time activities as compared to the control group when work hours were reduced. However, no significant effects were found in the different groups of activities on days off. See Figure 12 below.

Figure 12. Interaction effects of group over time on days off.
Contrast scores were calculated since the model included a linear time-variable. They showed that the effects of the intervention could be seen between baseline and the 9-months follow-up, whereas no significant effects were seen between 9 months and the 18-months follow-up. The adjusted models (including educational level and working shift) showed results similar to those in the crude models. Data and results are presented in Figure 11-12 (p.72-73), in Table 5 (including main effects, p.75) and in Table 2 and 3 in the manuscript of Study II.

Subgroup analyses revealed no effects of gender, family status and job situation in relation to the intervention. Results are presented in the supplement of the manuscript of Study II.

6.2.2 Additional results

Table 5 shows the main effects of group (intervention vs control) and time (baseline, 9 months and 18 months); results are not included in the manuscript of Study II. As can be read from the table, there is a group difference in paid work on workdays and recovery activities on days off, when ignoring the effect of time. These effects can be seen in Figure 11 and 12, showing that the control group has more paid work and less time spent in recovery activities on workdays compared to the intervention group during all measurement periods. Moreover, there is a change in recovery activities on workdays and paid work on days off over time, without taking groups into account. Again, in Figure 11 and 12, it is shown that both recovery activities on workdays and paid work on days off increase over time when taking both groups into account.
Table 5. Main effects group and time in the multilevel mixed model.

<table>
<thead>
<tr>
<th>Workdays</th>
<th>Effects of group</th>
<th>Effects of time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff</td>
<td>p-value</td>
</tr>
<tr>
<td>Total workload</td>
<td>-0.31</td>
<td>0.065</td>
</tr>
<tr>
<td>Paid work</td>
<td>-0.38</td>
<td>0.011&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Non-paid work</td>
<td>0.04</td>
<td>0.735</td>
</tr>
<tr>
<td>Recovery activities</td>
<td>0.34</td>
<td>0.070</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Days off</th>
<th>Coeff</th>
<th>p-value</th>
<th>C.I. (95%)</th>
<th>Coeff</th>
<th>p-value</th>
<th>C.I. (95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total workload</td>
<td>-0.02</td>
<td>0.933</td>
<td>-0.46 – 0.42</td>
<td>0.01</td>
<td>0.893</td>
<td>-0.17 – 0.20</td>
</tr>
<tr>
<td>Paid work</td>
<td>0.01</td>
<td>0.883</td>
<td>-0.12 – 0.14</td>
<td>0.09</td>
<td>0.010&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.02 – 0.16</td>
</tr>
<tr>
<td>Non-paid work</td>
<td>0.01</td>
<td>0.960</td>
<td>-0.46 – 0.44</td>
<td>-0.08</td>
<td>0.388</td>
<td>-0.26 – 0.10</td>
</tr>
<tr>
<td>Recovery activities</td>
<td>0.67</td>
<td>0.003&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.22 – 1.12</td>
<td>0.22</td>
<td>0.073</td>
<td>-0.19 – 0.45</td>
</tr>
</tbody>
</table>

<sup>a)</sup> Coefficient refers to the time interval Baseline to 18-months follow-up.
<sup>b)</sup> Significant at the 0.01-level

6.3 Study III – Group CBT for insomnia

This study represents an intervention study with a waiting-list control group, where the main results are based on the interaction effects of groups over time. Moreover, the moderating effect of level of burnout scores at baseline was investigated. Moderating effects of common mental disorder as well as intention-to-treat analyses are presented as additional results.

6.3.1 Results

Based on diagnostic criteria (Bastien et al., 2001), 53% in the intervention group were in remission between baseline and follow-up (ISI≥15 at baseline and <15 at follow-up), as compared to 20% in the control group. See Figure
Moreover, contrast scores showed that there was a significant within-group effect on ISI in the intervention group between baseline and post-measurement. Importantly, there was a significant improvement of ISI scores for the control group between post-measurement and follow-up, also shown in Figure 13 below. The results show that there is a greater improvement of ISI-scores in the intervention group as compared to the control group over the three measurement periods. However, the multilevel mixed model showed no significant difference between groups over time in the degree of insomnia for the full sample, nor in the sleep parameters as measured with sleep diary or with actigraphy. Mean values are presented in Table 4 and interaction effects in Table 5 in the manuscript of Study III.

**T-tests significant at the 0.01-level**

**Figure 13. Proportion of participants fulfilling clinical insomnia at the three time points.**
Sensitivity analyses (by excluding shift workers from the sample) showed a significant interaction effect between groups over time, with a decrease in ISI for the intervention group (Coeff=-1.319, p=0.044, C.I.=-2.600 - -0.038, see Table S1 and S2 in supplement of the manuscript of Study III). Item analyses of ISI showed significant interaction effects of groups over time in the items Dissatisfaction with current sleep (p=0.032) and Experience sleep problems as disturbing (p=0.045), which improved more over time in the intervention group as compared to the control group (see Table S3 and S4 in supplement in the manuscript of Study III).

There was a moderating effect of baseline-levels of burnout scores on the effect of the intervention (Coeff=3.28; p=0.009; C.I.=0.818-5.746). Analyses of the intervention group only, which was divided into two groups based on the cut-off value 3.75 on SMBQ (Grossi et al., 2003) at baseline showed that participants with low levels of burnout symptoms at baseline significantly improved on insomnia over time, whereas participants with high levels of burnout symptoms at baseline did not (Coeff=2.51; p=0.005; C.I.=0.770-4.244) (see Figure 3 in the manuscript of Study III). In the control group, no differences between participants with high or low burnout scores at baseline could be seen. The effects on other sleep parameters measured with diary or actigraphy were not moderated by the level of burnout scores at baseline, nor in the intervention group neither in the control group.

Participants from both the intervention group and control group completed an evaluation questionnaire after having participated in the group CBT-program and the results showed that 94% felt they had been helped by the intervention and 91% would recommend the program to other employees within their organization.
6.3.2 Additional results

When studying the included participants (N=51), it is shown that a large number of the subjects suffers from some type of mental disorder, beyond clinical insomnia (ISI>14). See Table 6. The variable “Common mental disorder” in the table below indicates subjects showing symptoms over the threshold levels of clinical significance in HADSa>10p, HADSD>10p or high levels in SMBQ≥3.75p.

Table 6. Number of participants scoring over and under the threshold values of clinical significance on ISI, HADS and high and low levels in SMBQ at baseline. N=51.

<table>
<thead>
<tr>
<th></th>
<th>N under threshold</th>
<th>N over the threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISI - Insomnia</td>
<td>14</td>
<td>37 (72.5%)</td>
</tr>
<tr>
<td>HADSa - Anxiety</td>
<td>29\textsuperscript{a}</td>
<td>21 (42.0%)</td>
</tr>
<tr>
<td>HADSD - Depression</td>
<td>46\textsuperscript{b}</td>
<td>4 (8.0%)</td>
</tr>
<tr>
<td>SMBQ - Burnout</td>
<td>19\textsuperscript{b}</td>
<td>29 (60.4%)</td>
</tr>
<tr>
<td>Common mental disorder</td>
<td>20\textsuperscript{a}</td>
<td>30 (60.0%)</td>
</tr>
</tbody>
</table>

\textsuperscript{a) One missing \quad \textsuperscript{b) Three missing}

Analyses were made with the level of anxiety symptoms (according to HADSA) and the level of depression symptoms (according to HADSD) at baseline. The three-way interaction of Group, Time and HADSA showed a significant effect on ISI: Coeff=2.671; p=0.028, C.I.=0.281 – 5.060, but not on the other sleep parameters (based on diary and actigraphy data). However, this effect was due to a main effect of time in the intervention group. That is, in the intervention group ISI scores decreased over time, independently if participants scored high or low on HADSA. The model with HADSD showed no significant three-way interactions. When entering the variable CMDbl (common mental disorder at baseline) into the model, there was again a significant three-way interaction effect on ISI: Coeff=3.249; p=0.006, C.I.=0.950 – 5.548, but not in the rest of the sleep parameters. Additional analyses showed...
that subjects suffering from a common mental disorder at baseline do not benefit from the intervention to the same extent as do subjects with low levels, or absence of common mental disorders. These analyses were made on the intervention group only, which was divided into two groups based on the value of common mental disorder (N_{yes}=13, N_{no}=12). A significant interaction effect of CMDblxTime (Coeff=2.41; p=0.004; C.I.=0.751-4.064) was shown.

An intention-to-treat analysis was performed and is presented here as a sensitivity analysis. All individuals that participated in baseline measurements were consequently included in the model, which resulted in N=62 individuals. As can be seen in Table 7 below, there are no differences as compared to the original analyses of the study, although ISI almost reaches a level of significance (p=0.061).

Table 7. Intention-to-treat analysis with N=62 included individuals.

<table>
<thead>
<tr>
<th></th>
<th>Interaction effect of Group*Time</th>
<th>p-value</th>
<th>C.I. (95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Questionnaire data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISI</td>
<td>-0.111</td>
<td>0.061</td>
<td>-2.275 - 0.053</td>
</tr>
<tr>
<td>SMBQ</td>
<td>0.024</td>
<td>0.857</td>
<td>-0.240 - 0.229</td>
</tr>
<tr>
<td><strong>Diary data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSQ</td>
<td>-0.024</td>
<td>0.753</td>
<td>-0.178 - 0.129</td>
</tr>
<tr>
<td>Non-restorative sleep</td>
<td>-0.079</td>
<td>0.411</td>
<td>-0.268 - 0.110</td>
</tr>
<tr>
<td>Bedtime worries</td>
<td>0.002</td>
<td>0.962</td>
<td>-0.101 - 0.106</td>
</tr>
<tr>
<td><strong>Actigraphy data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep length</td>
<td>-0.021</td>
<td>0.827</td>
<td>-0.214 - 0.171</td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>0.249</td>
<td>0.804</td>
<td>-1.715 - 2.214</td>
</tr>
</tbody>
</table>

a) Coefficient refers to the time interval Baseline to 18 months follow-up.
7 DISCUSSION

The overall purpose of the present thesis was to evaluate two different interventions; reduced work time and group CBT for insomnia aimed at improving stress and sleep in working individuals. In the following section, findings will be discussed in relation to this aim. The more specific aims and results will be discussed study by study. Furthermore, this section includes a discussion on the strengths of the studies and their limitations. Finally, the findings of the thesis will be discussed in relation to the field of public health and policy making.

7.1 Overall findings

The results of this thesis confirm the notion that the occupational intervention of reduced work time can reduce stress and improve recovery opportunities among employees. The individual-level group CBT-intervention at the workplace shows some evidence of being effective in certain groups of employees, but the program needs to be developed and re-evaluated.

Since work time reduction was beneficial for perceived stress and sleep both on workdays and on days off, one could argue that reduced work time could be one way of diminishing workload and enhancing recovery opportunities between workdays. Findings in the study on time-use in relation to reduced work time showed that even if the extra free-time on workdays is used in domestic work, total workload decrease and recovery activities increase when work hours were reduced. Interestingly, no gender differences were found in relation to the intervention of reduced work time.
The results of Study III show no significant improvement of sleep in the full sample. However, the study showed that insomnia symptoms could be reduced through a group CBT-program where employees learn how to constructively handle periods of suboptimal sleep, if employees did not work during non-traditional work hours and if they did not suffer from high levels of burnout scores.

7.2 Specific findings put in context

Findings are put in the context of the initial aim. They are separately presented for all three studies in the following paragraphs.

7.2.1 Study I – Work time reduction

The aim of Study I was to evaluate a controlled intervention of a 25% reduction of weekly work hours and its impact on subjective sleep quality (SSQ), sleep length, subjective sleepiness and perceived stress. Furthermore, the aim was to explore the effects on days off and to analyze gender differences, age and family situation.

The hypothesis of Study I was that a substantial work time reduction for full-time workers during one and a half years would result in longer sleep duration, better subjective sleep quality, lower daytime sleepiness and perceived stress, including worries and stress at bedtime during workdays. This hypothesis was confirmed. The explorative investigation of the effects on days off revealed that subjective sleep quality, sleepiness and stress, as well as worries and stress at bedtime improved as a result of the reduced work time.

Put in the context of earlier findings in non-randomized intervention studies on 6h workdays, where improved subjective sleep quality and reduced mental fatigue (Åkerstedt et al., 2001), as well as reduced symptoms of job
exhaustion (Nätti & Anttila, 1999), was found, the results in Study I confirm these results. However, despite the fact that parents and women working full-time often have a higher load (Berntsson, Lundberg & Krantz, 2006; McElwain, Korabik & Rosin, 2005) and that health and sleep problems are more prevalent in older (Sivertsen et al., 2009; Boot et al., 2016), no individual differences were found related to parental status, age or gender, except for stress, which decreased more on workdays for those having children when work hours were reduced, and sleepiness, which decreased slightly less for women than for men on days off.

The absence of gender differences in this study could be due to restricted power. When entering a third factor in the model, the groups that are compared over time become smaller. Importantly, there were only 78 men in the intervention group and 74 men in the control group. Still, little is known about gender differences in relation to work time reduction, and the conclusion supported by these data is that gender differences did not apply.

7.2.2 Study II – Time-use

Study II aimed at exploring time-use data with a focus on workload and recovery activities, in relation to an intervention of reduced work time. The purpose was to investigate how employees disposed of their time on workdays and days off during such an intervention. Subgroups connected to gender, family status and work situation were also explored.

Based on the effort-recovery model, it was hypothesized that since reduced work time implicitly leads to enhanced recovery opportunities, total workload should decrease and recovery activities increase as a result of the reduced work time. The results confirmed this hypothesis; total workload (time spent in paid and non-paid work put together) diminished on workdays as a result of the reduced work time, even though the amount of time spent in
domestic work increased. More time was spent in recovery activities on workdays as well, especially in terms of own-time activities, such as reading or listening to the radio, watching TV or being active on the computer or in other hobby activities. Recovery activities even increased on days off, as reflected by the extended time spent in free-time activities such as physical exercise, cultural activities or traveling. There were no specific individual differences in terms of gender, work situation or family status, except for non-paid work on workdays (in the adjusted model), which increased more after the introduction of reduced work time for those having children.

Although no earlier study on time-use related to work time reduction has been made through activity-reporting sheets, previous research has investigated the balance between work and other domains in life in relation to reduced work time. One study, made through questionnaires and interviews, shows that reduced work time is associated with a better balance between work and family life (Anttila, Näätä and Vaisänen, 2005), where the positive impact of a shorter workday on work-family conflict was more valued by employed parents as compared to employees who did not have any children. Moreover, Åkerstedt et al. (2001) found through questionnaires that the strongest effect of a work time reduction on time-use was the increasing time spent with family and friends.

Spending more time with one’s children and in household duties, would necessarily not be classified as workload. How these activities are perceived is highly individual (Sonnentag, 2001). Demerouti et al. (2009), point out that there is no empirical support for a putative detrimental effects of household work or child care on recovery. In speculation, household work might impede recovery by increasing total workload, while child care might facilitate recovery by strengthening bonds and increasing social support, which act as buffers of stress.
7.2.3 Study III – Group CBT for insomnia

The aim of the third study was to evaluate a workplace-based group CBT-intervention for insomnia among employees reporting moderate sleep disturbances. An explorative aim was to investigate the moderating effects of burnout scores at baseline on the effects of the intervention.

The fact that the intervention evaluated in this study was based on methods of which the efficiency is backed up by solid evidence lead to the hypothesis that this intervention would show beneficial effects on sleep and insomnia symptoms. This hypothesis was partly, but not fully, confirmed; no effects were found on insomnia symptoms or other sleep parameters such as subjective sleep quality and quantitative sleep efficiency when the intervention group was compared to the control group over time in the full sample. However, there were significant and moderate within-group effects in the intervention group on ISI-scores, and when excluding shift-workers from the full sample, there was a significant effect of the intervention on insomnia symptoms between groups over time. Moreover, insomnia symptoms were significantly reduced in participants who did not meet the criteria for high levels of burnout scores at baseline.

Putting these results in the context of earlier findings, it reveals that some of the results are in line with earlier findings and some are not. Insomnia symptoms assessed both through validated scales (e.g. ISI) and diaries have previously been reduced as a result of group CBT interventions, but no effects have been seen on sleep duration (Navarro-Bravo et al., 2015). Small effects were found by Koffel et al. (2015) on sleep efficiency, but beneficial within-group effects were shown in the intervention group on ISI-scores ($d=0.70$), sleep duration and sleep quality. In the present study, both sleep duration and especially sleep efficiency, which were objectively measured with actigraphy, were relatively good at baseline (see Table 3 in the manuscript of Study III), thus small effects were expected to be observed in these sleep parameters.
Notably, the significant effects related to the intervention only concern ISI scores and no other sleep parameters. It might be that ISI is more sensitive to the overall experience of the participants’ sleep as compared to diary data or actigraphy. The items in ISI may be easily impacted by the participants’ expectations and mindset. Another explanation might be that the experience of having sleep problems, as it is asked for in ISI, reflect poorer sleep than it actually is when measured with diary data and actigraphy.

Moreover, the effects of a CBT program for insomnia might be seen once the participants have actually implemented the tools and tested the different methods, which might take some time. This phenomenon was observed in the meta-analysis by Koffel and colleagues (2015), where patients continued to improve on total sleep time and sleep quality long after the group CBT-program had ended. Consequently, eventual beneficial effects could have been seen after the follow-up measurement in Study III. This period could not be extended in the present study, since the control group was awaiting their participation in the group CBT-program. A more comprehensive program with more sessions (Koffel et al., 2015), could have led to stronger results; however, probably the time expenditure during work hours would then have been too large.

The moderating effect of level of burnout scores at baseline on the effects of the intervention is an interesting explorative finding that could give added knowledge to the field. Despite the fact that there are studies showing group CBT for insomnia to be efficient in cases of comorbidity with anxiety and depression (Blom, 2015; Lichstein et al., 2010; Rybarczyk et al., 2009; Smith et al., 2005; Stepanski & Rybarczyk, 2006), no study has investigated the treatment efficiency of a workplace based group CBT-intervention for insomnia related to level of burnout, even though sleep and stress are highly interconnected (Armon, 2008; Ekstedt et al., 2009; Linton et al., 2015; Van Laethem et al., 2013).
The intervention was not effective for subjects with high level of burnout scores. If this finding, based on subgroup analyses performed post-hoc, can be replicated, it could partly be explained by the setup of the program. Following a group CBT for insomnia at the workplace during work hours might be stressful per se. When suffering from high stress-levels, a program involving both presence during work hours, reading chapters, testing new methods and doing homework might be altogether too demanding. The fact that high stress-levels and sleep problems mutually nurture each other’s development over time could also be a contributing factor, and a program focusing more on stress-management might probably have been more effective for those participants suffering from high levels of burnout scores.

7.3 Strengths and limitations

In order to value the robustness of the findings in this thesis, strengths and limitations of the two interventions are presented and discussed in the following paragraphs.

7.3.1 Work time reduction - Study I and II

The main strength of Study I and II is that they, to the best of our knowledge, are the first controlled intervention studies of a considerable work time reduction with retained salary, using a randomized procedure and including a large number of workplaces. It is also the first time that time-use is investigated through diary data in relation to an intervention of work time reduction. An important feature of these studies is that the decreased level of workload could be ensured thanks to the fact that new staff was recruited to cover up for the reduction of work time. Another strength is that the studies have high statistical power due to low attrition rate and large sample size. Moreover, diaries
provide reliable data with low risk for recall bias (Bolger et al., 2003) and allow for analyses of workdays and days off separately. The activity reporting sheets in the diary enable the possibility to investigate time-use patterns in a very detailed manner. Finally, there was a relatively long follow-up period of 18 months after introduction of the intervention.

Some limitations should be noted. Firstly, in Study I and II, the lack of objective measurements for the outcome can have introduced bias, such as overestimation of the effects of the intervention. Moreover, despite the large group of participants in these studies, there might however be a problem of power resulting an increased risk for Type II errors in the sub-analyses.

Importantly, the randomization procedure could not be fully implemented, since one workplace was not able to recruit new staff. Consequently, this workplace was automatically part of the control group. However, sensitivity analyses by excluding this workplace showed no differences in comparison with the original analyses. Moreover, participants could obviously not be blind to the intervention. The participating workplaces likely had high expectations for the project and hoped for a participation in the intervention group, even though they knew the study implied a randomization procedure. We do not know how their attitudes (in either the intervention or the control group) towards the project were affected after the randomization. Moreover, it is important to consider the fact that participants were relatively healthy and that they had low prevalence of severe sleep/wake disturbances as well as severe stress already from start. There might be stronger effects of a work time reduction among employees with poorer sleep and higher levels of stress.

In Study II, some limitations are related to the activity reporting sheets. Since activities should be reported every 30 minutes, only one activity category was reported even though participants might in practice have been active in more than one category. Moreover, even though one of the instructions was to fill out the activity reporting sheet throughout the day, we do not know to
what extent this instruction was followed. Furthermore, there are some activities that were not included among the predefined categories, since they were not developed to the same extent in 2005-2006 as they are today (e.g. activities in social media). Because of the close relation to fatigue and well-being (Sonnentag, 2001; Sonnentag & Bayer, 2003; Sonnentag & Natter, 2004; Winwood et al., 2007), physical exercise should preferably constitute its own category, which was not the case. Moreover, it was not possible to analyze passive and active recovery activities separately.

Furthermore, there might be different patterns in time-use between those working four days a week, eight hours a day, and those working five days a week, shorter workdays. However, sensitivity analyses indicated no such differences. It is shown in Bildt et al. (2007) that the control group would prefer 7.5 hour workdays four days a week instead of 6-hour workdays five days a week, whereas in the intervention group (who had the experience of working 6h workdays during 18 months) a 6-hour workday and a shorter work week were equally valued. Interestingly, in Lorentzon’s report (2017) from a trial of reduced work time, the nurses who participated wished to work four days a week instead of 6h/day when they were asked at baseline, whereas, after the intervention had started, they were very satisfied with the 6-hour workday. Importantly, differences between three types of work time reduction (working 6h/day, getting extra days off or extra weeks off) was explored by Nätti and Anttila (1999) and by Anttila, Nätti and Väisänen (2005). The positive effects, such as decreased job exhaustion and ameliorated work-family balance were similar for all types of reduced work time.

Finally, our findings in these studies may not be generalizable to situations where work time is reduced without retained salary. Participants in Anttila, Nätti and Väisänen’s study (2005) thought that the negative aspects of a reduced income that follows a reduction in work time could be overshadowed by getting the possibility to spend more time with one’s children and to be relieved from workload. However, these were only speculations and we do
not know how a reduction of work time together with reduced salary would be experienced in real life. Moreover, in the report by Bildt et al. (2007) it was clear that participants wanted reduced work time (on average they wanted to work 31.5 hours per week); however, this was only under the circumstances of retained salary (only 3-5% had a positive attitude towards reduced work time with a corresponding salary reduction). Interestingly, findings in Paul Fuehrer’s thesis (2010) about the value of time indicate that it is not always monetary issues that prevent people from reducing their work time. His thesis demonstrates that leisure time is only valuable when it is connected to a gainful employment. Thus, leisure time is differently appreciated, valued and used depending on if a person is employed, unemployed or retired. What also matters in how we value our leisure time, according to Fuehrer (2010), is the balance between the time we dispose and the possibilities we have to manage our time-use. This indicates that the question of being positive or not about reduced work time (with or without retained salary) is complex and is not easy to evaluate before having had the experience of it.

7.3.2 Group CBT for insomnia - Study III

In Study III, the main strength is that data collections were made with several complementary and reliable instruments providing well-founded results; subjective diary data and questionnaires as well as objective actigraphy during ten days at each data collection. Moreover, the program was developed and implemented by an experienced psychologist and sleep researcher. The fact that the sessions were delivered at the workplace (reducing time and money expenditure) and that it was highly appreciated by the participants might facilitate implementation in other work settings.

The main limitation in this study was the participant attrition, which led to relatively low statistical power. One could argue that having made measurements of the control group after crossing over to the group CBT-interven-
tion could have strengthened the basis of power to evaluate the program. However, because of time and budgetary limitations this was not feasible. Moreover, there were no exclusion criteria connected to comorbidity or work time arrangements (e.g. shift workers). The heterogeneous sample might have contributed to lower mean effect sizes and thereby reduced power. Importantly, in the sensitivity analyses, where employees working shifts were excluded, there was a significant interaction effect of groups over time on the level of insomnia symptoms. This indicates that the program would need to be adapted to the specific sleep problems related to irregular work hours in order to be efficient even for employees working shift.

Importantly, there were five non-completers in this study, that were not included in the analyses. There is a possibility that those who dropped out in the intervention group were those who felt they did not gain any effect from the program. Those in the waiting-list control group might have dropped out because they spontaneously improved. Consequently, sensitivity analyses were performed with an intention-to-treat approach, and they showed the same pattern of effects as did the original analyses, indicating that the conclusions of the study hold when performing an intention-to-treat analytic approach.

Notably, almost half of the participants in the control group reported that they had adopted new ways of handling their sleep problems during the measurement period. Indeed, there were improvements of the control group over time in both sleep length and ISI scores. In addition, participants from the control group were employed at the same organization as participants in the intervention group. Thus, colleagues from the different groups had the possibility to discuss the program during the intervention. These facts might bias the interaction effects of groups over time. For logistic reasons, the randomization was made in such way that it resulted in one or two intervention groups and one or two control groups at each workplace. It would not have been possible for one employee to travel to another workplace to take part in
a group session. Given a restricted number of participating workplaces, a randomization at the workplace level would have created groups with only shift workers or groups with only employees working at the office, which would have weakened the possibility to generalize the results.

Another consideration is that data from diaries and actigraphy did not show any effect of the intervention. In the review by Sadeh (2011) it is shown that actigraphy seems to detect group differences and is sensible to changes in sleep parameters following treatment. The non-significant effects related to diary data and actigraphy in this present study is probably due to the fact that the baseline levels of the sleep parameters were not as poor as one could have expected in a sample reporting moderate subjective sleep problems. Moreover, modest effects in combination with small samples will considerably reduce the statistical power.

Importantly, no complete process evaluation of the program was effectuated, and mediators of change should preferably be measured during treatment in upcoming similar studies. Notably, there were indications in the evaluation questionnaires of the program being highly appreciated by the participants.

Finally, we do not know when the diaries were actually filled out during the day, which is a limitation that applies to all three studies. The instruction was to fill out the wake diary every day in the evening before going to bed and the sleep diary every morning right after awakening. This limitation would not have applied if data had been reported online.

7.4 Implications for policy and public health

Findings in Study I and II enrich the knowledge about work hours and the impact on sleep, sleepiness, stress and time-use. Since high self-reported
stress, sleep disturbances and elevated sleepiness have been linked to increased accident and occupational injury risk, poorer work performance, lower productivity and higher risk of health-related problems (Cooper & Dewe, 2008; Haaramo et al., 2012; Rosekind et al., 2012), it is likely that employees with good sleep, low stress levels and high levels of daytime alertness will increase work productivity and decrease costs associated with ill-health and accidents. The latter would carry highly positive consequences for public health.

In a society where the imbalance between work and other domains in life is a predominant issue (European Foundation for the Improvement of Living and Working Conditions, 2016), getting more time for family matters might actually make it easier to psychologically detach from obligations in the evening and relax. This in turn may have positive effects on sleep and overall daily stress-levels (Morin, Rodrigue, & Ivers, 2003). Moreover, increased time for recovery will also have positive effects on health, job performance and life satisfaction (Geurts & Sonnentag, 2006; Sluiter et al., 2001; Sonnentag, 2003; Sonnentag & Zijlstra, 2006; Sonnentag & Fritz, 2006). In addition, there is strong evidence supporting the fact that enhanced recovery opportunities have beneficial effects on stress and sleep (Barck-Holst et al., 2015; Nätti & Anttila, 1999; Sonnentag & Zijlstra, 2006; Sonnentag & Fritz, 2006; Åkerstedt et al., 2001). The positive effects of a better balance between work and family and between effort and recovery are probably beneficial even for the subject’s eventual partner and children.

Overall, the findings from Study I and II is valuable for employees, employers and for policy makers in the debated topic of reduced work time in exposed areas, such as the public sector. Notably, the results in study I and II should not be generalized into situations where salary is not retained. Retaining salary levels as well as employing new staff to cover up for workload might require a large budget, which is one of the main factors discussed within the political debate of reduced work time. The effects were relatively small.
(e.g. on a 9-graded scale, sleepiness decreased from 4.3 to 3.7 and perceived stress decreased from 3.1 to 2.7 on workdays over 18 months) and next step would be to investigate whether these positive effects would have substantial impact on productivity and health.

Importantly, there are many studies - both longitudinal studies, meta-analyses and reviews showing that longer work hours (full-time with considerable overtime work) is associated with different aspects of negative health outcomes (Artazcoz et al., 2009; Caruso et al., 2004; van der Hulst, 2003; Kivimäki et al., 2017; Nixon et al., 2011; Song et al., 2014; Sparks et al., 2013; Taris et al., 2011; Virtanen et al., 2011). Handling overtime work could therefore be a first approach or an alternative to the very costly reduction of work hours. Other interventions, such as postponing the start hour of work (Wheaton, Chapman & Croft, 2016), could also have positive effects on sleep and sleepiness.

Another alternative could be the interventions similar to that in Study III, which should – if promising results from the subgroup analyses would be confirmed – be relatively cost-effective and easy to implement in, for example, occupational health care. It might be profitable to use a stepped care approach when targeting sleep problems at the workplace, where the first step would be a group CBT-intervention for insomnia and the second step would be individual treatment for those who do not respond to the intervention. Similarly to what has been tested in primary care (Salomonsson et al., in press). Notably, it seems to be important to take the level of stress into account when implementing such a program in a workplace setting. This would allow for a more customized program that is, for example, internet-based or available via an app (Bostock et al., 2016; Blom et al., 2015), where participants could work at their own pace. Employees with more severe stress problems should receive adequate support for these symptoms beyond a group intervention at the workplace. Importantly, a customization of the program might be more effective
from a clinical perspective; however, from a research perspective it would probably be more difficult to evaluate.

Finally, the results should be discussed in relation to long-term sickness absence due to stress-related diagnoses, which has increased considerably during the last 5-6 years. Actually, stress-related diagnoses is now the leading cause of sickness absence in Sweden (Försäkringskassan, 2016). Even though rates of sickness-absence were not investigated within the framework of this thesis, one could argue that since poor sleep is a predictor of poor health and strongly associated with psychosocial work stress, the studies might bring added knowledge in the pursuit of finding strategies that prevent stress-related poor health. Consequently, work time reduction might be one way of diminishing or preventing stress-related sickness absence. Reducing the prevalence of sleep problems in the working population could also be a way of diminishing the public health-issue of stress in society.

Based on the knowledge that a reduction of work hours seems to reduce stress and promote sleep, and also enhance recovery opportunities and facilitate a healthy balance between work and other domains in life, one could speculate that sickness absence would eventually decrease and that productivity would increase. The same would be true for an efficient workplace based CBT-intervention for insomnia, and this would mean societal gains both in terms of public health and economy. However, to my knowledge there is no evidence that long term sickness absence is significantly decreased in relation to a work time reduction of 25%. In the report by Bildt et al. (2007) sickness absence did not significantly decrease. Lorentzon et al. (2017) found that long-term sickness absence decreased by 4.6%; however, no statistical tests were performed on this decrease. In the study by Von Thiele Schwarz and Hasson (2012), where a minor work time reduction was evaluated (2.5h/week), it was shown that the average number of days of sickness absence decreased with 4.9% (long-term sickness absence -6.2%). Interestingly, obligatory physical exercise 2.5h/week during work hours generated more economic gains for the
employer (22.2%) as compared to reduced work time alone (6.2%). Gains following the work time reduction derived from the reduction of indirect costs, such as costs for replacements and productivity losses. Moreover, Von Thiele Schwarz et al. (2011) found that objective production levels (calculated as the number of patients treated by the dentists that participated in the study) increased and self-rated productivity sustained, despite 2.5h less work per week.

However, the fact remains that sleep is a key component of recovery. Good sleep is essential for psychological and physiological health (Sivertsen et al., 2014), and the economic consequences of insomnia are highly considerable (Wickwire, Shaya & Scharf, 2016). Therefore, actions regarding this growing public health issue are needed, and the results of this thesis might add knowledge to the field of public health, but more work needs to be done.

### 7.5 Future studies

In order to develop strategies to ameliorate health and well-being in the working population, future research should develop research questions and methodology further. Some suggestions are presented below.

When evaluating implementations of work time reduction, there should be longer follow-up periods and larger samples including more men. Sickness absence should be addressed in detail, and there is a great need for cost-benefit analyses (e.g. taking productivity and health care consumption into account). Time-use should be studied with predefined categories making it possible to distinguish between active and passive recovery activities, and to measure physical activity as well as use of digital devices and social media. There should be additional questions on whether the specific category of activities is experienced by the participant as a recovery activity or as an effort (e.g. taking care of own children). More thorough analyses of different sub-groups, such as parents with young children, employees approaching the age of retirement...
or employees in certain occupations, should be made. In any case, studies on work time reduction need to be repeated in the current labor market since the intervention in Study I and II was effectuated more than 10 years ago. It might be that the labor market has changed since 2005 with respect to, for example, job intensity, job security and staffing.

Group CBT for insomnia in a workplace setting should be evaluated through studies using a larger sample, since small samples increase the risk for random and not replicable findings. The program should be evaluated in participants with established sleep problems and it should be adapted to shift workers and employees suffering from chronic stress. The program could preferably include apps or internet-based modules. There should be more focus on process evaluation by documenting the implementation of the program, in order to understand the relations between the different parts of the program and the outcomes (Saunders, Evans & Joshi, 2005). Moreover, future studies on group CBT for insomnia at the workplace should also include evaluation of job-related consequences of poor sleep quality before and after the intervention (e.g. Barnes, Miller & Bostock, 2017).

Finally, and importantly, economic evaluations of the intervention should be effectuated (Tompa et al., 2010), either in terms of for example decreased sick-leave rates or in terms of productivity gains. When no obvious objective measures of productivity are available, evaluations could be done subjectively, for example through the productivity subscales of the Health and Work Questionnaire (HWQ; Shikiar et al., 2004, von Thiele Schwarz et al., 2014).
8 CONCLUDING REMARKS

It is concluded that a 25%, fully compensated reduction of work hours for full-time workers can lead to long-term positive effects on sleep duration and sleep quality, as well as on sleepiness and levels of perceived stress. During this work time reduction, total workload of both paid and non-paid work was reduced and time spent in recovery activities increased. This indicates a more balanced relation between effort and recovery. Such effects could be beneficial for an employee’s life satisfaction, daily functioning and health development. Moreover, the group CBT-intervention for insomnia at the workplace reduced insomnia symptoms in working subjects with low levels of concurrent burnout and in employees having daytime work. These findings indicate that a workplace-based group CBT-intervention for insomnia, if adapted to the individual needs, might be a feasible method in order to treat sleep problems and prevent development of more severe and chronic sleep disorders.

The title of this thesis, “How to work for a good night’s sleep” refers to something that is probably often reflected upon by several policy makers, and the aim of this thesis was to find strategies to promote good sleep in the working population. Based on the framework of this thesis, there might be two ways in which you can work for a good night’s sleep: either you work shorter workdays in order to reduce stress and enhance recovery opportunities, or you learn how to work with well-established methods for insomnia problems. As shown in this thesis, a 25% work time reduction may result in approximately 20 minutes longer sleep duration on workdays. However, even with a short workday you may still develop insomnia symptoms, and therefore the knowledge and use of methods to reduce insomnia – or other sleep problems, will always be useful.
Importantly, however, from a societal perspective it must be noted that reduction of work time with retained salary is generally very expensive and health economists should evaluate the cost and the benefits in a more robust manner. Moreover, the efficacy of the CBT-treatment should be further investigated in future studies both regarding the employee’s sleep and the benefits for the employer and society it might imply.
9 ACKNOWLEDGEMENTS

When I was admitted to the introductory course in psychology at Stockholm University in 2009 I was already settled down with job and family. Nevertheless, I wanted to learn more about psychology which had always fascinated me, and after one term at the University, I was hooked; I gave up my job with the goal to pursue my studies and to one day write a doctoral thesis within the field.

I am so glad that I took the step and that this thesis has finally become a definite entity. My gratefulness is directed towards everyone and everything that made it possible to complete this work.

I would especially like to thank my supervisor Göran Kecklund for all his support and encouragements throughout my time at the Stress Research Institute. He has been patient, wise and he has shown that he is truthfully a person, and a leader full of empathy.

Göran has, together with my two co-supervisors Mats Lekander and Kristiina Rajaleid provided a tremendous amount of knowledge and expertise into my daily work. The time they have spent and the feedback they have provided has been highly appreciated and of great value for me. They made me grow not only as a researcher, but also as a person. Thank you!

Furthermore, I would like to thank Marie Söderström for everything I know today about group-CBT for insomnia. I would also like to thank my colleague Johanna Schwarz for always taking time to answer my questions on multilevel modeling in STATA. I presume the questions have been relevant but sometimes a bit annoying.

Thanks to all co-authors for having critically revised my manuscripts before submission and to Constanze Leineweber, Hugo Westerlund and John Axelsson for their thorough review of my work before print.
Moreover, I am deeply thankful to my friend Helena Ullstrand who created the front-page illustration of my thesis.

Molly (my dog) and Castano (my horse) also merit a thank you, since they are the essence of my own recovery.

Finally, I would like to thank my wonderful little family who gives me meaning in life and a lot of love. Thanks for having listened to my sermons on stress and sleep management throughout the years. They may have been my first listeners, but they are definitely not the last.
10 REFERENCES


Kyle SD; Miller CB; Rogers Z; Siriwardena AN; MacMahon KM; Espie CA. Sleep restriction therapy for insomnia is associated with reduced objective total sleep time, increased daytime somnolence, and objectively impaired vigilance: implications for the clinical management of insomnia disorder. Sleep. 2014;37:229-237.


