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Shift work and sleep

A study investigating the agreement between subjective and objective assessed sleep, and the association between variation in rotating shifts and sleep among nurses

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Preface

This master's thesis is part of a field study undertaken at the National Institute of Occupational Health (STAMI), investigating shift work sleep and pain. The project was led by Dagfinn Matre, MSci, Ph.D, from the National Institute of Occupational Health and Kristian Bernhard Nilsen, MD, Ph.D, from the Department of Neuromedicine and Movement Science at the Norwegian University of Science and Technology (NTNU) and, the Department of Neurology and Clinical Neurophysiology at Oslo University Hospital, and the National Institute of Occupation Science.

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"For the things we have to learn before we can do them, we learn by doing them."

-Aristotle

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Abstract

Background: The modern society is dependent on shift workers for 24-hour services. Shift work is associated with a number of different negative health outcomes, most evidently the disruption of sleep. Sleep disturbance is also associated with negative physical and psychological outcomes. The assessment of sleep in epidemiological studies have largely been restricted to self-reported sleep duration. Actigraphy has the potential to become an objective, pragmatic and cost-worthy assessment of sleep, but its agreement with subjective assessment of sleep in the field setting is not well characterized, especially within shift working populations.

Aims: To investigate the agreement between subjective and objective measured sleep parameters among shift working nurses, and to investigate the association between variation, expressed as mean absolute variation in rotating shift work and sleep.

Method: Participants were recruited from a larger cross sectional field study meant for investigating shift work, sleep and pain. 91 nurses, with a mean age of 38, wore an ankle-actigraph and used an electronic diary for a period of 28 days. By using an electronic diary and ankle-placed actigraphy, the agreement between subjective and objective measured sleep parameters were characterized by using Bland-Altman plot. Variation in shift work were tested in linear regression models for association with sleep parameters.

Results: We found that the mean difference from self-reports to actigraphy was -4 minutes for wake after sleep onset, -12 minutes for total sleep time and -4 for number of awakenings with increasing discrepancy with higher number of awakenings. The mean difference from self-reports to actigraphy was -11% for sleep efficiency, it had fair agreement when considering good sleepers, but poorer agreement for lower sleep efficiency. The variation in shift work, expressed as an aggregated mean absolute deviation, was unable to predict any of the sleep parameters.

Conclusion: The agreement between subjective and objective measured sleep parameters differed depending on the sleep parameter in question. The general trend was that diary reported measures was lower than actigraphy measures. The mean absolute deviation as an aggregated measure for variation in shift work was unable to predict any sleep parameters. Implications for future studies are discussed.

Sammendrag

Bakgrunn: Det moderne 24 timers samfunnet er avhengig av skiftarbeidere for døgntilgjengelige tjenester. Skiftarbeid er assosiert med en rekke negative helseutfall, spesielt plager knyttet til søvnvansker. Søvnvansker er også assosiert med somatiske sykdommer og mentale lidelser. Selv-rapportert søvnlengde er et ofte benyttet søvnmål i epidemiologiske studier. Med aktigrafi har det blitt mulig å måle søvn i større feltstudier på en objektiv og kostnadseffektiv måte. Det er mangel på studier som har undersøkt påliteligheten til aktigrafi i feltstudier med de relevante søvnmålene, og overenstemmelse mellom objektive og subjektive søvnmål er ikke tilstrekkelig karakterisert i ulike populasjoner.

Formål: Hensikten med denne studien var å undersøke overenstemmelsen mellom flere objektive og subjektive søvnmål hos en gruppe skiftarbeidende sykepleiere. Studien har også undersøkt om gjennomsnittlig absolutt deviasjon, som et uttrykk for variasjon i skiftarbeid, kan predikere noen av søvnmålene.

Metode: Forsøkspersoner ble rekruttert fra en større feltstudie ved Statens arbeidsmiljøinstitutt som undersøkte skiftarbeid, søvn og smerte. 91 sykepleiere med en gjennomsnittsalder på 38, gikk med aktigraf i en periode på 28 dager. Ved bruk av elektronisk dagbok og ankelmontert aktigrafi ble overenstemmelse mellom subjektive og objektive mål på søvn undersøkt ved å benytte Bland-Altman plot. Variasjonen i skiftarbeid ble testet i lineære regresjonsmodeller for assosiasjon til de ulike søvnmålene.

Resultater: Vi fant en gjennomsnittlig forskjell fra selvrapporter til aktigrafi på -4 minutter for våkentid etter søvnstart, -12 minutter for total søvntid og -4 for antall oppvåkninger med økt diskrepans desto høyere antall oppvåkninger. Den gjennomsnittlige forskjellen fra selvrapporter til aktigrafi var -11% for søvneffektiviteten, den hadde rimelig overenstemmelse ved høy søvneffektivitet, men var dårligere for lavere søvneffektivitet. Variasjon i skiftarbeid, uttrykt med gjennomsnittlig absolutt deviasjon, kunne ikke predikere noen av søvnparameterne.

Konklusjon: Studien konkluderer med at overenstemmelsen mellom subjektive og objektive søvnmål avhenger av det anliggende søvnmålet. Den gjennomgående trenden er at selvrapporterte målinger underestimerer søvnmålene sammenlignet med aktigrafi målingene. Gjennomsnittlig absolutt deviasjon, som utrykk for variasjon i skiftarbeid, kunne i predikere søvnmålene. Implikasjoner for videre studier er drøftet.

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List of abbreviations

AASM:	The American Academy of Sleep Medicine
BIS:	Bergen Insomnia Scale
CSD:	Consensus sleep diary
ECG:	Electrocardiogram
EEG:	Electroencephalograms
EES:	Epworth Sleepiness Scale
EMG:	Electromyogram
EOG:	Electrooculogram
MAD:	Mean absolute deviation
NA:	Number awakenings
NREM:	Non-rapid eye movement
NSF:	Norsk sykepleierforbund, Norwegian Nurses Organisation
PSG:	Polysomnography
PSQI:	Pittsburgh Sleep Quality Index
REK:	Norwegian Regional Committee for Medical Research Ethics
REM:	Rapid eye movement
SCN:	Suprachiasmatic nucleus
SD:	Standard deviation
SE:	Sleep efficiency
SOL:	Sleep onset latency
SSB:	Statistisk sentralbyrå, Statistics Norway
STAMI:	Statens arbeidsmiljøinstitutt, National Institute of Occupational Science
SWD:	Shift work disorder
SWS:	Slow-wave-sleep
TST:	Total sleep time
VAS:	Visual Analogue Scale
WASO:	Wake after sleep onset

1 Introduction

In Norway, there are 135,000 health care workers (SSB, 2015b), of whom 88,000 are nurses (SSB, 2015a). Nurses are needed 24 hours a day in several institutions and working hours are normally divided into day-, evening- and night shifts. Rotational work schedules are often used, meaning that the time when the shift begins or ends may vary from day-to-day. Some nurses may work only day shifts or only night shifts. Approximately 70% of the nurses are working rotational shift work and around 45% are working night shifts (Aagestad et al., 2015). The term "shift work" is used to describe work outside of regular working hours, including work during weekends (Hassel & Krogstad, May 2011). Regular working hours is from 07.00- 17.00 according to the Basic Collective Agreement (Hovedtariffavtalen, 2016, § 7.1).

Shift work and night work is associated with a number of different negative health outcomes. For instance, shift workers are at higher risk of developing psychological symptoms, such as depression, anxiety and irritability (Costa, 2003; Roelen et al., 2014), as well as heart disease, type 2 diabetes (Szosland, 2010) and cancer (Lie, Andersen, & Kjaerheim, 2007). Cancer appears to increase with the number of years in rotating shift work and night shift work (Lie et al., 2014). A systematic review by Virtanen et al. (2012) suggests an increased risk of 40% for developing coronary heart disease in workers with long working hours. Disturbed sleep is the most common adverse health effect reported among shift workers (Akerstedt, 2003; Eurofound, 2016; Harrington, 2001; Lie et al., 2014). Thus, it is not surprising that 41% of nurses report sleeping problems compared to the mean of 29% for the working population in Norway (Aagestad et al., 2015). Disturbed sleep is associated with a number of different negative health outcomes (Sivertsen, Krokstad, Overland, & Mykletun, 2009). A cross-sectional and retrospective study undertaken by Taylor et al. (2007) found that people with insomnia more frequently reported diseases such as heart disease, neurologic disease, high blood pressure, chronic pain, breathing problems, gastrointestinal and urinary problems. Moreover, the risk of developing depression is higher among individuals with insomnia, and reduced sleep quality is more frequent in people with mental disorders (Ford & Kamerow, 1989; Vgontzas & Kales, 1999). Sleep disorders may also affect social life, family, efficiency at work, and therefore are a significant societal and individual burden (Kyle, Morgan, & Espie, 2010; Uehli et al., 2014). Also, there is evidence that long working hours, night work and rotating shifts influence safety and, hence, accidents at the workplace. For instance, Belenky, Åkerstedt, and Wesensten (2016) found that the interaction between workload, sleep loss and adverse circadian rhythm phase (time of day) causes lower performance and higher self-reported sleepiness and fatigue. Even on days off, rotating shift workers may be less alert than people working regular hours (Lowden, Kecklund, Axelsson, & Akerstedt, 1998). These factors increase the risk of errors and accidents, and occupational sleep medicine aims to reduce these risks (Belenky et al., 2016).

Several studies have looked at the association between shift work and sleep (Akerstedt, 2003; Axelsson, Akerstedt, Kecklund, & Lowden, 2004; Harrington, 2001; waage, Pallesen, & Bjorvatn, 2007). Studying different types of shift work and its effect on sleep is not without obstacles, especially within a population of shift workers. It requires the accurate assessment of sleep quality, the necessary time frame of exposure and a way to differentiate between more or less hazardous working hours (Flo et al., 2013; Sallinen & Kecklund, 2010; Thun et al., 2016; Vedaa et al., 2016). There are multiple ways to characterize different working hours, for instance using separate models investigating each shift type separately (night work, rotational shift work, fixed shifts (day or night))(Flo et al., 2013; Thun et al., 2016) and also the speed of rotation (slowly or rapid rotating shifts)(Pilcher, Lambert, & Huffcutt, 2000). Another method is calculating the mean absolute deviation (MAD, see 5.5)(Bohle, Willaby, Quinlan, & McNamara, 2011; Harma et al., 2015). Multiple methods are also used in the assessment of sleep patterns, including polysomnography (PSG), actigraphy and self-reporting diaries (Ancoli-Israel et al., 2015; Blackwell et al., 2008; Cespedes et al., 2016; Plante, 2014). In the sleep laboratory, the gold standard has been polysomnography, since it gives detailed information about sleep quality. However, since it is costly, cumbersome and often requires participants to sleep in a laboratory (or at home) (Stone & Ancoli-Israel, 2017), epidemiological studies have largely focused on self-reported sleep using a sleep diary and its measures (Cespedes et al., 2016; Lauderdale, Knutson, Yan, Liu, & Rathouz, 2008). Despite being a quick and easy way to measure sleep parameters, self-reported sleep is crude and susceptible to recall-bias (Stone, Shiffman, Schwartz, Broderick, & Hufford, 2003). One valuable alternative has been actigraphy, which is increasingly being used as an objective method to determine sleep/wake patterns during one night of sleep (Stone & Ancoli-Israel, 2017). One study in healthy adults showed that the sensitivity to detect sleep for actigraphy (GT3X+) is 95%, while specificity for detecting epochs of wakefulness is low with 60% compared to PSG (Cellini, Buman, McDevitt, Ricker, & Mednick, 2013). Several other studies found similar results (Paquet, Kawinska, & Carrier, 2007; Sadeh, 2011).

To improve the epidemiological study on sleep and health outcomes, it would be of value to characterize the relationship between objective and subjective assessment of sleep. So far, only a few studies have done this, and unfortunately, actigraphy data is usually collected for a limited time period and the statistical analysis is often restricted to simple correlations on sleep duration (Cespedes et al., 2016; Herring et al., 2013; Lauderdale et al., 2008). However, sleep duration should not be the only parameter of investigation. Furthermore, as Martin Bland and Douglas Altman (Bland & Altman, 1986) made clear, a high correlation does not necessarily imply good agreement between two methods. In fact, the correlation offers very little description of the relationship between two different measurements. Multiple studies have found only a modest correlation between actigraphy and self-reported sleep, as well as a systematic over-reporting in sleep duration (Auger, Varghese, Silber, & Slocumb, 2013; Herring et al., 2013; Lauderdale et al., 2008). Thus, there is a need to characterize the agreement between subjective and objective assessment for multiple sleep parameters for a sufficient time duration, preferably for more than five days (Short, Arora, Gradisar, Taheri, & Carskadon, 2017; Ustinov & Lichstein, 2013).

Good sleep quality is desirable to improve the occupational health off shift workers and to promote lower social costs and improved quality of life (Manzoli, Sotgiu, Magnavita, & Durando, 2015). According to the Norwegian law on public health (Folkehelseloven, 2012,§ 1.), there is a common responsibility of working towards promoting health for all working-groups. Investigating the relationship between rotational shift work and sleep quality may provide important information for the prevention of sickness absence and its economic costs to society, and to improve the working conditions for shift workers and their well-being.

An introduction of the aims for the thesis is presented in chapter 2 and the relevant literature is described in chapter 3. In chapter 4 the method is represented, chapter 5 and 6 will give an overview over data material, analyses and statistics, and in chapter 7 the results are represented. Further, in chapter 8 method and results will be discussed and in chapter 9 the conclusion is given.

2 Aims

The purpose of this study is to investigate the agreement between the subjective and objective assessment of sleep parameters, and whether these parameters are predicted by the mean variation in nurses' rotational shift work.

For all three hypotheses, multiple standard sleep parameters has been used in the current study. These were total sleep time (TST), number awakening (NA), wake after sleep onset (WASO) and sleep efficiency (SE) (explained in Table 2, p. 28). The first aim has been to investigate the agreement between the subjective and objective assessments of sleep among nurses. For investigating the association between sleep parameters and variation in shift work, mean absolute deviation (MAD) has been used as a measure for the variation in shift work.

2.1 Hypotheses

The three main hypotheses explored in this research were:

1) Sleep measures from subjective measurements (diary) agree with objective measurements (actigraphy).

2) Variation in rotational shift work, expressed as MAD, predict self-reported sleep measures; and

3) Variation in rotational shift work, expressed as MAD, predict actigraphy sleep measures.

3 Background and Theory

3.1 Shift work

Of all the workers in Europe 21% report working shifts (Eurofound, 2016, p. 58). The modern society depends on a 24-hour service system for a number of services (e.g., transport, construction, oil-industry, agriculture and health care). Thus, health care workers are frequently required to work shifts. There is no precise definition of shift work, but it is generally defined in opposition to regular working hours. Regular working hours are from 07.00- 17.00 (Monday to Friday) according to the Basic Collective Agreement (Hovedtariffavtalen, 2016, § 7.1). Shift work is organized and characterized in different ways; forward (morning, evening, night) and backwards (night, evening, morning), rapid rotating shifts (several shift types within a week) or slow rotating shifts (one shift type lasting a week or more), quick returns (i.e., less than 11 hours between shifts) and night shifts (Flo et al., 2013; Pilcher et al., 2000).

3.2 Shift work and health

Shift work is related to a number of different public health problems (Costa, 2003), and negative consequences for well-being, social life and health (Eurofound, 2016, p. 52). Multiple studies indicates that rotating shift work can increase the risk of diabetes mellitus (Gan et al., 2015), overweight and obesity (Buchvold, Pallesen, Oyane, & Bjorvatn, 2015), and gastrointestinal disorders (Knutsson & Boggild, 2010). Night shift can increase the risk of cancers such as breast cancer (Wang et al., 2013), prostate cancer (Rao, Yu, Bai, Zheng, & Xie, 2015), and colorectal cancer (Wang et al., 2015), as well as increase the risk of metabolic syndrome (Wang et al., 2014) and cardiovascular disease (Vyas et al., 2012). Some studies have also linked night shifts with a higher risk of early spontaneous pregnancy loss (Stocker, Macklon, Cheong, & Bewley, 2014), premature birth and low birth weight (Palmer, Bonzini, Harris, Linaker, & Bonde, 2013). Notwithstanding the multitude of associations, the most common health problem in shift workers are sleep disturbances, such as insomnia, sleepiness (Akerstedt, 2003) and fatigue (Oyane, Pallesen, Moen, Akerstedt, & Bjorvatn, 2013).

3.3 Shift work and sleep

Shift work requires people to work night and evening shifts, and for many people, this might create difficulties in obtaining adequate amount of sleep (7-8 hours) (Hirshkowitz et al., 2015). People working shifts report more sleeping problems than the rest of the general public (Harma & Kecklund, 2010). The reasons for these difficulties are manifold. First, humans are adapted, through evolution, to a circadian rhythm (see 3.5) which is highly influenced by light and dark (Akerstedt, 2003). Second, a recreational life is essential to human psychology, and many recreational activities are mainly available during the day or evening. Thirdly, our social culture is somewhat adapted to regular working hours, with free time during the evening or early nights. Fourth, humans are, as the psychologist Ian Newby-Clark put it, “creatures of habit” (Newby-Clark, 2009). For these reasons shift work can create obstacles for combining cultural life with regular and optimal sleep (Eurofound, 2016, p. 52). Although there are some benefits from shift work, for example, being home with one’s children while the spouse is working during the day, there is an abundance of evidence showing negative impacts on disturbed sleep and health (Harma & Kecklund, 2010; Harrington, 2001; Thun et al., 2016; Thun & Waage, 2016; waage et al., 2007). In short, sleep can be negative affected by lifestyle factors, shift work, night work and social habits (Akerstedt, 2010), and sleep disturbance can effect personal, family and social life (Garbarino, Lanteri, Durando, Magnavita, & Sannita, 2016).

The frequency of sleeping problems among Norwegian nurses is the second highest among all occupations measured (Aagestad et al., 2015, p. 117). There is also an association between the number of sick leave days and rotating shift works among female nurses, even after adjusting for life style factors and job satisfaction (Lien, Pallesen, Bjorvatn, & Moen, 2014). Workers in the health and social services have the highest level of sick absence with 7.7% in Norway (4.7% for men and 8.4% for women) compared to all industries with 5.4% (4.1% for men and 6.9% for women)(SSB, 2016).

One interesting point is that different types of shift work can affect sleep outcomes differently. According to a meta-analysis by Pilcher and colleagues (2000), permanent night shifts resulted in decreased sleep length, while permanent evening shifts resulted in increased sleep length. Also, the speed of rotation between shifts had an impact on the sleep length. Slow rotating shifts had a less adverse effect on sleep compared to rapid rotating shifts. Permanent night shifts had a positive effect on sleep compared to night shifts included in rotational shifts. Finally, adding morning shifts in the rotational schedule had moderate adverse effect on sleep length (Pilcher et al., 2000). These differences highlight the importance of future studies to accurately characterize "shift work" such that relevant associations and causations can be better understood.

3.4 Sleep physiology

After the discovery of rapid eye movement (REM) sleep in 1953, sleep is now considered to be an active brain state (Aserinsky & Kleitman, 2003). The study of sleep and sleep disorders flourished in the 1960s, and in 1968 researchers developed the first standardized criteria for staging sleep (Rechtschaffen & Kales, 1968). Based on physiological parameters, two main states of sleep have been defined, REM sleep and non-rapid eye movement (NREM) sleep (Carskadon & Dement, 2017; Heier & Wolland, 2007). Different stages of sleep are associated with different wave patterns, which helped to clarify the difference between REM sleep and NREM sleep. By using electroencephalogram (EEG) criteria, NREM sleep can further be divided into the stages N1, N2 and N3. Previously, NREM was divided into four stages, but in 2007 The American Academy of Sleep Medicine (AASM) recommended three stages (Schulz, 2008). Despite this, papers and books, such as the newest edition of *Principles and Practice of Sleep Medicine* (6th edition, 2017), still use four stages of NREM sleep. A short discussion of the sleep cycle will follow.

In the N1 stage, one is experiencing light sleep/drowsiness while muscle tone and conscious awareness gradually decrease. In EEG, the stage is defined by the disappearance of alpha waves (7-12 Hz) and the appearance of theta waves (4-7 Hz). Interestingly, people who are aroused during this stage, frequently report being fully awake. In the N2 stage, conscious awareness fully disappears and muscular tone further decreases. This stage is the longest and constitutes about 45-55% of the total sleep in adults, and is, thus, the longest. In EEG, N2 is characterized by short lasting 12-14 Hz wave patterns called "sleep spindles", often preceded by characteristic "K-Complexes". In the N3 stage (previously known as stages 3 and 4), also called slow-wave-sleep (SWS) or deep sleep, ordinary stimuli from the environment no longer produce any reactions. This stage is thought to be the most restful form of sleep. It restores the body and relieves the feeling of sleepiness (Waterhouse, Fukuda, & Morita, 2012). In EEG, it is defined by the appearance of high amplitude low frequency (0.5-4 Hz) delta waves. In general, NREM sleep is usually associated with minimal mental activity. After the first approximately 90 minutes of NREM sleep, the REM-stage occurs, lasting usually less than 10 minutes. Most muscles are paralyzed at this stage, and body temperature, heart rate and breathing becomes less regulated and for some functions, even unregulated. REM-sleep has high-frequency EEG waves, similar to the waking state. The end of one sleep-cycle is marked by the end of REM sleep. Most commonly, the sleep-cycle is repeated 4-6 times during one night of sleep (Carskadon & Dement, 2017; Heier & Wolland, 2007; Nordhus & Pallesen, 2007).

Sleep architecture represents this cyclical pattern of sleep as it shifts between the different sleep stages. In total, NREM and REM constitutes 75%-80% and 20%-25% of total sleep time, respectively (Carskadon & Dement, 2017).

3.5 Circadian rhythm

The circadian rhythm is a 24-hour sleep-wake cycle in the body (Achermann & Borbely, 2003; Waterhouse et al., 2012). Sleep is regulated by two parallel mechanisms, homeostatic drive and circadian rhythm, controlled by the hypothalamus, especially the suprachiasmatic nucleus (SCN)(Achermann & Borbely, 2003; Waterhouse et al., 2012). The suprachiasmatic nucleus acts like a timer, hence its nickname "the brain´s master clock", and during wakefulness, this cluster of cells releases hormones, for example cortisol, to keep us awake and melatonin during the nighttime to make us sleepy (Saper, Scammell, & Lu, 2005). Although the exact nature of sleep drive is unknown, homeostatic pressure builds up during wakefulness and continues until the person goes to sleep. During sleep, the homeostatic pressure decreases to a certain threshold, and wakefulness occurs (Goel, Basner, Rao, & Dinges, 2013). One of the molecular mechanism for sleep, specifically the sensation of sleepiness, is believed to be the gradual accumulation of adenosine in the brain (Saper et al., 2005). This is further supported by the fact that caffeine, the active wakefulness ingredient in coffee and other beverages, reversibly blocks the action of adenosine on its receptors, thus temporarily inhibiting the sensation of sleepiness (Roehrs & Roth, 2008).

3.6 Sleep hygiene

Sleep hygiene includes environmental and behavioral recommendations to promote healthy sleep, and has successfully been used in treatment of mild to moderate insomnia (Irish, Kline, Gunn, Buysse, & Hall, 2015). These recommendations include: avoid caffeine before bedtime (the relationship between caffeine and sleep is dose-dependent) avoid the use of alcohol, as it can decrease sleep onset latency (SOL) and increase the number of arousals, perform regular exercise, maintain a regular sleep-wakefulness pattern, reduced bedtime noise, keep the bedroom dark at a low temperature, and avoiding being exposed to light before bedtime (Irish et al., 2015). Wright (2013) and his colleagues include additional sleep recommendations aimed to help shift workers: taking naps before night shifts (Garbarino et al., 2004; Leger, Philip, Jarriault, Metlaine, & Choudat, 2009), using eye masks and ear plugs during daytime sleep, consideration of melatonin medication, balance between social and family life, work and sleep. Lastly, it is recommended to address and treat symptoms of psychosocial stress and depression, as they are known to influence sleep (Wright, Bogan, & Wyatt, 2013).

3.7 Shift work disorder

The prevalence of shift workers developing Shift Work Disorder (SWD) is approximately 10% (Roth, 2012; Wright et al., 2013). Age seems to affect the tolerance of shift work; sleep disturbance in shift workers increase with increasing age (Harma, 1996; Harrington, 2001). Individual differences may also affect tolerance to shift work, individuals who function better in the evening seem to tolerate shift work better (Saksvik, Bjorvatn, Hetland, Sandal, & Pallesen, 2011). Some individuals are less able to adapt their normal endogenous patterns of sleep and wakefulness to the desired pattern required by their shift work (Sack et al., 2007). These individuals can experience SWD, a circadian rhythm sleep disorder (SWD, ICD-10 G47.26), characterized by excessive daytime sleepiness and symptoms of insomnia. The sleep disturbance may also result in decreased function in different areas, for example, social and occupational activities (AASM, 2001). Criteria for SWD (ICSD-2) are complaints of insomnia or excessive sleepiness lasting more than one month, sleep log (and actigraphy) demonstrating disturbed circadian rhythm for a minimum of seven days, and sleep time is often associated with a shift work schedule (Drake, Roehrs, Richardson, Walsh, & Roth, 2004; Waage et al., 2014). Short rest periods between shifts of 11 hours or less and night work over one year might also predict SWD (Flo, Pallesen, Moen, Waage, & Bjorvatn, 2014). People with SWD may experience difficulties in staying awake during early morning working hours and night shifts, as well as problems falling asleep during the day (Drake et al., 2004; Wright et al., 2013).

3.8 Sleep disturbance

For the working population in Norway, approximately 29% experience sleeping problems, however, nurses are highly represented with 40% report having a sleeping problem (Aagestad et al., 2015; Kronholm et al., 2016). The most common sleep disorder is insomnia, which is the inability to obtain sufficient sleep, either from difficulties falling asleep or staying asleep, or simply the subjective experience of poor sleep quality (Bjorvatn, Sivertsen, Oyane, Nordhus, & Pallesen, 2009; Medicine, 2005). Over a 10-year period, the prevalence of insomnia in the Norwegian adult population has increased from 12% to 16% (Pallesen, Sivertsen, Nordhus, & Bjorvatn, 2014). Additionally, women experience insomnia more frequently than men (Sivertsen, Krokstad, Overland, & Mykletun, 2009) and elderly women report insomnia more often (Pallesen et al., 2014) than younger women. Furthermore, insomnia is an important component of the sleep difficulties experienced by shift workers (Vallieres, Azaiez, Moreau, LeBlanc, & Morin, 2014). Insomnia is associated with functional limitations, mental disorders (e.g. depression or anxiety) and sickness absence (Bjorvatn, Sivertsen, Oyane, Nordhus, & Pallesen, 2009; Pallesen et al., 2014). Hence, sleeping problems have significant socioeconomic consequences (Folkehelserapporten, 2014). Disturbed sleep can result in daytime sleepiness and a higher need to sleep during the day (Johns, 1992). Several prospective cohort studies have found sleeping problems to be a risk factor for different pain conditions (Canivet et al., 2008; Mork & Nilsen, 2012; Odegard et al., 2011). Individuals who are sleepy might also be more sensitive to pain compared to non-sleepy individuals (Chhangani et al., 2009). For example, in a study on shift workers, individuals experienced higher pain intensity when stimulated with electrical and mechanical stimulation after two nights of reduced sleep duration compared to individuals after normal nights of sleep (Matre, Knardahl, & Nilsen, 2016).

3.9 Measuring sleep

For clear and meaningful measures of sleep, carefully defined sleep parameters are used. Standard sleep parameter when reporting sleeping patterns from actigraphy, PSG and sleep diaries are parameters such as time in bed (TIB), the duration between reported log diary bedtime (lights off) and wake time (lights on). Sleep onset latency (SOL), is the time it takes to fall asleep from lights off. Total sleep time (TST), is the duration of sleep during the main period of sleep. Wake after sleep onset, measures the total wake time during the major sleep period, and sleep efficiency (SE), is the percent of time spent asleep relative to time in bed (Ancoli-Israel et al., 2003; Blackwell, Ancoli-Israel, Redline, & Stone, 2011; Blackwell et al., 2008; Stone & Ancoli-Israel, 2017) (Ancoli-Israel et al., 2015).

3.9.1 Polysomnography

Polysomnography is the "gold standard" for measuring sleep patterns (Stone & Ancoli-Israel, 2017). With PSG one collects data from EEG, submentalis electromyogram (EMG), measuring muscle activity during sleep, and electrooculogram (EOG), measuring eye movement. Other data may be collected as well, depending on the sleep complaints from the patient. Thus, PSG gives detailed information about sleep patterns and is a valuable tool for investigating sleep and sleep disorders (Stone & Ancoli-Israel, 2017).
However, even though it is especially relevant for diagnosing sleeping disorders and investigating the interaction between activity level and sleep, PSG is costly and may disturb the sleep of the subject (Blackwell et al., 2011; Plante, 2014). A viable alternative to objectively measure both activity level and sleep pattern is actigraphy.

3.9.2 Actigraphy

Actigraphy is a non-invasive objective method to assess sleep/wake patterns in humans and has been extensively used since its introduction in the beginning of 1970s (Ancoli-Israel et al., 2003; Ancoli-Israel et al., 2015; Blackwell et al., 2008). Actigraphs are clock-like devices that can be worn on the wrist, ankle, waist or thigh (Ancoli-Israel et al., 2015). Benefits of using actigraphy compared to PSG are several. It is economical, less cumbersome and can detect and record movements up to several weeks at time compared to one night sleep-over with PSG in a sleep laboratory (Korshoj et al., 2014; Stone & Ancoli-Israel, 2017), but can also be used in home settings.

The movement detectors actigraphs utilize are accelerometers. They are able to register movements in one to three axes depending on the actigraph being used (Chen & Bassett, 2005). The registration of movements are sampled at 30-100 Hz and then stored in epochs from 30 seconds up to several minutes (Stone & Ancoli-Israel, 2017; Troiano et al., 2008). The most validated and commonly used are 30 seconds to 1 minute, but in most devices epoch duration is user selectable (Ancoli-Israel et al., 2015). From the collected data material, scoring algorithms are used to score epochs to periods of awake or asleep, called sleep-wake-analysis (Ancoli-Israel et al., 2015; Jean-Louis et al., 1996; Stone & Ancoli-Israel, 2017). The software (ActiGraph Software Department, 2012, Pensacola, FL, USA) used for ActiSleep+ and wGT3x-BT (monitor, ActiGraph, Pensacola, FL, USA) has two already installed validated algorithms for sleep-wake-analyses. Sadeh, Sharkey, and Carskadon (1994) compiled one of the algorithms, and Cole, Kripke, Gruen, Mullaney, and Gillin (1992) developed the "Cole-Kripke"-algorithm. Validation studies on actigraphy indicates that both algorithms identify epochs (sleep/awake) with 91% accuracy when using PSG as the gold standard. Using sleep as a "positive test" and awake as a "negative test", Cole's algorithm and Sadeh's algorithm had a sensitivity of 99% and 97%, respectively. However, both algorithms had low specificity, 34% for Cole's and 44% for Sadeh's (de Souza et al., 2003), meaning that the actigraph algorithms have limitations in correctly identifying the waking epochs during sleep, when using PSG as the reference standard.

In physical activity research (Prince et al., 2008), actigraphs have been a valuable objective tool for measuring activity. Actigraphy has also been used to study physical activity and its correlation to diabetes (Brage et al., 2004), cardiovascular diseases (Korshoj et al., 2012) and different working positions (Korshoj et al., 2014).

Actigraphy can measure stereotyped and repetitive movements, which we call period limb movements of sleep, which can be disrupting for sleep (Stone & Ancoli-Israel, 2016). Leg worn actigraphy has been used to quantify PLMS (Plante, 2014). By measuring activity-inactivity from limb movement one can measure periods of wakefulness and sleep. The correlation between wrist actigraphy and PSG is moderate to high for total sleep time (TST) and shows a moderate correlation for SE and WASO (Blackwell et al., 2008). Further results from Blackwell and colleagues (2008) shows a systematic underestimation of WASO and therefore an overestimation of TST and SE measured by actigraphs compared to PSG.

3.9.3 Subjective measures of sleep

Sleep diaries are considered the gold standard for subjective sleep assessment. Diaries are daily reports documenting the previous night of sleep (Carney et al., 2012). Sleep diaries are widely used in clinics and sleep studies. They are easy to use, have a low cost and recall bias can be avoided to some level when diaries are filled out on a daily basis (Short et al., 2017). Five nights are recommended for healthy sleepers when aggregating data, to estimate their normal sleeping pattern, several days are needed in subjects with an irregular sleep pattern (Short et al., 2017). Sleeping parameters such as SOL and WASO required 2-3 weeks to provide adequate stability in 32 elderly normal sleepers (Wohlgemuth, Edinger, Fins, & Sullivan, 1999).

4 Method

4.1 Study population

Participants from the current study are a part of a larger cross-sectional field study meant for investigating shift work, sleep and pain undertaken in Norway at the National Institute of Occupational Health (STAMI). The study population was recruited from the Norwegian Nurses Organization which randomly selected members from hospitals in Norway. In total, 22 500 participants received an invitation from the National Institute of Occupational Health (STAMI). Participants were eligible for inclusion if they were between 18 and 65 years of age and had working schedules that included morning, evening and night. Participants were excluded if they had experienced pain lasting more than three months in the last two years with an intensity of more than three on a visual analogue scale (VAS) 0-10, 0= no pain and 10= worst imaginable pain); had worked less than 50% full time; were pregnant; breastfeeding; or had a sickness absence for more than two weeks during the last six months. In total, 5 400 nurses fulfilled the criteria for participation based on statistics taken into account from the inclusion and exclusion criteria, of which 4 001 showed interested in participating in the project and were invited to complete the baseline questionnaire. Participants who completed the baseline questionnaire were 1 032. A total of 711 nurses completed all 28 days of diary reports. From these, 100 nurses volunteered to wear an actigraph. Seven subjects had missing data due to technical problems, and two subjects were excluded due to lack of data (less than five days of data from actigraphy and diary). Thus, 91 nurses constituted the study population for this thesis (Figure 1), with a mean age of 38, and consisting of 82 women (90%) and 9 men (10%) (Figure 2).

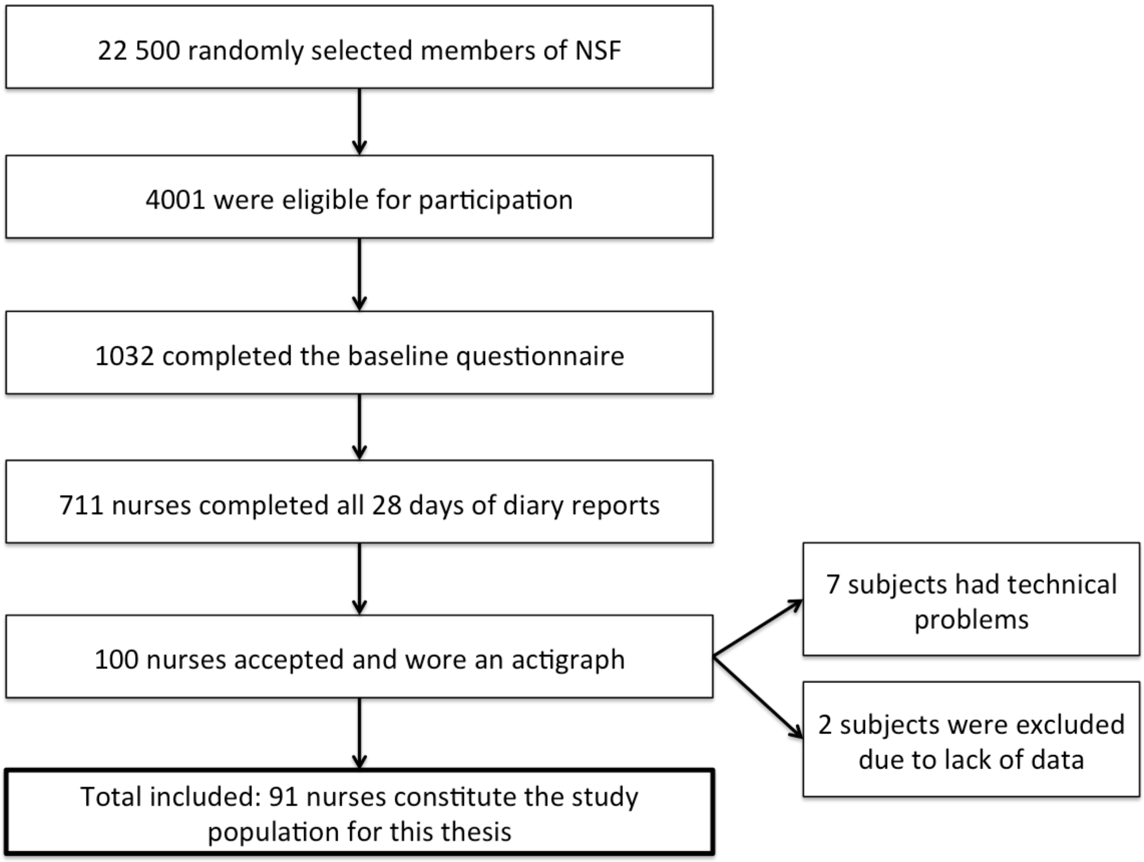

Figure 1: Overview showing included/excluded subjects in the present study.
NSF=Norwegian nurses organization.

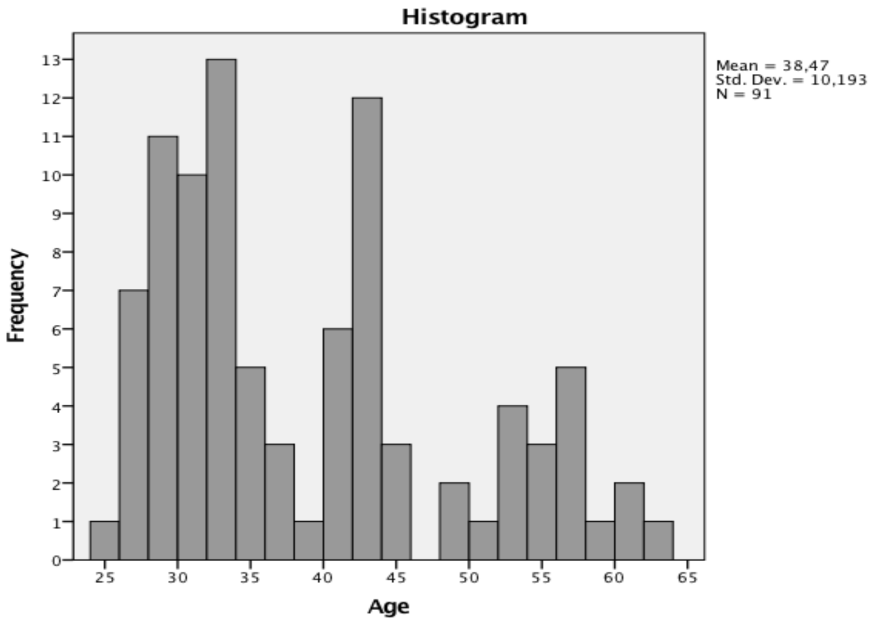

Figure 2: Age distribution in the current study population.
Std.Dev. (SD) = Standard Deviation, N= number of participants.

4.2 Study design

The study design was a cross-sectional field study where the study population filled out a baseline questionnaire (appendix 1), wrote an electronic diary for 28 days (appendices 2 and 3) and wore an actigraph for up to 28 days (Figure 3).

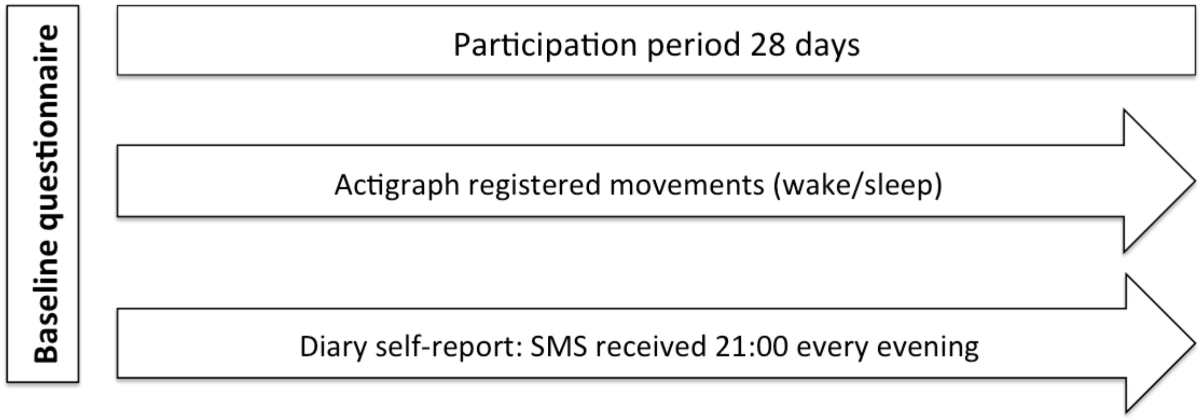

Figure 3: Actigraphy and diary collected during the 28-day participation period.

4.3 Baseline questionnaire

The baseline questionnaire combined several standardized questionnaires on sleep (see next section) and pain (which is not included in this thesis). The baseline questionnaire also collected information about age, gender, relationship status, children, lifestyle (alcohol- and smoking habits, medication and caffeine), physical activity, health complaints, and working factors (psychosocial and physical working environment). The exact questions used are listed in appendix 1.

4.4 Sleep measures from questionnaires

The three standardized questionnaires about sleep used in the baseline questionnaires were the Epworth Sleepiness Scale (ESS), the Pittsburg Sleep Quality Index (PSQI) and the Bergen Insomnia Scale (BIS). A short introduction on each of these will follow. The reader can find the questionnaires available online (BIS, 2008; ESS, 1990; PQSI, 1989).

The Epworth Sleepiness Scale is a questionnaire involving eight questions about daytime sleepiness and the likelihood of falling asleep in different situations (Johns, 1992). An exact period is not given, but the questionnaire asks for response *'in recent* *time'* meaning within the last few weeks or months. Every item is scored with a Likert type scale from 0 (no chance of dozing) to 3 (high chance of dozing), which gives a sum score from 0 to 24 points. A high score indicate high level of daytime sleepiness.

The Pittsburgh Sleep Quality Index is an international questionnaire covering different subjective experiences of sleep quality over a one-month time interval (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The questionnaire consists of 19 items comprising seven different factors: subjective sleep, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. Items are scored in a Likert type scale or in actual hourly response. The sum of all scores constitutes one global score which shows an overall view of sleep quality from 0 (better) to 21 (worst). In general, a global PSQI score above 5 is associated with poor sleep quality.

Bergen Insomnia Scale is based on the criteria for insomnia in Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) and is, thus, both a quantitative measure and a diagnostic tool for insomnia (Pallesen et al., 2008). It contains six questions relating to sleep and tiredness during the last month. The participants are asked to report the average number of days he or she has experienced a specific sleeping problem in a week, that is in the last 0 to 7 days, which gives a continuous sum score from 0 to 42. High total scores indicate significant symptoms of insomnia (Pallesen et al., 2008).

4.5 Electronic diary

The electronic diary consisted of a series of questions on sleep pattern, work and musculoskeletal pain, however, the latter information was not used in the current study (appendices 2 and 3). The work questions asked whether the respondent had been to work, and if so, the working hours (start/end given in hours/minutes), specified by two drop-down menus, one for hours (0, 1, 2, 3 ...) and one for minutes (0, 5, 10, 15, 20 ...). The sleep questions were based on *The Consensus Sleep Diary* (CSD) (Carney et al., 2012). According to Carney and his colleagues (2012) this is both a research and clinical tool for collecting data on the quality of sleep. The data material was sent via the internet at 21:00 every evening and answers were received from 21:01 and until the next day, and securely saved on a server at STAMI.

The Consensus Sleep Diary contains nine core questions about sleep: 1.What time did you go to bed? 2.What time did you try to go to sleep (lights off)? 3.How long did it take you to fall asleep? 4.How many times did you wake up, not counting your final awakening? 5. In total, how long did these awakenings last? 6.What time was your final awakening (lights on)? 7.What time did you get out of bed for the day? 8. How would you rate the quality of your sleep (on a five point scale)? 9. Comments (free space)? (Carney et al., 2012). Also included in the daily diary from STAMI were the following additional questions: Did you wake up earlier than planned (yes/no)? How much extra sleep did you get (hours/minutes)? Did you use any sleep medication (yes/no)?

4.6 Actigraphy

In this study we used ActiSleep+ and wGT3x-BT (monitor, ActiGraph, Pensacola, FL, USA). Both devises measure accelerometry in three axes in a sampling rate of 30Hz. For the sleep/wake analyses we used the Cole-Kripke algorithm validated for healthy adults (Cole et al., 1992) and both actigraphs are validated and reliable in the use of sleep/wake detection (Cellini et al., 2013; Cellini, McDevitt, Mednick, & Buman, 2016).

Participants received the actigraph (ActiSleep+ or wGT3X-BT monitor, ActiGraph, Pensacola, FL, USA), as well as instructions for use, by mail. The standard instruction informs the user that the actigraph measures when they are awake/asleep, and that the participants should wear the actigraph day and night, treat it with care, and only take it off during showering or bathing (Ancoli-Israel et al., 2015). Usually, actigraphs are worn on the wrist, however, due to the nature of nursing work (strict hygiene), it was worn on the non-dominant ankle.

5 Data material

Actigraphs were used to capture and record continuous information about sleep/wake patterns in the study population. Data material from the actigraphs, ActiSleep+ and wGT3x-BT (monitor, ActiGraph, Pensacola, FL, USA) was pre-processed by a research assistant at STAMI by using the ActiLife software v6.5. (ActiGraph Software Department, 2012, Pensacola, FL, USA). In this study, the times registered in the diaries as lights off and lights on was plotted into the software and the Cole-Kripke algorithm was used for calculating the differing sleeping parameters, validated for healthy adults (Cole et al., 1992). Diary and baseline data were pre-processed by a post doc researcher working in the same project.

5.1 Organizing data material

The pre-processed actigraphy data contained one Excel document per participant. These 91 documents were collected into one Excel document, containing 1,513 observations, with one observation corresponding to data from one day (24-hours) of the sleep parameters TST, WASO, NA, SE and SOL. However, SOL was excluded because the actigraph did not score it correctly. The actigraphs mainly registered SOL as sleep and in many cases, recorded this as low as 0 minutes. A study carried out by Zinkhan et al. (2014) had similar results. Actigraphs are known to underestimate epochs of wakefulness during the night, compared to PSG, and therefore they underestimate parameters like SOL and WASO (Marino et al., 2013; Sadeh, 2011). A variable named "day index" indicated the relative day in the 28-day period in the actigraphy dataset and diary dataset, the two datasets was merged based on day index and identification number (ID) for each participant. The new data set contained all variables for further analysis. The resulting dataset had a total of 1 412 days with information from 91 subjects, containing sleep parameters from both objective and subjective measures from 6-22 days, and covariates from the baseline questionnaire, such as age and scores from ESS and BIS.

The participants have different number of days with data including subjective and objective data, a distribution of this is described in Table 1a. A dataset containing no missing data with 28 days from 91 participant would have given 2 548 days (100%), the current dataset with 1 412 days gives 55% of days with valid data and 45% of days with missing data. Lastly, some participants did not have all shift types included during their time of participation. Table 1b shows the distribution of missing shift types for each participant.

Table 1a: Showing distribution of days containing subjective and objective data per participant during the participation period of 28 days.

																In total
Number of days	6	8	9	10	11	12	13	14	15	16	17	18	19	20	22	1 412 days
Number of participants	1	2	3	3	3	7	5	2	11	11	18	9	11	4	1	91 participants

Table 1b: Showing distribution of participants and shift types included in their shift work schedule during the time of participation (28 days).

	All shift types	Only night shifts	No morning shifts	No evening shifts	No night shifts
Number of participants	53	4	1	8	25

5.2 Variables

Actigraphy data from 91 nurses working rotating shifts (morning, evening, night and days off) were collected for a period of 28 days. Furthermore, diary data (appendix 3) was used to collect data about sleep and working times from the nurses. Sleep analysis from the actigraphy data and diary data was quantified into continuous variables TIB, SOL, TST, WASO, NA and SE. Table 2 gives a detailed explanation for each sleep measure included in this study and how it was calculated. Working hours were calculated from the diary containing the number of shifts and shift types: morning, evening, night and days off. Sleep parameters were calculated from the actigraphs and self-reported diaries.

Table 2: Overview of sleep variables, explanation and calculation.

Measurements of sleep	Explanation	Calculation
Time in bed (TIB) (hours/min)	The time spent in bed from "lights off" to "lights on".	From diary in the current study.
Sleep Onset Latency (SOL)	The time it takes to fall asleep after lights off.	From diary and calculated from actigraphy data.
Total sleep time (TST) (hours/min)	The amount of actual sleep time in one sleep episode.	TST = TIB - (SOL+WASO) Calculated based on actigraph measurements (ActiSleep+ or wGT3X-BT monitor, ActiGraph, Pensacola, FL, USA). Based on Cole-Kripke algorithm adjusted with lights off and lights on from diary.
Wake after sleep onset (WASO) (hours/min)	Total amount of minutes scored as awake after the first epoch registered as sleep.	Registered in diary and calculated from actigraph.
Number of awakenings (NA)	Number of awakenings in the period of time spent in bed from lights off to lights on.	Registered in diary and calculated from actigraph.
Sleep efficiency (SE) (%)	The proportion of sleep in the episode potentially filled with sleep.	The ratio of TST to TIB, TST/TIB*100.

5.3 Aggregation

The data material contained up to 22 days of data per subject. Aggregation was undertaken to provide accurate estimates of the "typical" sleep of each individual. Sleep patterns may vary from night to night and from weekdays to weekends within an individual. By using aggregation this variation was reduced, giving greater accuracy for "typical" sleep for each sleep parameter used. Five days or more are recommended for healthy adults when using aggregation (Short et al., 2017). Measurements for WASO, TST, NA and SE were aggregated both for subjective and objective measures. The result was one dataset containing a mean value per variable for each subject.

5.4 Covariates

According to Carskadon and Dement (2017) predictors that can alter sleep are age, previous sleep-wake history, use of medications or drugs (e.g., alcohol and caffeine), phase of circadian timing system, sleep disorders and temperature in the bedroom. Covariates included in the analysis were age, BIS and ESS. The numbers of covariates were limited to three because the sample size was less than 100 participants (Field, 2013).

5.5 Mean Absolute Deviation

Mean absolute deviation (MAD) was used as a measure of variability in the number of different shift types and days off per participant. This measure was chosen in preference to Standard Deviation (SD) because it is easily interpretable, less sensitive to differences in the number of observations between subjects, and robust for deviations from normality (Bohle et al., 2011; Harma et al., 2015). The mean absolute deviation was calculated for shift types by counting the number of each shift type in the 28-day period: number of morning shifts, number of evening shifts, number of night shifts, and number of days off.

$$MAD = \frac{\sum |x - \mu|}{N}$$

(x= each shift type and days off. μ= the mean of number of days. N=number of observations (days) per participant.). The measurement MAD represents the averaged distance that all shift types and days off are from the mean. Below follows two examples for expressing the variation using MAD.

Case 1 (Figure 4) is an example of low variation in MAD. This individual is working 7 morning shifts, 7 evenings, 7 nights and has 7 days off, giving in total, a working schedule over 28 days, with a mean of 7 days. All distances from the mean are 0 and the MAD value is in this case 0. Hence, the lowest variation in MAD represents a working schedule in which the participant is working an equal number of each shift type, including days off.

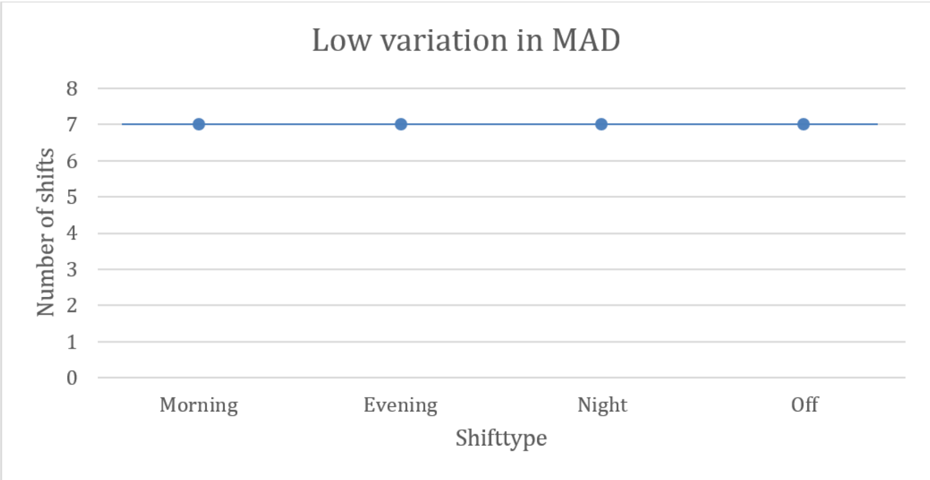

Figure 4: Case 1 showing large variation in shift types and days off over 28 days. Each dot is showing the distance from the number of each shift type from the mean. Low MAD value= 0.
MAD= mean absolute deviation.

Case 2 (Figure 5) is an example of large variation in MAD. This subject is working 20 morning shifts, 0 evenings, 0 nights and has 8 days off. This gives a total of 28 days and a mean of 7. Morning shifts have an absolute deviation of 13 from the mean, while evening and night shifts have a distance of 8 and number of days off has a deviation of 1 from the mean. Using the formula above, this gives a MAD value of 4. Hence, a high numbers of days for one specific shift type is the same as low variation within the shift schedule; and is represented by larger MAD values.

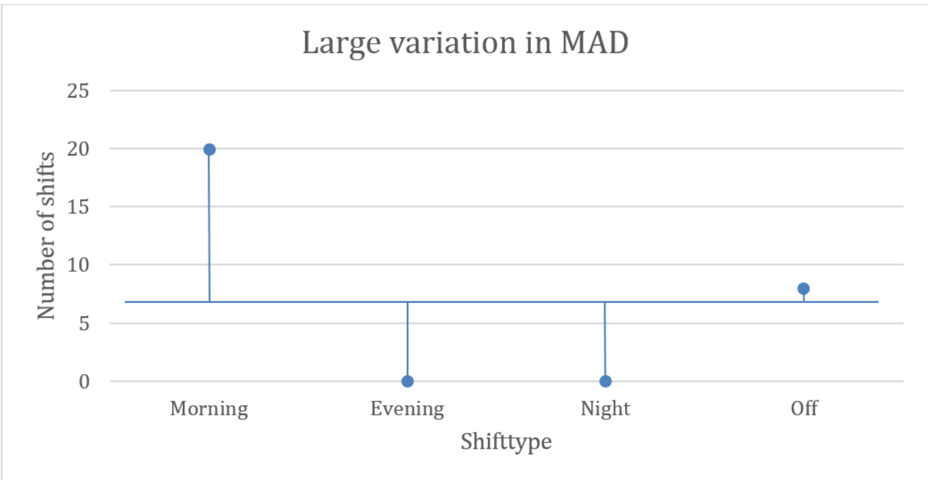

Figure 5: Case 2 showing low variation in shift types and days off over a period of 28 days. Each dot is showing the distance from the number of each shift type from the mean. Large MAD value= 4.
MAD= mean absolute deviation.

6 Statistics and analyses

6.1 Statistical overview

In this study a Bland-Altman plot was used to investigate the agreement between subjective and objective measures of sleep. Further linear regression was used to analyze the relationship between variation in shift schedules and subjective and objective sleep parameters. Statistical analyses was undertaken using IBM SPSS Statistics Version 24. See Table 3 for detailed information.

Table 3: Overview showing specific hypotheses, variables included in the different analyses, measuring levels used for the specific variables, covariates and analysis used in the current study.

Hypotheses	Variables	Measuring level	Covariates	Analyses
H1: Sleep measures from subjective measurements (diary) agree with objective measurements (actigraphy). 1a: TST measurements from the diaries are in agreement with TST from actigraph measurements. 1b: NA measurements from the diaries are in agreement with NA from actigraph measurements. 1c: WASO measurements from the diaries are in agreement with WASO from actigraph measurements. 1d: SE measurements from the diaries are in agreement with SE from actigraph measurements.	Actigraph-estimated WASO, NA, TST and SE Diary-estimated WASO, NA, TST and SE Variable 1: **Difference** between subjective and objective Variable 2: **Mean** between subjective and objective	Continuous WASO, TST: hours (min) SE: percent NA: number		1. One-Sample t-test of the difference variable 2. Bland-Altman plot for the description of agreement 3. Linear regression for systematic trends
H2: Variation in rotational shift work, expressed as MAD, predict self-reported sleep measures 2a: Large variation between shift types is associated with increased WASO. 2b: Large variation between shift types is associated with increased NA. 2c: Large variation between shift types is associated with reduced TST. 2d: Large variation between shift types is associated with reduced SE.	**Independent variable:** Variation in shift types calculated as MAD. **Dependent variable:** Actigraph-estimated WASO, NA, TST and SE	Continuous Shift types: morning, evening, night and days off 1-4 WASO, TST: hours (min) SE: percent NA: number	Age BIS ESS	Linear regression
H3: Variation in rotational shift work, expressed as MAD, predict actigraphy sleep measures. 3a: Large variation between shift types is associated with increased WASO. 3b: Large variation between shift types is associated with increased NA. 3c: Large variation between shift types is associated with reduced TST. 3d: Large variation between shift types is associated with reduced SE.	**Independent variable:** Variation in shift types calculated as MAD. **Dependent variable:** Actigraph-estimated WASO, NA, TST and SE	Continuous Shift types: morning, evening, night and days off 1-4 WASO, TST: hours (min) SE: percent NA: number	Age BIS ESS	Linear regression

WASO= wake after sleep onset, NA= number awakening, TST= total sleep time, SE= sleep efficiency, BIS= Bergen insomnia scale, ESS= Epworth sleepiness scale, MAD= mean absolute deviation.

6.2 Bland-Altman plot

The so-called Bland-Altman plot is a graphical method to compare the agreement between two measures by plotting the differences between them against the mean of both measures (Bland & Altman, 1986). Using the mean of the difference and two standard deviations, one can visualize the average difference and the approximated 95% limits of agreement (Bland & Altman, 1995). Additionally, we used the one-sample t-test to test for a statistically significant mean difference, and linear regression to detect any systematic trends (e.g. higher p-values have better agreement than lower values).

6.3 Multiple regression

Multiple regression was used to determine the relationship between dependent variables (WASO, NA, TST and SE) and the independent variable (variation in shift types, MAD) adjusting for covariates. In total eight regression analyses were done. The aim of the analysis was to see if there was any significant association between MAD and sleeping parameters, after adjusting for covariates (using a standard threshold for significance at $p = 0.05$).

6.4 Assumptions

The analyses did not violate the assumptions of normality, linearity or homoscedasticity, as assessed visually through histograms, P-P plots (normality) and residual plots (linearity and homoscedasticity). Using a tolerance of > 0.1, collinearity was within the acceptable range. The average variance influence factor (VIF) was not greater than 1 (Field, 2013). A few outliers were detected in the dataset and a few analyses were done without outliers, but they did not influence any of the results. Therefore outliers were not removed or winsorized, because their values was both theoretically and physiologically possible.

6.5 Ethics

The study was approved by the Norwegian Regional Committee for Medical Research Ethics (approval number 2012/199, appendix 4). Participants received information about the study in writing and they all signed an informed consent form.

7 Results

7.1 Agreement between subjective and objective sleep measures

The mean difference between the subjective measures and objective measures were all negative, meaning that all sleep parameters were underestimated by the diary (Table 4a). The mean difference between the measures, as well as their standard deviations, were used to generate the lines in the Bland-Altman plot, as shown in Table 4a. Further, linear regression models were used to test for any significant trend in the plots. Results are shown in Table 4b.

Table 4a: Showing difference in subjective and objective sleep measures.

	Mean difference	SD of diff	+1.96 SD	-1.96 SD
WASO (hours)	-0.065 (95% CI: -0.10;-0.03)	0.191	0.309	-.439
NA (number)	-3.946 (95% CI: -4.54;-3.35)	2.864	1.667	-9.559
TST (hours)	-0.213 (95% CI: -0.35;-0.07)	0.673	1.106	-1.532
SE (%)	-10.882 (95% CI: -12.83;-8.93)	9.371	7.485	-29.249

The mean difference was found by subtracting subjective measurements from objective measurements, further the table shows standard deviation (SD) of difference and the upper (+1.96 SD) and lower (-1.96 SD) limits of agreement used in Bland-Altman plots. SD= standard deviation, WASO= wake after sleep onset, TST= total sleep time, NA= number awakenings, SE= sleep efficiency.

Table 4b: Showing linear regression coefficients calculated using the variables in Bland-Altman plots.

	Regression coefficient all subjects included	Regression coefficient without outliers
WASO (hour)	.113 (p=0.536)	
NA (number)	-1.382 (p<0.001)	
TST (hour)	.347 (p<0.001)	.195 (p<0.001)
SE (%)	-2.011 (p<0.001)	1.822 (p<0.001)

WASO= wake after sleep onset, TST= total sleep time, NA= number awakenings, SE= sleep efficiency.

7.1.1 Wake after sleep onset

Measurements for WASO from the diaries were on average 0.065 hours (3 minutes and 54 seconds) less than WASO measurements from actigraphy (Table 4a). The upper and lower limits of agreement were 0.31 and -0.44 hours, respectively. As the mean of the two measurements increased, there was no proportional change in the difference between the subjective and objective measures of sleep (p=0.536, Table 4b, Figure 6).

7.1.2 Number of awakenings

Measures from the diary for NA were on average 3.95 times fewer than NA measures from actigraphy (Table 4a). The upper and lower limits of agreement were 1.67 and -9.56 times, respectively. There was better agreement between the measures for lower NA (Figure 6). As the mean between the two measurements increased, there was a proportional increase in the absolute difference between subjective and objective measures of sleep. The objective measure of NA identified more awakening in respect to the subjective measure. For each additional awakening, there was an average 1.38 increase in the absolute difference between subjective and objective measures of NA ($p<0.001$, Table 4b).

7.1.3 Total sleep time

Measures of TST from the diaries were on average 0.21 hours (12 minutes and 36 seconds) lower than TST measures from actigraphy (Table 4a). The upper and lower limits of agreement were 1.11 and -1.53 hours, respectively. As the mean between the two measurements increased, there was a proportional change in the absolute difference between subjective and objective measures of sleep, for each hour; an average change of 0.34 hours (20 minutes and 49 seconds) in difference ($p<0.001$, Table 4b). By removing the outlier the assessment of proportional bias was smaller. As the mean between the two measurements increased, there was a proportional change in the absolute difference between the two assessments, for each hour, an average of 0.195 hours (11 minutes and 42 seconds) in difference ($p<0.001$, Table 4b).

7.1.4 Sleep efficiency

Measures from the diary for SE were on average 10.9 percentage points smaller than SE measures from actigraphy (Table 4a). The upper and lower limits of agreement were 7.5 and -29.2, respectively. There was higher agreement between the measures for higher SE (Figure 6). As the mean between the two measurements decreased, there was a proportional increase in the absolute difference between subjective and objective measures of sleep ($p<0.001$, Table 4b); for each percent, there was an average decrease of 2 percentage points in difference. When excluding the outlier from the analysis, as the mean between the two measurements decreased, there was a proportional increase in the absolute difference between the mean between subjective and objective measures; for each percent, an average increase of 1.8 percentage points in difference (p<0.001, Table 4b).

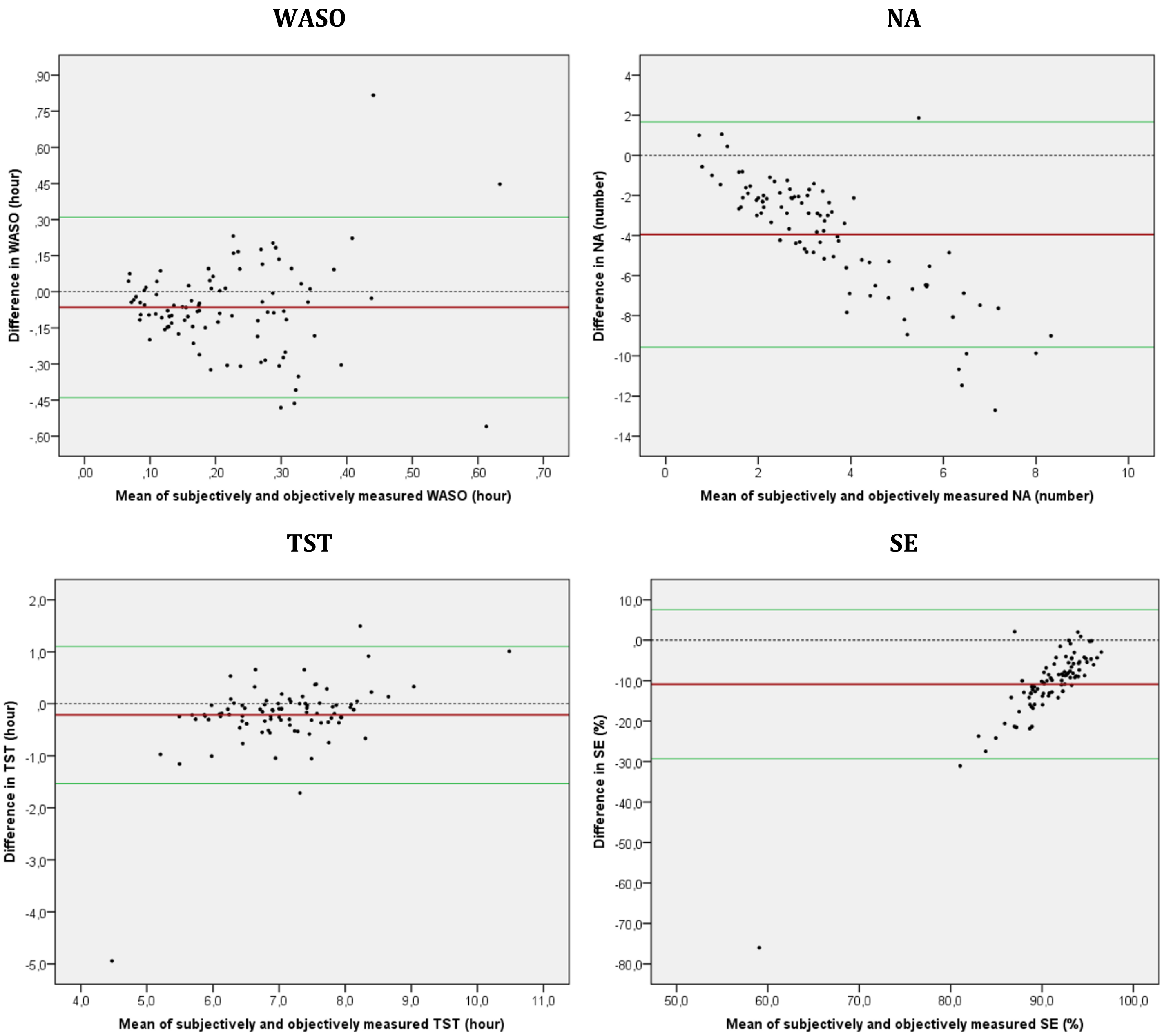

Figure 6: Bland-Altman plots from the data presented above . The red line shows the mean difference between the two measures. The green lines showing the upper and lower limits of agreements using ± 1.96 standard deviations from the mean difference between the two measures. The black dotted line represents zero difference. WASO= wake after sleep onset, TST= total sleep time, NA= number awakenings, SE= sleep efficiency.

7.2 Association between variation in shifts and sleep measures

7.2.1 Association between variation in shift type and subjective sleep measures

We tested the association of variation in shift type (predictor, MAD) among nurses with the four different sleep parameters as dependent variables (WASO, NA, TST and SE). In general, none of the sleep parameters were significantly predicted by variation in shift type, as measured with MAD (Table 4).

Of the covariates tested, subjects with higher BIS at the beginning of the study had a greater likelihood for reporting higher WASO during the time of participation (p=0.008). The participants reporting more insomnia symptoms (BIS) at baseline also had a greater likelihood of reporting decreased SE (p=0.007, Table 4).

On average, participants with higher age slept shorter TST (p=0.002, Table 4).

7.2.2 Association between variation in shift type and objective sleep measures

We tested the association of variation in shift type (predictor, MAD) among nurses with the four different sleep parameters (dependent variables) from actigraphy. As with the subjective measure of sleep, none of the sleep parameters were significantly predicted by shift variation, as measured with MAD (Table 5).

However, of the covariates tested, actigraphs worn by younger participants registered an increase in NA; on average (p=0.044, Table 5). Further, actigraphs worn by older participants registered, on average, a decreased TST (p<0.001, Table 5).

Table 5: Subjective sleep parameters from diary
Result from regression analyses. Subjective WASO, NA, TST and SE. Dependent Variables: WASO= wake after sleep onset, TST= total sleep time, NA= number awakenings, SE= sleep efficiency. Independent Variable: Shift type variation, MAD= Mean Absolute Deviation.

	WASO	B	SE B	β	t	P
Predictors of WASO (n=91)	**Age**	.002	.002	.167	1.587	.116
	Epworth Sleepiness Scale	-.003	.006	-.059	-.505	.615
	Bergen Insomnia Scale	.006	.002	.312	2.71	.008
	Shift type variation, MAD	-.02	.018	-.123	-1.158	.25

	NA	B	SE B	β	t	P
Predictors of NA (n=91)	**Age**	.006	.011	.062	.56	.577
	Epworth Sleepiness Scale	-.005	.038	-.016	-.129	.898
	Bergen Insomnia Scale	-.006	.016	-.049	-.403	.688
	Shift type variation, MAD	-.079	.12	-.074	-.657	.513

	TST	B	SE B	β	t	P
Predictors of TST (n=91)	**Age**	-.036	.011	-.334	-3.213	.002
	Epworth Sleepiness Scale	-.04	.04	-.117	-1.012	.314
	Bergen Insomnia Scale	-.021	.016	-.144	-1.265	.209
	Shift type variation, MAD	.094	.125	.079	.756	.452

	SE	B	SE B	β	t	P
Predictors of SE (n=91)	**Age**	-.144	.091	-.164	-1.58	.118
	Epworth Sleepiness Scale	-.315	.327	-.111	-.963	.339
	Bergen Insomnia Scale	-.372	.135	-.313	-2.767	.007
	Shift type variation, MAD	.464	1.03	.047	.451	.653

Table 6: Objective sleep parameters from actigraphy
Result from regression analyses. Objective WASO, NA, TST and SE. Dependent Variables: WASO= wake after sleep onset, TST= total sleep time, NA= number awakenings, SE= sleep efficiency. Independent Variable: Shift type variation, MAD= Mean Absolute Deviation.

	WASO	B	SE B	β	t	P
Predictors of WASO (n=91)	**Age**	-.002	.002	-.14	-1.264	.21
	Epworth Sleepiness Scale	-.001	.006	-.016	-.129	.898
	Bergen Insomnia Scale	-.001	.002	-.041	-.338	.736
	Shift type variation, MAD	-.018	.018	-.116	-1.041	.301

	NA	B	SE B	β	t	P
Predictors of NA (n=91)	**Age**	-.067	.033	-.224	-2.041	.044
	Epworth Sleepiness Scale	.031	.117	.032	.264	.793
	Bergen Insomnia Scale	-.026	.048	-.065	-.543	.589
	Shift type variation, MAD	-.149	.369	-.044	-.403	.688

	TST	B	SE B	β	t	P
Predictors of TST (n=91)	**Age**	-.03	.008	-.389	-3.771	p<.0005
	Epworth Sleepiness Scale	-.014	.029	-.056	-.49	.626
	Bergen Insomnia Scale	-.012	.012	-.113	-1.006	.318
	Shift type variation, MAD	.03	.09	.034	.329	.743

	SE	B	SE B	β	t	P
Predictors of SE (n=91)	**Age**	.01	.021	.053	.474	.636
	Epworth Sleepiness Scale	.004	.077	.007	.056	.956
	Bergen Insomnia Scale	.025	.031	.095	.782	.436
	Shift type variation, MAD	.198	.241	.092	.821	.414

8 Discussion

This study demonstrated that the agreement between actigraphy and diary assessed sleep varies within the four different sleep parameters used. The general trend is that diary reported measures are lower for WASO, NA, TST and SE compared to actigraphy. Further, this study found that variation in shift work, expressed as MAD, did not significantly predict subjective or objective sleep parameters.

8.1 Discussion of method

8.1.1 Statistical analyses

8.1.1.1 Bland-Altman plots

The agreement between sleep parameters assessed by actigraphy and self-reports was estimated with the Bland-Altman plot proposed by Bland and Altman (1986), which is also recommended by Sadeh (2011) when comparing methods. There is no specific requirements when it comes to sample size in the Bland-Altman plot. It was preferred over the use of correlation, because it can be misleading when investigating the agreement between two methods. When using correlation one can only measure the degree of association between the two methods. Thus, it investigates the linear relationship between two variables, and not the agreement between the two. For example, when the "true" TST becomes higher, the subjective and objective measures of TST also becomes progressively higher. This will undoubtedly give a correlation, but you do not know whether the two measures gives the identical value of TST (which is agreement). So even though both measures shows higher values for TST among people who sleep longer, that does not mean that the actual value is identical to both measure.

Thus, it investigates the relationship between two variables, and not the agreement between the two. Further a hypothetical example for how correlation can be misleading will be given. When measuring sleep with actigraphy and PSG a correlation can soon arise, when TST becomes higher, TST measured with actigraphy and PSG becomes higher. Thus, you have a correlation. This can be misleading in the sense that actigraphy and PSG measure "the same value of TST "(which is agreement). Although both shows higher values for TST among people who sleep longer, that does not mean that the actual value is identical to both. For example, actigraphy may measure TST to be 7.5 hours when PSG measures TST to be 6.5 hours. This means that, even though they correlate, it is generally impossible that they agree with each other about the "true" value.

The use of the Bland-Altman plot expands the knowledge of agreement between different sleep measures compared to the use of correlation. Multiple studies have used both correlation and the Bland-Altman plot for sleep parameters, and shown strong correlation, but deviations in agreement between PSG and actigraphy (Dick et al., 2010). A similar study (de Souza et al., 2003) demonstrated strong correlation between SOL and TST from actigraphy and PSG, but the Bland-Atman plots showed that actigraphy overestimated SOL, TST and SE and underestimated NA compared to PSG.

8.1.1.2 Multiple regression

Multiple linear regression with several predictors were made to investigate the relationship between variations in shifts (MAD, dependent variable) and sleep parameters (independent variables). The ample size in regression depends on the effect size, which tells us how well our predictor will predict the outcome of the study. The number of predictors should be 4 or less in a sample size of 91 (Field, 2013).

8.1.2 Validity and reliability

Validity is the degree to which the assessment reflects the phenomenon one wishes to measure; in short, if we measure accurately what we want measured. By splitting validity into sensitivity and specificity, the accuracy of the measurement can be detected (Magnus & Bakketeig, 2013, pp. 55-62).

8.1.2.1 Validity and reliability of actigraphy

Sleep is a complex state of physiological and behavioral process. One night of sleep contains four stages which circulates through the night (Carskadon & Dement, 2017). The pattern of sleep may change from night to night and from weekdays to weekends (Short et al., 2017). By dividing the sleep into epochs of wake and sleep one can compare and validate actigraphs (different placements and different types) and sleep diaries to PSG. A review undertaken by Sadeh (2011) indicated that actigraphy had a reasonable validity and reliability when measuring sleep and wake in healthy adults with good or average sleep quality. However, as shown by Ancoli-Israel et al. (2003), actigraphy becomes less reliable as sleep becomes more disturbed, and more reliable when assessing data from five days or more (Sadeh, 2011; Ustinov & Lichstein, 2013). The outcomes of these studies resemble the findings of this research study. These results are largely consistent with our finding.

8.1.2.2 Validity and reliability of sleep diaries

The subjective perception of sleep might not necessarily be expected to agree with objective measures, but the subjective perception of sleep is a unique and valued perspective in sleep research (Carney et al., 2012). The subject's own perception of sleep and how it affects their function during the day is important to capture because it also effects the individual perception of well-being and health (Jungquist, Pender, Klingman, & Mund, 2015; Weaver, 2001). Sleep diaries are the "gold standard" for subjective sleep assessment, but in sleep studies there is a lack of a standardized format. Participants used the diaries to report their sleep on a night-by-night basis. The absence of a standardized sleep diary compromised the ability to fully compare results from previous studies. However, the consensus sleep diary (CSD) is an important step towards a validated, standardized sleep diary (Carney et al., 2012), although it requires more research to assess its validity. Gathering diary assessments from a minimum of five nights is recommended in order to indicate good to excellent reliability of sleep in healthy adolescents, with a normal sleeping pattern (Short et al., 2017).

The use of actigraphy in sleep medicine has raised questions concerning the validity and reliability of self-reported sleep (Stone, Shiffman, Schwartz, Broderick, & Hufford, 2002; Stone et al., 2003). In a randomized controlled trial by Stone et al. (2003), 80 chronic pain patients were randomized to paper diary and electronic diary, with a given time frame to fill out the diary on a daily basis. Reported compliance with the paper diary was 90%, but actual compliance was only 11% (within the given time frame). 75% of the participants filled out several days in the diary but not during the given day or time frame. The electronic diary had an actual compliance of 94%, which suggests that an electronic diary is a more reliable and effective way of collecting diary information. Electronic diaries are also more time efficient for researchers and have the capability of time stamping the entry of answers and therefore, decreasing recall-bias by collecting accurate data (Carney et al., 2012; Stone et al., 2002).

8.1.3 Internal validity

High internal validity means that the study was undertaken in a way that that made it possible to prove a causal relationship between variables by minimizing limitations from bias and confounding factors (Webb & Bain, 2011b, p. 230). The question is whether the results in the study reflects the true situation in the study population. When dealing with people with individual differences and exposures, the true association can be difficult to prove. Some strengths and weaknesses will be mentioned in the following paragraphs.

In the current study actigraphy was used in combination with an electronic diary to measure both periods of wakefulness and sleep continuously for a period of 28 days. Having both subjective and objective measures are recommended to obtain more detailed information about sleep, taken in consideration that actigraphs only measures body movements and not other mechanisms related to sleep (Sadeh, 2011). Further, inclusion and exclusion criteria were used, as well as collecting information about time for working hours and days off. This was done to mitigate known factors that might influence sleep and to reduce selection bias. Further, we controlled for the covariates age, Bergen Insomnia Scale (BIS) and Epworth Sleepiness Scale (ESS) in our regression models to reduce systematic error. Lastly, to minimized recall-bias, an electronic diary was used. Participants received an SMS via internet at 21:00 p.m. and answers received later than the next evening were excluded.

Still, the study has several weaknesses. We followed the nurses for a period of 28 days, but several of the subjects had data from less than 28 days. Days of data from actigraphy and diaries varied from 6-22 days within the selected group of 91 participants. Also, as in all observational studies, it is difficult to prove causation; in this case the link between variation between shift types (calculated as MAD) and possible outcomes in sleep (WASO, TST, SE and NA).

8.1.3.1 Placement of the actigraph

There is a number of different actigraph devices and belonging algorithms on the marked, and different studies often applies different devices. Therefore, comparison of results was done with caution. The current study used the actigraph ActiSleep+ or wGT3X-BT (monitor, ActiGraph, Pensacola, FL, USA) placed on the ankle. Algorithms for detecting sleep-wake patterns were validated with actigraphs worn at the wrist and not the ankle, as used in the study from Cole et al. (1992) and Sadeh et al. (1994). A study undertaken by Middelkoop, van Dam, Smilde-van den Doel, and Van Dijk (1997) with 20 healthy young adults measured activity level for 45 consecutive hours. Data from actigraphs were obtained from wrists, ankles and trunk. The study found that ankle-placement of the actigraph registered less movement than wrist-placed actigraphs. This indicates that the placement of actigraph is of importance when measuring activity/inactivity, and may have influenced the results in this study.

The current study, used actigraphs placed on the ankle and the score for SOL was very low, in many cases 0, therefore it was excluded from the study. Sleep onset latency is considered a gradual process rather than an instant moment (Ogilvie, 2001), which makes it difficult for actigraphs and self-reports to measure compared to PSG (Tryon, 2004; Zinkhan et al., 2014). Thus, it is not surprising that PSG, actigraphy (wrist placement) and subjective sleep measures have shown discrepancy in several studies when measuring SOL (Baker, Maloney, & Driver, 1999; Kölling, Endler, Ferrauti, Meyer, & Kellmann, 2016; Signal, Gale, & Gander, 2005). In these studies SOL is longer for subjective measures compared to objective measures, and is therefore comparable to findings, with actigraphy measuring lower values for SOL than self reports. Low SOL values may have influenced our results by overestimating sleep duration and SE during the night. Other studies using the hip placed actigraphs have also demonstrated low SOL values in their results (Zinkhan et al., 2014).

8.1.4 External validity

External validity is the degree to which the results from a study is generalizable to a wider population (Webb & Bain, 2011b, p. 232). It depends on good internal validity, biological insight of the study population in comparison to the wider population and statistical representativeness (Webb & Bain, 2011b, p. 232). The degree to which the study population represents the wider population is crucial when generalizing the results and plays an important role when evaluating the effect of public health interventions (Webb & Bain, 2011b, p. 232).

In our study we had a randomly selected sample, which was meant to represent every element of the shift working population of nurses. However, there is a low response rate in this study. From 4001 eligible participants only 1032 completed the baseline questionnaire, and from these 100 volunteered to wear an actigraph. Sampling bias may occur when the sample does not represent the entire target population (Webb & Bain, 2011a, p. 179). The nonresponse may have affected the measures and statistical results (e.g., if nurses with sleeping disturbance did not have the energy to volunteer to wear an actigraph). It is difficult to obtain information about nonresponders, although a comparison of the results from this study to recent statistics about nurses can be done. Statistically nurses are overrepresented in the sick leave rate (SSB, 2016), compared to the overall working population. Further, nurses seems to have a higher frequency of reporting sleeping problems than the rest of the general population (Aagestad et al., 2015). A longitudinal study with two measures with five years apart within shift work demonstrated that leaving shift work decreased the risk of repetitive awakenings during the night and the risk of difficulties falling asleep compared to those who continued working shifts (Akerstedt, Nordin, Alfredsson, Westerholm, & Kecklund, 2010). Selection bias may mask the real effect of the relationship between shift work and sleep in the current study.

The "healthy worker effect" is a common bias in occupational studies (Webb & Bain, 2011a). Our study population contained healthy adults working shifts more than 50%. Nurses working rotational shifts might be more robust to this kind of work than the general population (Knutsson & Akerstedt, 1992). When comparing our sample of nurses to an overall population of nurses, the sample might be healthier subset.

Evidently, the sample in our study was based on inclusion an exclusion criteria, and had reasonably good sleep. In summary, the low response rate from the 4001 eligible participants could cause a selection bias and an underestimation of the causation between shift work and sleep when comparing the sample to the general population, or even among a population of nurses. Findings from the current study precludes generalization to shift workers with sleep disturbances.

8.2 Discussion of results

8.2.1 Agreement

This study showed that the agreement between actigraphy and diary assessed sleep varied between the four different sleep parameters used. The general trend is that diary reported sleep measures were lower compared to actigraphy. This can be interpreted as the actigraph overestimating or the subjective self-report underestimating the true value, or, perhaps more likely, there is a combination of both. As we shall see, the contribution of bias differ between the different sleep parameters. Hence, the results on agreement cannot be generalized for all sleep parameters, and each measure must be interpreted in their respective context. This is further elaborated below.

For comparisons to this study, one of the more important studies on different methods for assessing sleep characteristics is the German study by Melanie Zinkhan and colleagues (Zinkhan et al., 2014). With polysomnography as a reference, they assessed two different actigraphs SOMNOwach plus for hip and wrist and ActiGraph GT3X+ placed on the hip, as well as self-reported sleep, on a number of sleep parameters (TST, SOL, NA, SE and WASO) during one night of sleep in a laboratory with 100 subjects from the general population. As shown by Middelkoop et al. (1997) the placement of actigraphs have a significant effect on the measurements. The agreement study by Zinkhan et al. (2014) found that wrist-placed actigraphy was superior to hip-placed actigraphy, and that hip-placed actigraphy recorded almost all epochs during the night as sleep. This is not very surprising since wrist actigraphy detects more movements than ankle actigraphy, and hip or trunk-placement detects the least amount of movements (Middelkoop et al., 1997; Van Hilten, Middelkoop, Kuiper, Kramer, & Roos, 1993). More importantly for the purpose of this discussion, when measuring the mean duration of immobility during the night, ankle-placements detected a mean duration of immobility periods to 7-7.3 minutes, which is closer to wrist-placements with 6.9 minutes than to trunk-placement with 9.5 minutes (Middelkoop et al., 1997). This indicates ankle actigraphy measured TST and SE is more comparable to wrist actigraphy, than trunk actigraphy (because immobility is mainly registered as sleep by the sleep/wake algorithm). In a relatively recent publication of 255 polysomnographic overnight studies with 449 paired actigraphic recordings placed at the ankle and wrist, both placements accurately could estimate TST (Latshang et al., 2016). Further the movement during nocturnal sleep is more relevant when measuring NA and WASO because the algorithm register activity as wakefulness. Movement index (% of the proportion of activity during the nocturnal period) was 2.2-2.4% for ankle-placement, and was therefore closer to trunk-placement with 1.7% than wrist-placement with 2.9-3%. However, the algorithms used are only validated for wrist actigraphy and, hence, most studies have used a wrist placement. Due to the findings above, further discussion will mainly focus on ankle and wrist placement, and not hip-placed actigraphy, but with the awareness that ankle-placement of the actigraph may underestimate WASO and NA in the current study.

8.2.2 Wake after sleep onset

The mean difference between subjectively and objectively assessed WASO was about four minutes on average, with reasonably narrow confidence intervals. Furthermore, the interval of agreement gives us a 95% probability that the absolute difference between subjectively and objectively assessed WASO will at maximum be 22 minutes and 12 seconds (with actigraphy giving larger WASO than self-reported). Next, there were no significant linear relationships between the mean of the two methods and the difference between them. In general, for our healthy population, this indicate good agreement between actigraphy and sleep diary assessed WASO, because it showed no specific bias or trend.

Zinkhan et al. (2014) found that self-reported WASO was 77 minutes higher than actigraphy-assessed, which is different from our findings. The cause for this difference cannot easily be explained. However, one point will be made. The single night in the laboratory setting is more susceptible to a first-night effect (Curcio, Ferrara, Piergianni, Fratello, & De Gennaro, 2004), which would increase WASO. Several studies shows that actigraphs underestimate wakefulness during sleep periods compared to PSG (de Souza et al., 2003; Marino et al., 2013; Sadeh, 2011), an increased WASO will likely increase the discrepancy between actigraphy assessed WASO and self-reported WASO. In the study by Zinkhan et al. WASO was *"even better estimated by self-report than by any of the actigraph devices with respect to mean difference to PSG in our study"* (Zinkhan et al., 2014). The first-night effect is indicated by their higher mean WASO compared to our mean WASO. Thus, in our prospective field study, we found better agreement between diary and actigraphy assessed WASO than the study done by Zinkhan and colleagues (2014). Whether this is the result of a lower WASO compared to the laboratory setting or because the agreement between ankle actigraphy and sleep diary is in fact better when measured in a prospective field study setting, is unknown. A study comparing actigraphy and subjective reports found that actigraphy overestimated NA and WASO, as evident in this study, but using Pearson's correlation in their statistical analysis (Jungquist et al., 2015). When looking at their mean for WASO it was 66 minutes for actigraphy and 1.8 minutes for electronic diaries with a smaller sample of 35 participants.

8.2.3 Number of awakenings

The mean difference between subjectively and objectively assessed NA was about four, with fairly narrow confidence intervals, with actigraphy reporting a higher number than sleep diaries. Furthermore, the interval of agreement gives us a 95% probability that the absolute difference between subjectively and objectively assessed NA will, at maximum, be 9.6 times (with actigraphy giving higher NA than self-reported). Next, there was a clear and significant linear relationship between the mean of the two methods: the difference between objectively and subjectively assessed NA increases with higher NA. Taken together our results indicate only a fair agreement between actigraphy and sleep diary assessed NA, with poorer agreement for higher NA.

Zinkhan et al. (2014) found that self-reporting was on average 3 awakenings lower than wrist actigraphy assessed NA. This is fairly consistent with our findings, taking into consideration the different settings (laboratory vs. home), time frames (one night vs. 6-22 days) and the difference in mean NA (5 vs. 3.5, averaged between self-report and actigraphy). Still, neither actigraphy nor self-reporting satisfactorily assess NA when compared to PSG. Disagreement when estimating NA is confirmed in several studies with actigraphy giving a higher number compared to diary reports (Jungquist et al., 2015; Kölling et al., 2016; Lockley, Skene, & Arendt, 1999; Zinkhan et al., 2014). Several factors may also influence the actigraph to cause measurement errors, such as having an active partner, lying very still awake for periods of the night, movement disorders or medications (Tryon, 2004). Some awakenings may also have been too brief to remember, so that the subjects might not recall them in the morning (Baker et al., 1999).

8.2.4 Total sleep time

The mean difference between subjectively and objectively assessed TST was approximately 12 minutes with fairly narrow confidence intervals, and the actigraphy reporting higher TST than sleep diaries. Furthermore, the interval of agreement gives us a 95% probability that the absolute difference between subjectively and objectively assessed TST will, at maximum, be 1.53 hours (with actigraphy reporting higher TST than sleep diaries). Next, there was a significant linear relationship between the mean of the two methods and the difference between them. Post hoc analysis (using the regression without outliers) revealed that the regression line intercepts the zero difference mark at 7.9 hours. This means that, as the mean between the subjective and objective assessments of TST becomes increasingly lower than 7.9 hours, there is a proportional increase in difference of approximately 0.2 hours between the two methods for each additional hour, with the actigraphy giving higher TST than subjective assessment. Conversely, above a TST mean of 7.9 hours, each additional hour in mean TST is related to an increased 0.2 hour difference between the two methods, with the actigraphy now reporting lower TST in respect to the subjective assessment. Taken together, our results indicate good agreement between actigraphy and sleep diary assessed TST, especially around 7-8 hours of reported sleep in a healthy population. However, there is a trend for divergence with substantially higher or lower TST.

Going back to the larger laboratory agreement study by Zinkhan et al. (2014); they found a difference between actigraphy and self-reported TST that was 31.5 minutes, with actigraphy reporting higher TST than the sleep logs. This is largely consistent with our field study and, again, especially so when considering their lower mean TST compared to our mean TST, as well as the difference in setting and time frame. Two additional points, one of which will be elaborated upon when comparing our results with epidemiological studies, should be noted. Their subjective assessment of TST was based on the direct question *"During last night, how many hours of actual sleep did you get?"* (Zinkhan et al., 2014), while our subjective TST is calculated according to the CSD (Carney et al., 2012). As we shall see, their method will in all likelihood result in a larger subjective TST than we reported. Additionally, as noted previously, ankle actigraphy will on average report less activity and, thus, larger TST, when compared to wrist actigraphy. Both of these points might indicate that the true discrepancy between their results and ours is somewhat larger than noted. Regardless, both their and our results indicate good agreement between actigraphy and self-reported TST, which are consistent with other laboratory studies (Sadeh, 2011).

8.2.5 Sleep efficiency

The mean difference between subjectively and objectively assessed SE was 10.9 percentage points with narrow confidence intervals, and actigraphy reporting higher SE than sleep diaries. Furthermore, the interval of agreement gave us a 95% probability that the absolute difference between subjectively and objectively assessed SE would, at maximum, be about 30 percentage points (with actigraphy reporting higher TST than sleep diary). Next, there was a clear and significant linear relationship between the mean of the two methods: the discrepancy between subjective and objective assessment of SE, increased with lower mean SE. Taken together, there was a fair agreement between actigraphy and sleep diary assessed SE when the averaged SE was fairly high, but the level of agreement fell substantially for lower SE. Although we lacked data of participants reporting lower than 85% SE, the linear relationship was very clear from both the Bland-Altman plots and the highly significant regression analysis, both of which indicated poor agreement for lower SE.

The laboratory study by Zinkhan et al. (2014), found 9 percentage points in difference between actigraphy and self-reported SE, with self-reporting giving lower values of SE. Although this is very similar to our findings, the discrepancy is probably larger when considering the lower mean SE in their study, the use of wrist actigraphy (instead of ankle) and the implications of the linear relationship we found in our study (described above). Their mean SE was 79.7%, 77.9% and 69.0% assessed with PSG, wrist actigraphy and self-report, respectively. In comparison, our mean SE was 96.2% and 85.3% for ankle actigraphy and sleep diary, respectively. In fact, when the SE is around

80%, we would expect, using our Bland-Altman plots, a difference of about 30 percentage points. In this regard, it is interesting to note that their hip placed actigraphy indeed differed with self-reported SE with 28.2 percentage points.

In summary, WASO, NA, TST and SE have different levels of agreement and bias. Our analysis on TST and WASO indicated good agreement between actigraphy and self-reporting. The number of awakening had relatively poor agreement, as well as a highly significant trend with increasing discrepancy with higher NA. Finally, SE had fair agreement when considering good sleepers, but with increasing discrepancy for lower SE. When considering our field study design, the healthy study population and the use of ankle actigraphy instead of wrist actigraphy, these findings are consistent with previous studies on the validity of actigraphy (Sadeh, 2011).

8.2.6 Agreement with duration of sleep in epidemiological studies

Most epidemiological studies that have investigated the agreement between subjectively assessed and actigraphy assessed sleep have focused on sleep duration, closely related to TST (Auger et al., 2013; Cespedes et al., 2016; Lauderdale et al., 2008). The need for such studies are obvious, since majority of other validation studies use actigraphy in comparison to PSG in the laboratory setting, which precludes generalization of the results to longitudinal assessments in field settings to some degree (Hauri & Wisbey, 1992; Lichstein et al., 2006).

A comparable cohort with no apparent perception of sleep problems is the Coronary Artery Risk Development in Young Adults. Lauderdale et al. (2008) collected sleep measures in two waves of three days with actigraphy, a sleep log and questions about usual sleep duration from 669 subjects. Their data on subjective sleep duration was derived by analyzing a question from the PSQI ("During the past month, how many hours of *actual sleep* did you get at night" (emphasis in the original)) and from a sleep log question which asked for their best estimate of how much actual sleep they got each night. They found subjectively reported TST to be higher than actigraphy assessed TST with an average of 0.8 hours, giving them a moderate correlation. Additionally, they found that over-reporting was stronger for those who slept less. These findings are comparable and similar to other studies with measurement for several days (Arora, Broglia, Pushpakumar, Lodhi, & Taheri, 2013; Auger et al., 2013; Cespedes et al., 2016; Herring et al., 2013; Jungquist et al., 2015; Kölling et al., 2016; Lauderdale et al., 2008; Van Den Berg et al., 2008).

Two obvious points of difference between these studies and ours must be emphasized. First, the aforementioned studies have assessed subjective sleep duration with either a direct question or calculated the duration of sleep based on when the subject reported trying to go to sleep and when they woke up. In contrast, the CSD used in our study does not ask for a direct estimation of TST. Rather than simply calculating the duration of sleep based on the self-reported time for "tried to sleep" (lights off) and "final awakening" (lights on), we derived the TST by further subtracting this with the self-reported SOL and WASO. Overly simplified, one can say that the epidemiological studies cited are biased towards total time in bed (either using sleep logs or crude questions about sleep), while our study tried to adjust for this bias by subtracting SOL and WASO. Second, these studies have relied on wrist actigraphy to calculate the objective sleep parameters. The ankle actigraphs used in our study probably increased the objective assessment of TST in comparison to wrist actigraphy (Middelkoop et al., 1997). Taken together, it is not surprising that our results found a lower self-reported TST in comparison with objective TST than the other longitudinal studies. However, it is interesting that our study found a significantly lower mean difference between subjectively and objectively measured TST.

Unfortunately, many previous cohorts who have investigated agreement between objective and subjective assessments of sleep have focused on Pearson's product-moment correlations (Lauderdale et al., 2008; Lockley et al., 1999; Monk et al., 1994; Wolfson et al., 2003). However, as noted previously, two variables might be highly correlated, and yet have a poor agreement (Bland & Altman, 1986). The few studies that have used more relevant statistics when investigating the agreement between the self-reported questionnaires typically used in epidemiologic studies and actigraphy assessed sleep duration, SOL, SE and WASO, have shown poor agreement (Girschik, Fritschi, Heyworth, & Waters, 2012; Van Den Berg et al., 2008). By using the more recently developed CSD and ankle actigraphy, this study demonstrated good agreement between subjective and objective assessment of WASO and TST using the relevant statistics. To quote the expert panel who presented the CSD, "*this document [CSD] represents a critical first step in the process of standardizing a sleep diary for use across a wide-range of research and clinical application. It is important that additional work investigate the reliability and validity of this instrument*" (Carney et al., 2012). The results presented and discussed above, are an attempt to do just this.

8.3 Variation in rotating shifts work for predicting sleep parameters

This study found that variation in shift work, expressed as MAD, could not significantly predict subjective or objective sleep parameters. Still, the association between shift work and physical health outcomes, is well established (Vedaa et al., 2016), and the mechanisms believed to underlie these outcomes include biorhythmic disruption and sleep deprivation (Knutsson, 2003). Thus, it is not surprising that of the many health-related effects found, disturbed sleep is the most common (Akerstedt, 2003). Still, as noted by Mikko Härmä and colleagues, the increasing epidemiological research on working hours and health has been somewhat inconsistent (Harma & Kecklund, 2010; Harma et al., 2015). One long-standing reason for the unclear association is the use of crude self-reported assessments of working time and sleep quality (Costa, 2003; Harma et al., 2015). Exploring new measures of shift work (e.g., using MAD as a marker for variation in shifts) and sleep quality (e.g., actigraphy) may help to further our understanding of the underlying mechanisms between shift work and health related outcomes. Still, some important characteristics of the shift schedules are believed to affect health, especially sleep, more than others. These include night and early morning shifts (Sallinen & Kecklund, 2010), length of the shift (Lowden et al., 1998), quick returns (Barton & Folkard, 1993; Vedaa et al., 2016), types of schedule and the direction and speed of rotations (Pilcher et al., 2000; Tucker, Smith, Macdonald, & Folkard, 2000).

In this study, we primarily focused on the agreement between the objective and subjective assessment of sleep in a field study of healthy shift workers. Secondly, we tested the use of MAD, as an expression of shift work variation, to predict subjectively and objectively assessed sleep parameters. In general, we found no evidence of such an association. This may be because there was no such association (i.e. between MAD and sleep quality) or because the nature of the association and the aforementioned limitations in the method used were unable to detect it. Given the earlier methodological discussion and the existing literature, several possible reasons for our findings are outlined below.

Firstly, we investigated the association of sleep quality with variation in shift work within a population of healthy shift workers, all of whom had a rotational schedule which included night shifts. Even if MAD could predict sleep quality in a working population with normal-day workers and shift workers, there is no reference population in our sample to compare rotational shift work with daytime work, or even shift work excluding night shifts. In other words, if MAD could predict sleep quality, it would be harder to detect such an association within a rather homogenous and healthy and similar shift working population, than in a study population where daytime workers (with high MAD) were represented.

Second, both sleep quality and the variation in shift work was aggregated across time. This means that even if there was a relationship between sleep quality and the day-to-day variation in shifts, the aggregation of data into mean values would not capture this association. In other words, using mean values for the entire study period, there are no means of detecting such an association, unless a significant portion of the study population reported *on average* a lower MAD and poor sleep quality. For instance, individuals with low MAD could easily have had poor sleep quality when they were rotating between different shifts, but report high sleep quality during the days they were working similar shifts. Also, individuals with an averaged low MAD may have both slow or fast rotating shifts. For instance, a person working seven days followed by seven evenings and, lastly, seven nights, will have the same averaged MAD as a person working one day, followed by one evening, followed by one night, followed by one day and so on for the same time period. In other words rapid or slow rotation between shifts are not captured when using MAD in this way. Thus the aggregation into mean values, attenuates both the association between sleep quality and MAD, and it does not capture the character of the variation in shift work, only the mean variation across time.

Third, there are significant individual differences on the effect of sleep from shift work (Härmä, 1993; Saksvik et al., 2011). Also, shift work by itself may select towards people who can more easily adapt to the working hours required (Knutsson & Akerstedt, 1992). With our exclusion criteria, for example sickness absence of more than two weeks in the last six months and VAS < 3 (1= no pain, 10= worst imaginable pain), we may have risked a sampling bias on an otherwise healthy worker effect. Looking at SE and TST the vast majority of subjects slept between 6.5-7 hours and reported SE over 85%, which may indicate a rather homogenous healthy study population, who sleep well. Combining this with our rather small sample size and the short duration of follow-up, as well as the use of aggregated MAD and sleep values, we can speculate that this would not give enough statistical power to detect a true association. Even though these reasons can explain why we did not find an association between variation in shift work and sleep quality, we cannot conclude that this is the cause. Indeed, it may well be that using aggregated MAD as a measure of variation in shift work is in fact not associated with the mean objective or subjective sleep assessment.

9 Conclusion

This study found good agreement between actigraphy and self-reported TST and WASO. The number of awakenings had relatively poor agreement, as well as a highly significant trend with increasing discrepancy with higher NA. Finally, SE had fair agreement when considering good sleepers, but with increasing discrepancy for lower SE. The general trend is that diary reported measures are lower for WASO, NA, TST and SE compared to actigraphy. More research is needed to validate the use of a standardized sleep diary such as CSD, especially in different study populations. Lastly, an aggregated MAD was unable to predict any of the sleep parameters. The limitations of MAD and the use of aggregated data when investigating the association between sleep and shift work are discussed.

The results of this study are of less significance for the general population. On the other hand, this study is a small contribution towards greater knowledge in the work of improving the working condition for shift workers and understanding the relationship between shift work and sleep. The research also makes a small contribution to the validation of the CSD. In the long term this knowledge may contribute to better quality of life for shift workers through health promotion interventions and improvements in shift work schedules.

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Appendix 1

Spørreskjema om skiftarbeid og helseplager, Statens arbeidsmiljøinstitutt

Skiftarbeid og helseplager

Statens arbeidsmiljøinstitutt (STAMI) er ansvarlig for oppbevaring av opplysningene.

Opplysningene skal brukes til å forske på hvilke konsekvenser skiftarbeid kan ha for helsa.

Alle forskere som skal analysere de innsamlede opplysningene har underskrevet taushetserklæring og har avtale med Ressurssenteret ved STAMI, som har ansvaret for at den enkelte besvarelse forblir konfidensiell og sikkert oppbevart.

Det er frivillig å gi opplysningene. Du kan kreve innsyn i hva som er lagret om deg og du kan kreve å rette feil og å slette opplysningene.

Spørreundersøkelsen tar om lag 30 minutter å besvare. Undersøkelsen inneholder i hovedsak spørsmål som besvares med avkrysning av et eller flere mulige alternativer. I noen spørsmål er det ikke oppgitt svaralternativer og disse besvares med tall eller ord.

Ved å begynne å besvare spørreskjemaet erklærer du å ha lest informasjonen om studien og du samtykker i å delta i spørreundersøkelsen (Del 1, beskrevet i informasjonen om studien).

Løpenummer

Viktig informasjon om utfylling av spørreskjema

•Bruk knappene 'Forrige side' og 'Neste side' nederst i nettleseren for å bla i spørreskjemaet. IKKE bruk tilbakepilen øverst i nettleseren for å gå tilbake i spørreskjemaet.

•Husk at på noen sider må du scrolle ned for å se alle spørsmålene.

Bakgrunn

1. Kjønn:

Kvinne .. ☐ 1

Mann .... ☐ 2

2. Fødselsår:

1 9 ☐☐

3. Nåværende sivilstatus. *Sett bare ett kryss.*

Enslig .... ☐ 1

Gift eller samboende.......... ☐ 2

Separert eller skilt.......... ☐ 3

Enke eller enkemann..... ☐ 4

4. Hvor mange hjemmeboene barn under skolealder har du?

Ingen.. ☐ 1

1-2 .... ☐ 2

3 eller flere.. ☐ 3

5. Har du omsorgsansvar for pleietrengende (eldre, ektefelle)?

Ja .... ☐ 1

Nei.. ☐ 2

7. Hva er din offisielle yrkes tittel?

Sykepleier .... ☐ 1

Hjelpepleier .... ☐ 2

Jordmor ………………………………. ☐ 3

8. Hvilken type avdeling arbeider du på?

Intensiv/overvåkning .... ☐ 1

Sengepost.. ☐ 2

Annen sykehusavdeling......................... ☐ 3

Annet .... ☐ 4

Hvis annet spesifiser:

☐

	Ja	nei
Har du hatt sykemelding mer enn 2 uker de siste 6 måneder?	☐	☐
Er du i permisjon?	☐	☐
For kvinner: Er du gravid?	☐	☐
For kvinner: Ammer du?	☐	☐

For å sende deg påminnelser om dagboken trenger vi mobilnummeret ditt.

Mobil nummer (8 siffer):

Er mobiltelefonen en smarttelefon?

Ja ☐

Nei ☐

Vet ikke ☐

For å motta en link til dagboken trenger vi epostadressen din. Vennligst oppgi epostadressen din under:

Søvn

Tretthet

Spørsmålene gjelder din vanlige måte å reagere på i den senere tid. Selv om du ikke har gjort noe av dette i den siste tiden, så prøv likevel å finne ut hvordan situasjonene ville virke på deg.

8. Hvor sannsynlig er det at du døser av eller sovner i følgende situasjoner, i motsetning til kun å føle deg trett?

		Ville aldri døse/sovne	*En liten sjanse for å døse/sovne*	*Moderat sjanse for å døse/sovne*	*Stor sjanse for å døse/sovne*
a)	Sitte og lese	☐	☐	☐	☐
b)	Se på TV	☐	☐	☐	☐
c)	Sitte, inaktiv på et offentlig sted (f.eks. på teater eller et møte)	☐	☐	☐	☐
d)	Som passasjer på en én-times biltur uten pause	☐	☐	☐	☐
e)	Legge deg for å hvile om ettermiddagen hvis omstendighetene tillater det	☐	☐	☐	☐
f)	Sitte og snakke med noen	☐	☐	☐	☐
g)	Sitte stille etter lunsj (uten å ha inntatt alkohol)	☐	☐	☐	☐
h)	I en bil, som har stoppet for noen få minutter i trafikken	☐	☐	☐	☐

Døgnrytme

Vennligst svar på hvert spørsmål ved å sette et kryss i den ruten som best passer for deg.

9. Når ville du foretrukket å stå opp hvis du hadde en full dags jobb (8 timer) og kunne velge arbeidstiden selv?
   - før 0630 ☐ 1
   - 0630-0729 ☐ 2
   - 0730-0829 ☐ 3
   - 0830 eller senere ☐ 4

10. Når ville du foretrukket å legge deg hvis du hadde en full dags jobb (8 timer) og kunne velge arbeidstiden selv?
   - før 2100 ☐ 1
   - 2100-2159 ☐ 2
   - 2200-2259 ☐ 3
   - 2300 eller senere ☐ 4

11. Hvis du alltid måtte legge deg kl 2400, hvordan ville det da være å sovne inn?
   - veldig vanskelig, ville ligget våken lenge ☐ 1
   - ganske vanskelig, ville ligget våken en stund ☐ 2
   - ganske lett, ville sovnet etter en kort stund ☐ 3
   - lett, ville sovnet praktisk talt med en gang ☐ 4

12. Hvis du alltid måtte stå opp kl 0600, hvordan ville dette vært?
   - veldig vanskelig og ubehagelig ☐ 1
   - ganske vanskelig og ubehagelig ☐ 2
   - litt ubehagelig, men ikke noe stort problem ☐ 3
   - lett – ikke et problem i det hele tatt ☐ 4

13. Når begynner du vanligvis først å merke at du er trøtt og har behov for søvn?
   - før 2100 ☐ 1
   - 2100-2159 ☐ 2
   - 2200-2259 ☐ 3
   - 2300 eller senere ☐ 4

14. Etter at du har stått opp om morgenen, hvor lang tid tar det før du fungerer helt bra?
   - 0-10 min ☐ 1
   - 11-20 min ☐ 2
   - 21-40 min ☐ 3
   - mer enn 40 min ☐ 4

15. I hvilken grad du er en morgen- eller kveldsaktiv person?
   - Veldig morgenaktiv (opplagt om morgenen og trøtt om kvelden) ☐ 1
   - Til en viss grad morgenaktiv ☐ 2
   - Til en viss grad kveldsaktiv ☐ 3
   - Veldig kveldsaktiv (morgentrøtt og kveldsaktiv) ☐ 4

Søvn

Følgende spørsmål har med ditt vanlige søvnmønster *den siste måneden* å gjøre. Du skal svare på hva som er mest riktig for de fleste dager hvor du ikke er på nattarbeid men sover på natten. Vennligst svar på alle spørsmål.

16. I løpet av den siste måneden, når har du vanligvis lagt deg om kvelden?
    Vanlig leggetid ⇨ ☐☐:☐☐

17. I løpet av den siste måneden, hvor lang tid (i minutter) har det vanligvis tatt deg å sovne om kvelden? ☐

Antall minutter ⇨ ☐☐☐

18. I løpet av den siste måneden, når har du vanligvis stått opp om morgenen?
Vanligvis stått opp kl ⇨ ☐☐:☐☐

19. I løpet av den siste måneden, hvor mange timer søvn har du faktisk fått om natten? (Dette kan være forskjellig fra hvor mange timer du oppholdt deg i sengen.)
Antall timer søvn hver natt ⇨ ☐☐

For hvert av de følgende spørsmål, kryss av for det beste svaret. Vennligst svar på *alle* spørsmålene.

20. I løpet av den siste måneden, hvor ofte har du hatt problemer med søvnen fordi du…

	Ikke i løpet av den siste måneden 1	*Mindre enn en gang i uken* 2	*En eller to ganger i uken* 3	*Tre eller flere ganger i uken* 4
a) Ikke klarer å sovne i løpet av 30 minutter	☐	☐	☐	☐
b) Våkner opp midt på natten eller tidlig om morgenen	☐	☐	☐	☐
c) Må opp for å gå på toalettet	☐	☐	☐	☐
d) Ikke klarer å puste ordentlig	☐	☐	☐	☐
e) Hoster eller snorker høyt	☐	☐	☐	☐
f) Føler deg for kald	☐	☐	☐	☐
g) Føler deg for varm	☐	☐	☐	☐
h) Har vonde drømmer	☐	☐	☐	☐
i) Har smerter	☐	☐	☐	☐

j) Andre grunner, vennligst beskriv ____

____

Hvor ofte har du hatte problemer med søvnen på grunn av dette?	☐	☐	☐	☐

21. I løpet av den siste måneden, hvordan vil du bedømme søvnkvaliteten din totalt sett?

- Veldig bra ☐
- Ganske bra ☐
- Ganske dårlig ☐
- Veldig dårlig ☐

	Ikke i løpet av den siste måneden	Mindre enn en gang i uken	En eller to gange i uken	Tre eller flere gange i uken
22. I løpet av den siste måned, hvor ofte har du tatt medisin (med eller uten resept) som hjelp til å sove?	☐	☐	☐	☐
23. I løpet av den siste måned, hvor ofte har du hatt problemer med å holde deg våken under bilkjøring, måltider eller når du holder på med sosiale aktiviteter?	☐	☐	☐	☐

24. I løpet av den siste måneden, hvor stort problem har det vært for deg å ha overskudd nok til å få ting gjort?

Ikke noe problem i det hele tatt .... ☐
Bare et lite problem .... ☐
Et visst problem.. ☐
Et stort problem.. ☐

25. Deler du seng eller rom med noen?

Deler ikke seng eller rom med noen................. ☐
Partner/romkamerat i annet rom .... ☐
Partner i samme rom, men ikke i samme seng . ☐
Partner i samme seng .... ☐

Hvis du har en partner eller romkamerat, spør han/henne hvor ofte i løpet av den siste måneden du har hatt…

	Ikke i løpet av den siste måneden	Mindre end en gang i uken	En eller to gange i uken	Tre eller flere gange i uken
a) høy snorking	☐	☐	☐	☐
b) lange pustestopp under søvnen	☐	☐	☐	☐
c) rykninger eller sammentrekninger i beina under søvnen	☐	☐	☐	☐
d) episoder med desorientering eller forvirring under søvnen	☐	☐	☐	☐

e) annen type uro under søvnen; vennligst beskriv____

____

Hvis det er annen type uro under søvnen, hvor ofte har du hatt den i løpet av den siste måneden?………... ☐ .... ☐ .... ☐ .... ☐

På spørreskjemaet under er det 6 spørsmål knyttet til søvn og tretthet. Vær vennlig å sett ring rundt det alternativet (antall dager pr. uke) som passer best for deg. 0 er ingen dager i løpet av en uke, 7 er alle dager i løpet av en uke.

Eksempel

Hvis du 3 dager i løpet av en uke har brukt mer enn 30 minutter på å sovne etter at du har slukket lyset, setter du ring rundt alternativ 3.

I løpet av den siste måneden, hvor mange dager pr. uke har du brukt mer enn 30 minutter for å sovne inn etter at lyset ble slukket	1 2 (3) 4 5 6 7

26.	I løpet av den siste måneden, hvor mange dager pr. uke har du brukt mer enn 30 minutter for å sovne inn etter at lyset ble slukket	1 2 3 4 5 6 7
27.	I løpet av den siste måneden, hvor mange dager pr. uke har du vært våken mer enn 30 minutter innimellom søvnen.	1 2 3 4 5 6 7
28	I løpet av den siste måneden, hvor mange dager pr. uke har du våknet mer enn 30 minutter tidligere enn du har ønsket uten å få sove igjen?	1 2 3 4 5 6 7
29	I løpet av den siste måneden hvor mange dager pr. uke har du følt deg for lite uthvilt etter å ha sovet.	1 2 3 4 5 6 7
30	I løpet av den siste måneden, hvor mange dager pr. uke har du vært så søvnig/trett at det har gått ut over skole/jobb eller privatlivet?	1 2 3 4 5 6 7
31	I løpet av den siste måneden, hvor mange dager pr. uke har du vært misfornøyd med søvnen din?	1 2 3 4 5 6 7

Har du en arbeidstidsordning som jevnlig overlapper med tidspunkt du vanligvis sover

Ja..................

Nei..............

Hvis ja, forårsaker dette søvnløshet og/eller søvnighet som følge av redusert søvnmengde?

Ja.............

Nei..................

Hvis ja, har dette vart i minst 3 måneder

Ja.................

Nei..............

Helse og livsstil

39. Din høyde? *(Antall cm)* ⇨ ☐☐☐ cm.

40. Din vekt? *(Antall kilo)* ⇨ ☐☐☐ kilo

Alkohol- og røykevaner, medisinbruk og koffeininntak

32. Røyker du?
Bare ett kryss
Nei ☐ 1
Ja ☐ 2

33. Hvis ja, hvor mange sigaretter pr dag? ⇨ ☐☐ sigaretter

34. Snuser du?
Bare ett kryss
Nei ☐ 1
Ja ☐ 2

35. Hvis ja, hvor mange porsjoner pr dag? ⇨ ☐☐ porsjoner

36. Hvor ofte drikker du alkohol?

Aldri ☐ 1
En gang pr måned eller sjeldnere ☐ 2
To til fire ganger i måneden ☐ 3
To til tre ganger i uken ☐ 4
Fire ganger i uken eller mer ☐ 5

37. Hvor mange alkoholenheter (dvs. en drink, et glass vin eller liten flaske øl) drikker du vanligvis når nyter alkohol?

1-2 ☐ 1
3-4 ☐ 2
5-6 ☐ 3
7-9 ☐ 4
10 eller flere ☐ 5

38. Hvor ofte drikker du seks alkoholenheter eller mer på en gang?

Aldri ☐ 1
Sjeldnere enn månedlig ☐ 2
Noen ganger i måneden ☐ 3
Noen ganger i uken ☐ 4
Daglig eller nesten daglig ☐ 5

41. På et dagskift*:*

Hvor mange kopper kaffe/te/cola eller andre drikker (med koffein-innhold) drikker du vanligvis i løpet av vakten? (samlet antall kopper) .... ⇨ ☐☐ kopper

På et kveldsskift:

Hvor mange kopper kaffe/te/cola eller andre drikker (med koffein-innhold) drikker du vanligvis i løpet av vakten? (samlet antall kopper) .... ⇨ ☐☐ kopper

På et nattskift:

Hvor mange kopper kaffe/te/cola eller andre drikker (med koffein-innhold) drikker du vanligvis i løpet av vakten? (samlet antall kopper) .... ⇨ ☐☐ kopper

42. *På en fridag:*

Hvor mange kopper kaffe/te/cola eller andre drikker (med koffein-innhold) drikker du vanligvis i løpet av en dag? (samlet antall kopper) .... ⇨ ☐☐ kopper

Bruker du noen av følgende medisiner fast?

- Smertestillende/antiinflammatorisk ☐
- Antidepressiv medisiner ☐
- P-piller ☐

Fysisk aktivitet

Med fysisk aktivitet mener vi aktiviteter som gjør at du en del av tiden får økt puls og blir andpusten. Eksempler på fysisk aktivitet er å gå fort, løpe, sykle, svømme, danse, ballspill, aerobics, eller styrketrening med eller uten treningsapparater/vekter.

111. Hvor mange <u>ganger i uken</u> driver du fysisk aktivitet så mye at du blir andpusten og/eller svett?

- Aldri.. ☐1
- Sjeldnere enn en gang i uka .... ☐2
- En gang i uka .... ☐3
- 2 – 3 ganger i uka .... ☐4
- Omtrent hver dag .... ☐5
- Flere ganger om dagen...................................... ☐6

112. Hvor mange <u>timer i uken</u> driver du idrett eller mosjonerer du så mye at du blir andpusten og/eller svett?

Avrund til nærmeste hele time.......... ⇨ ☐☐ timer

114. Hvor ofte gjør du øvelser eller trener du for å forebygge eller behandle plager i rygg, nakke, skuldre, armer, eller for å forebygge annen sykdom?

- Aldri.. ☐1
- 1-4 ganger i måneden....................................... ☐2
- 1-2 ganger i uken.. ☐3
- 2-4 ganger i uken.. ☐4
- Mer enn fire ganger i uken................................ ☐5

Symptomer og plager

På spørreskjemaet under blir du spurt om 11 ulike symptomer og plager. For hver plage skal du sette ett kryss i kategorien "plagens intensitet". Hvis plagens intensitet er "litt plaget", "en del plaget" eller "alvorlig plaget" skal du også krysse av i kategoriene for varighet, aktivitet og evt. gi en kommentar.

Symptomer og plager siste måned

	Plagenes intensitet				**Varighet totalt (dager)**			**Plager og aktivitet** (sett evt flere kryss per linje)				**Kommentarer**
	Ikke plaget	Litt plaget	En del plaget	Alvorlig plaget	1-10	11-20	21-31	Plager om natten	Plager i hvile	Plager ved aktivitet	Plager på jobben	Var det bestemte ting som utløste eller forverret plagene
Hodepine												
Nakkesmerter												
Smerter venstre skulder												
Smerter høyre skulder												
Smerter venstre underarm												

	Plagenes intensitet				Varighet totalt (dager)			Plager og aktivitet (sett evt flere kryss per linje)				Kommentarer
	Ikke plaget	Litt plaget	En del plaget	Alvorlig plaget	1-10	11-20	21-31	Plager om natten	Plager i hvile	Plager ved aktivitet	Plager på jobben	Var det bestemte ting som utløste eller forverret plagene
Smerter høyre underarm												
Smerter venstre håndledd, hånd												
Smerter høyre håndledd, hånd												
Smerter rygg												
Brystsmerter												
Smerter i bena												
Kvalme												
Oppkast												
Løs avføring, Diaré												

	Plagenes intensitet				Varighet totalt (dager)			Plager og aktivitet (sett evt flere kryss per linje)				Kommentarer
	Ikke plaget	Litt plaget	En del plaget	Alvorlig plaget	1-10	11-20	21-31	Plager om natten	Plager i hvile	Plager ved aktivitet	Plager på jobben	Var det bestemte ting som utløste eller forverret plagene
Forstoppelse												
Magesmerter eller mageknip												
Magekatarr eller sure oppstøt												
Hjertebank												
Eksem og utslett												
Kløe eller svie i øyne												
Pustevansker eller asthma												
Hoste												
Forkjølelse												

	Plagenes intensitet				Varighet totalt (dager)			Plager og aktivitet (sett evt flere kryss per linje)				Kommentarer
	Ikke plaget	Litt plaget	En del plaget	Alvorlig plaget	1-10	11-20	21-31	Plager om natten	Plager i hvile	Plager ved aktivitet	Plager på jobben	Var det bestemte ting som utløste eller forverret plagene
Søvnvansker												
Tretthet												
Svimmelhet												
Uro												
Nedtrykthet, depresjon												
Angst												
Hvis du har migrene: Anfall												
Skader siste mnd	Beskriv:											

Arbeidstid

6. Hvilken vakttyper arbeider du i for tiden?
   - Bare dag ☐ 1
   - Bare kveld ☐ 2
   - Bare natt ☐ 3
   - 2-delt ☐ 4
   - 3-delt ☐ 5

Hva er din stillingsprosent? (skriv et tall mellom 0 og 100)

☐

17. Hvordan trives du totalt sett med den arbeidstidsordningen du har nå?

    Bare ett kryss ⇨
    - Veldig dårlig ☐ 1
    - Ganske dårlig ☐ 2
    - Verken bra eller dårlig ☐ 3
    - Ganske bra ☐ 4
    - Veldig bra ☐ 5

18. Hvor mye medbestemmelse opplever du at du personlig har når det gjelder denne arbeidstidsordningen?

    Bare ett kryss ⇨
    - Ingen ☐ 1
    - Litt ☐ 2
    - Noe ☐ 3
    - Mye ☐ 4
    - Svært mye ☐ 5

Hvor mange uker går turnusen din over? ☐☐

Hvor mange år har du arbeidet som sykepleier? ☐☐

Hvor mange år har du arbeidet i turnus som inkluderer nattearbeid? ☐☐

Cirka hvor mange netter har du arbeidet de siste 12 måneder? ☐☐

Hvor mange timer har du arbeidet overtid i de siste 4 ukene? ☐☐

Har du annet lønnet arbeid? Nei ☐ Ja ☐

Hvis ja, inkludere det nattearbeid? Nei ☐ Ja ☐

Er det tilrettelagt for å ta en høneblund i arbeidstiden på natten?

Nei ☐
Ja ☐

	Meget sjelden eller aldri 1	Nokså sjelden 2	Av og til 3	Nokså ofte 4	Meget ofte eller alltid 5
b. Hvor ofte hender det at du benytter deg av muligheten til å ta en høneblund i arbeidstiden på natten?	☐	☐	☐	☐	☐

Har du noen gang mulighet for at sove på vakt?

Ja ☐
Nei ☐

Hvor mange dager pr uke rekker du ikke å ta matpause?

0	1	2	3	4	5
☐	☐	☐	☐	☐	☐

Arbeidsmiljø[6]

Psykososialt arbeidsmiljø

Jobbkrav

I hvilken grad passer disse utsagnene for deg?

Sett ett kryss på hver linje.

	Meget sjelden eller aldri 1	Nokså sjelden 2	Av og til 3	Nokså ofte 4	Meget ofte eller alltid 5
1. Er arbeidsbelastningen din ujevn slik at arbeidet hoper seg opp?	☐	☐	☐	☐	☐
2. Må du arbeide overtid?	☐	☐	☐	☐	☐
3. Er det nødvendig å arbeide i et høyt tempo?	☐	☐	☐	☐	☐
4. Har du for mye å gjøre?	☐	☐	☐	☐	☐

Rolleforventninger

I hvilken grad passer disse utsagnene for deg?

Sett ett kryss på hver linje.

	Meget sjelden eller aldri 1	Nokså sjelden 2	Av og til 3	Nokså ofte 4	Meget ofte eller alltid 5
4. Må du gjøre ting som du mener burde vært gjort annerledes?	☐	☐	☐	☐	☐
5. Får du oppgaver uten tilstrekkelige hjelpemidler og ressurser til å fullføre dem?	☐	☐	☐	☐	☐
6. Mottar du motstridende forespørsler fra to eller flere personer?	☐	☐	☐	☐	

Kontroll i arbeidet

I hvilken grad passer disse utsagnene for deg?

Sett ett kryss på hver linje.

	Meget sjelden eller aldri 1	Nokså sjelden 2	Av og til 3	Nokså ofte 4	Meget ofte eller alltid 5
1. Hvis det finnes flere forskjellige måter å utføre arbeidet ditt på, kan du selv velge hvilken framgangsmåte du skal bruke?	☐	☐	☐	☐	☐
2. Kan du påvirke mengden av arbeid som blir tildelt deg?	☐	☐	☐	☐	☐
3. Kan du selv bestemme ditt arbeidstempo?	☐	☐	☐	☐	☐
4. Kan du selv bestemme når du skal ta pauser?	☐	☐	☐	☐	☐
5. Kan du selv bestemme lengden på pausene dine?	☐	☐	☐	☐	☐
6. Kan du selv bestemme arbeidstiden din (fleksitid)?	☐	☐	☐	☐	☐
7. Kan du påvirke avgjørelser om hvilke personer som du skal samarbeide med?	☐	☐	☐	☐	☐
8. Kan du selv bestemme når du skal ha kontakt med pasienter?	☐	☐	☐	☐	☐
9. Kan du påvirke beslutninger som er viktige for ditt arbeid?	☐	☐	☐	☐	☐

Ledelsen

81. I hvilken grad passer disse utsagnene for deg?

Sett ett kryss på hver linje

	Meget sjelden eller aldri 1	Nokså sjelden 2	Av og til 3	Nokså ofte 4	Meget ofte eller alltid 5
1. Oppmuntrer din nærmeste leder deg til å delta i viktige avgjørelser?	☐	☐	☐	☐	☐
2. Oppmuntrer din nærmeste leder deg til å si fra når du har en annen mening?	☐	☐	☐	☐	☐
3. Prøver din nærmeste sjef å løse problemer med en gang de dukker op?	☐	☐	☐	☐	☐
4. Fordeler din nærmeste leder arbeidsoppgaver rettferdig og upartisk?	☐	☐	☐	☐	☐
5. Behandler din nærmeste leder de ansatte rettferdig og upartisk?	☐	☐	☐	☐	☐
6. Er forholdet mellom deg og din nærmeste leder en kilde til stress for deg?	☐	☐	☐	☐	☐

Organisasjonsklima

82. Hvordan er klimaet i din arbeidsenhet?

Ett kryss på hver linje.

	Svært lite eller ikke i det hele tatt 1	Nokså lite 2	Noe 3	Nokså meget 4	Svært meget 5
1. Konkurranseorientert	☐	☐	☐	☐	☐
2. Oppmuntrende og støttende	☐	☐	☐	☐	☐
3. Mistroisk og mistenksomt	☐	☐	☐	☐	☐
4. Avslappet og behagelig	☐	☐	☐	☐	☐
5. Stivbeint og regelstyrt	☐	☐	☐	☐	☐

Fysisk arbeidsmiljø

I spørsmålene under betyr "dag" eller "arbeidsdag" en arbeidsvakt.Angi dine fysiske arbeidsbelastninger for en gjennomsnittlig arbeidsvakt med mindre du blir spurt om en bestemt vakttype.

1. a) Er du i ditt daglige arbeid utsatt for vibrasjoner som får hele kroppen til å riste, for eksempel fra traktor, truck eller annen arbeidsmaskin? ❑ JA ❑NEI

   b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen?

   ❑ Nesten hele tiden

   ❑ Ca ¾ av tiden

   ❑ Ca halvparten av tiden

   ❑ Ca ¼ av tiden

   ❑ Svært liten del av tiden

2. a) Er du i ditt daglige arbeid utsatt for vibrasjoner fra maskiner eller verktøy som du holder med hendene? ❑ JA ❑NEI

   b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen?

   ❑ Nesten hele tiden

   ❑ Ca ¾ av tiden

   ❑ Ca halvparten av tiden

   ❑ Ca ¼ av tiden

   ❑ Svært liten del av tiden

3. a) Arbeider du slik at du tar i så hardt at du puster raskere? ❑ JA ❑NEI

   b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen?

   ❑ Nesten hele tiden

   ❑ Ca ¾ av tiden

   ❑ Ca halvparten av tiden

   ❑ Ca ¼ av tiden

   ❑ Svært liten del av tiden

4. a) Må du sitte på huk eller stå på knærne når du arbeider? ❑ JA ❑NEI

   b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen?

   ❑ Nesten hele tiden

   ❑ Ca ¾ av tiden

   ❑ Ca halvparten av tiden

   ❑ Ca ¼ av tiden

   ❑ Svært liten del av tiden

5. a) Må du løfte i ubekvemme stillinger? ❑ JA ❑NEI

b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen?

❑ Nesten hele tiden

❑ Ca ¾ av tiden

❑ Ca halvparten av tiden

❑ Ca ¼ av tiden

❑ Svært liten del av tiden

6. a) Arbeider du stående? ❑ JA ❑NEI

b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen?

❑ Nesten hele tiden

❑ Ca ¾ av tiden

❑ Ca halvparten av tiden

❑ Ca ¼ av tiden

❑ Svært liten del av tiden

7. Hvor lenge arbeider du sittende en vanlig arbeidsdag?

❑ Aldri

❑ Svært liten del av tiden

❑ Ca ¼ av tiden

❑ Ca halvparten av tiden

❑ Ca ¾ av tiden

❑ Nesten hele tiden

8. a) Arbeider du med hendene løftet i høyde med skuldrene eller høyere? ❑ JA ❑NEI

b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen du gjør dette?

❑ Nesten hele tiden

❑ Ca ¾ av tiden

❑ Ca halvparten av tiden

❑ Ca ¼ av tiden

❑ Svært liten del av tiden

9. a) Arbeider du i fremoverbøyde stillinger uten å støtte deg med hendene eller armene? ❑ JA ❑NEI

   b) Hvis ja, kan du anslå hvor stor del av tiden du gjør dette?

   ❑ Nesten hele tiden

   ❑ Ca ¾ av tiden

   ❑ Ca halvparten av tiden

   ❑ Ca ¼ av tiden

   ❑ Svært liten del av tiden

10. a) Hvis ja på spørsmål 75a, arbeider du i slike stillinger med ryggen kraftig vridd?

    ❑ JA ❑NEI

    b) Hvis ja, når du arbeider slik må du da løfte noe som veier mer enn 10kg? ❑ JA ❑NEI

11. a) Arbeider du med hodet bøyd fremover? ❑ JA ❑NEI

    b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen du gjør dette?

    ❑ Nesten hele tiden

    ❑ Ca ¾ av tiden

    ❑ Ca halvparten av tiden

    ❑ Ca ¼ av tiden

    ❑ Svært liten del av tiden

12. a) Arbeider du med gjentatte og ensidige hånd- eller armbevegelser? ❑ JA ❑NEI

    b) Hvis ja, kan du anslå hvor stor del av arbeidsdagen du gjør dette?

    ❑ Nesten hele tiden

    ❑ Ca ¾ av tiden

    ❑ Ca halvparten av tiden

    ❑ Ca ¼ av tiden

    ❑ Svært liten del av tiden

13. Må du daglig løfte noe som veier mer enn 20kg, og i tilfellet hvor mange ganger per dag?

    ❑ Ja, minst 20 ganger hver dag

    ❑ Ja, 5-19 ganger

    ❑ Ja, 1-4 ganger

    ❑ Nei

14. Innebærer dine arbeidsoppgaver at du utsettes for plutselige uventede store belastninger?
   - ❑ Sjelden eller aldri
   - ❑ Noe
   - ❑ Ofte

15. I hvilken består arbeidsoppgavene dine av å skyve eller dra personer eller tunge gjenstander som veier mer enn 50 kg.
   - ❑ Sjelden eller aldri
   - ❑ Av og til
   - ❑ Daglig
   - ❑ mange ganger daglig

16. Hvor fysisk tung opplever du vanligvis din arbeidssituasjon?
   Sett kun ett kryss

	0❑
Meget, meget lett	1❑
	2❑
Meget lett	3❑
	4❑
Ganske lett	5❑
	6❑
Noe anstrengende	7❑
	8❑
Anstrengende	9❑
	10❑
Svært anstrengende	11❑
	12❑
Svært, svært anstrengende	13❑
	14❑

17. Hvor mange ganger per **dag**skift gjør du følgende aktivitet:

Sett kun ett kryss per linje

	Antall ganger per skift			
Manuell forflytning av pasient i sengen	❑ 0	❑1-4	❑5-9	❑10 eller mer
Løfter eller støtter pasienter mellom seng og stol	❑ 0	❑1-4	❑5-9	❑10 eller mer
Løfter, bærer eller dytter tunge gjenstander	❑ 0	❑1-4	❑5-9	❑10 eller mer

18. Hvor mange ganger per **kveld**skift gjør du følgende aktivitet:

Sett kun ett kryss per linje

	Antall ganger per skift			
Manuell forflytning av pasient i sengen	❑ 0	❑1-4	❑5-9	❑10 eller mer
Løfter eller støtter pasienter mellom seng og stol	❑ 0	❑1-4	❑5-9	❑10 eller mer
Løfter, bærer eller dytter tunge gjenstander	❑ 0	❑1-4	❑5-9	❑10 eller mer

19. Hvor mange ganger per **natt**skift gjør du følgende aktivitet:

Sett kun ett kryss per linje

	Antall ganger per skift			
Manuell forflytning av pasient i sengen	❑ 0	❑1-4	❑5-9	❑10 eller mer
Løfter eller støtter pasienter mellom seng og stol	❑ 0	❑1-4	❑5-9	❑10 eller mer
Løfter, bærer eller dytter tunge gjenstander	❑ 0	❑1-4	❑5-9	❑10 eller mer

Samtykke til del 2 og 3 av studien

Du kan velge å unnlate å samtykke til del 2 og 3 av studien. Du kan også velge og bare samtykke til én av delene eller velge å samtykke til begge deler.

Selv om du ikke velger å samtykke til del 2 og/eller 3 er din deltakelse i del 1, dette spørreskjemaet + mobildagbok, fortsatt viktig.

Del 2

En gruppe av deltakerne blir trukket ut tilfeldig til å avgi inntil seks blod-, urin-, eller spyttprøver og til å bære aktivitetsmåler (se samtykkeerklæring for nærmere informasjon om dette).

Jeg er villig til å avgi spytt-, urin og blodprøver samt å bære aktivitetsmåler, dersom jeg blir trukket ut til dette

Ja... ☐ 1
Nei .... ☐ 2

Del 3

I framtiden kan det bli aktuelt å koble opplysningene som er oppgitt i denne undersøkelsen til registre.
Dersom du tillater at opplysningene i denne undersøkelsen kan kobles til registre (registre kan være forløpsdatabasen trygd (FD-trygd) fra Statistisk sentralbyrå og registrene i NAV, for eksempel om yrkesdeltakelse, sykefravær, diagnoser, uførhet og andre offentlige ytelser) kan du krysse av nedenfor.

Jeg samtykker i at opplysningene som jeg har gitt i denne undersøkelsen kan kobles med registre

Ja... ☐ 1
Nei .... ☐ 2

Appendix 2

Dagbok- generelle instruksjoner

Hva er formålet med dagboken? Dagboken er laget for å samle informasjon om ditt daglige søvnmønster.

Hva menes med siste døgn? Med siste døgn menes fra kl 21 den foregående kveld til kl 21 da du mottok tekstmeldingen med dagboken. Selv om du ikke fyller ut dagboken nøyaktig når tekstmeldingen kommer kl 21 er det fortsatt denne tidsperioden du skal svare for.

Hvor ofte og når skal jeg utfylle dagboken? Du skal fylle ut dagboken hver dag. Hvis det er mulig bør du fylle den ut omkring kl 21.

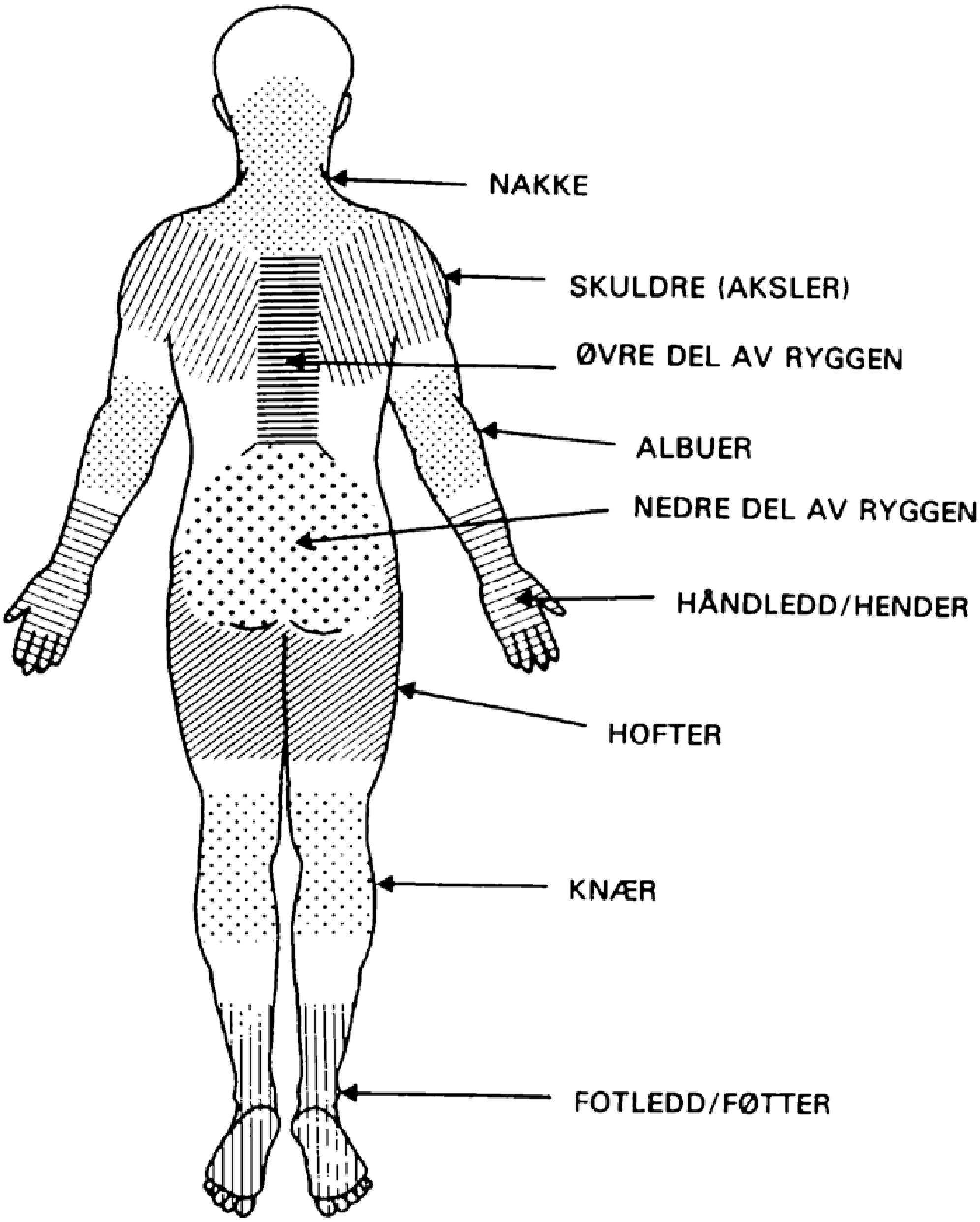
Hva gjør jeg hvis jeg glemmer en dag? Hvis du glemmer å utfylle dagboken hopper du over denne dagen og fyller ut neste dagbok som vanlig.

Hva hvis det skjer noe uvanlig som påvirker søvnen min eller som medfører at jeg er plaget av smerter i løpet av dagen? Hvis det oppstår en uvanlig hendelse (som sykdom, ulykke, nødssituasjon eller traume) som påvirker søvnen din eller medfører at du er plaget av smerter noteres dette i kommentarfeltet i slutten av dagboken.

Hva betyr ordene ”seng”, ”oppvåkning” og ”hovedsøvn” i dagboken? Denne dagboken er tilpasset personer som er våkne og sover på uvanlige tidspunkter. Ordet ”seng” betyr det sted du vanligvis sover. Ordet ”oppvåkning” betyr å våkne opp. En oppvåkning kan være en kort eller lengre avbrytelse av søvnen. ”Hovedsøvn” er den lengste søvnperiode i løpet av det siste døgnet. Dvs. har du sovet to lengre perioder i løpet av det siste døgn angis den lengste som hovedsøvn og den andre som ”søvn utenom siste hovedsøvn”.

Vil besvarelsen av disse spørsmålene holde meg våken? Det er vanligvis ikke noe problem. Du skal ikke bekymre deg om å angi presise tidspunkter og du skal ikke se på klokken. Bare gi ditt beste anslag.

Figuren under viser til ulike kroppsdeler og kan brukes som hjelpemiddel når du utfyller helsespørsmålene.



Instruksjoner til spørsmålene i dagboken

Veiledningen nedenfor forklarer hva du blir spurt om i hvert spørsmål i dagboken.

Helse

Angi symptomer og plager for det siste døgn Når du angir symptomer eller plager skal du tenke tilbake på siste døgn og markere det svaret som passer best for hvordan du totalt sett har hatt det. Det betyr at selv om du ikke har symptomer eller plager på det tidspunktet du fyller ut dagboken kan du angi at du har vært plaget tidligere i løpet av det siste døgnet.

Arbeidstid

Har du hatt fravær fra arbeid grunnet sykdom siste døgn? Angi om du har vært borte fra arbeid grunnet sykdom. Hvis du har dratt hjem fra arbeid tidligere enn planlagt på grunn av sykdom svarer du ”Ja”. Hvis du har vært syk på en fridag svarer du ”Nei”.

Har du vært på arbeid siste døgn? Hvis du har vært på arbeid det siste døgn svarer du ”Ja”. Hvis du har hatt fri eller hatt fravær fra arbeidet grunnet sykdom svarer du ”Nei” og hopper over de neste to spørsmål.

Hva var klokken da du startet arbeidsvakten? Dette spørsmål besvares kun hvis du har vært på arbeid i løpet av siste døgn. Angi tidspunktet vakten startet. Dette tidspunkt kan være i går hvis du har vært på nattevakt. Angi den faktiske arbeidstid, ikke den offisielle, hvis disse ikke stemmer overens.

Hva var klokken da du avsluttet siste arbeidsvakt? Skriv sluttidspunktet for siste arbeidsvakt. Hvis skjemaet utfylles mens du fortsatt er på kveldsvakt noterer du tidspunktet som vakten er planlagt avsluttet.

Søvn

Hva var klokken når du la deg i sengen? Angi tidspunktet du la deg i sengen. Dette behøver ikke være det samme tidspunkt som da du la deg til å sove.

Hva var klokken da du la deg for å sove? Angi det tidspunkt du la deg til å sove.

Hvor lang tid (i timer og minutter) tok det før du sovnet? Angi cirka hvor lang tid det tok deg å sovne fra du la deg til å sove.

Hvor mange ganger våknet du, <u>utenom</u> den siste gangen, da du sto opp? Angi hvor mange ganger du våknet mellom tidspunktet du sovnet og den siste gang du våknet.

Totalt, hvor lenge varte disse oppvåkningene? Hvor lang tid var du våken totalt mellom tidspunktet du sovnet og den siste gangen da du sto opp. For eksempel, hvis du våknet 3 ganger (20 minutter, 35 minutter og 15 minutter) legger du alle tidene sammen (20+35+15 = 70 minutter, da angir du 1 time og 10 minutter).

Hva var klokken da du våknet siste gang? Angi tidspunktet for den siste gangen du våknet.

Hva var klokken når du stod opp fra sengen etter hovedsøvnen? Angi det tidspunktet da du sto opp uten noen flere forsøk på å sovne. Dette tidspunktet kan være forskjellig fra din endelige oppvåkning (for eksempel kan du ha våknet kl 6:35 men ikke stått opp fra sengen før kl 7:20)

Våknet du tidligere enn du hadde planlagt? Hvis du våknet tidligere enn du ønsket eller hadde planlagt, svar ja. Hvis du for eksempel våknet av vekkeklokka, svar nei.

Hvor lenge (i timer og minutter) sov du utenom hovedsøvnen siste døgn? Angi hvor mye du sov utenom den angitte hovedsøvnen. Dette gjelder både høneblunder og lengre søvnperioder. Hvis du for eksempel har hatt to lengre søvnperioder angis lengden på den korteste perioden her. Den lengste perioden angis som hovedsøvn.

Hvordan var søvnen siste døgn? Angi din opplevelse av hvor godt du sov siste døgn, hovedsøvn og eventuell ekstrasøvn sett under ett.

Brukte du medisin (med eller uten resept) som hjelp til at sove? Hvis du brukte reseptpliktige medisiner eller andre medisiner, som for eksempel naturmedisiner, for å sove svarer du ja til dette spørsmål.

Kommentarer til helse, arbeidstid eller søvn: Her kan du skrive utfyllende opplysninger som gjelder punktene ovenfor. Feltet kan ikke brukes til å gi generelle tilbakemeldinger til forskningsgruppen.

Appendix 3

Statens arbeidsmiljøinstitutt

DAGBOK

(Ved eventuelt behov ligger mer utførlig forklaring her.)

Helse

Angi symptomer og plager i løpet av siste døgnet.

Smerter i nakken, skuldre eller øvre del av ryggen

- ○ **Ikke plaget**
- ○ **Litt plaget**
- ○ **Ganske plaget**
- ○ **Svært plaget**

Smerter i nedre del av ryggen

- ○ **Ikke plaget**
- ○ **Litt plaget**
- ○ **Ganske plaget**
- ○ **Svært plaget**

Smerter i armer, håndledd eller hender

- ○ **Ikke plaget**

- Litt plaget
- Ganske plaget
- Svært plaget

Smerter i hofter, ben, knær eller føtter

- Ikke plaget
- Litt plaget
- Ganske plaget
- Svært plaget

Hodepine

- Ikke plaget
- Litt plaget
- Ganske plaget
- Svært plaget

Magesmerter eller mageknip

- Ikke plaget
- Litt plaget
- Ganske plaget
- Svært plaget

Følelse av søvnighet

- Veldig opplagt
- Opplagt
- Verken opplagt eller søvnig
- Søvnig, men ikke anstrengende å være våken
- Veldig søvnig, anstrengende å være våken

Har du vært forkjølet eller hatt infeksjonssykdom siste døgn?

- Ja
- Nei

Arbeidstid

Har du hatt fravær fra arbeid grunnet sykdom siste døgn?

- Ja
- Nei

Har du vært på arbeid siste døgn?

- Nei
- Ja

Hvis 'Ja':
Hva var klokken da du startet arbeidsvakten?
00 : 00 (eks: 07:30)

Hva var klokken da du avsluttet arbeidsvakten?
00 : 00 (eks: 15:00)

Søvn

Angi for siste hovedsøvn:

Hva var klokken da du la deg i sengen?

00 : 00

Hva var klokken da du la deg for å sove?

00 : 00

Hvor lang tid tok det før du sovnet?

00 : 00

Hvor mange ganger våknet du, <u>utenom</u> den siste gangen, da du sto opp?

0

Totalt, hvor lenge varte disse oppvåkningene?

00 : 00

Hva var klokken da du våknet siste gang?

00 : 00

Hva var klokken da du sto opp fra sengen etter hovedsøvnen?

00 : 00

Våknet du tidligere enn du hadde planlagt?

- Ja
- Nei

Hvor mye sov du utenom hovedsøvnen siste døgn?

00 : 00

Hvordan var søvnen siste døgn?

- meget god
- god
- passelig
- dårlig
- svært dårlig

Brukte du medisin
(med eller uten resept)
eller alkohol som hjelp til å sove?

- Ja
- Nei

Kommentarer:

Send inn!

Appendix 4

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK sør-øst	Tone Gangnæs	22845520	06.03.2012	2012/199/REK sør-øst B
			Deres dato:	**Deres referanse:**
			17.01.2012	

Vår referanse må oppgis ved alle henvendelser

Dagfinn Matre

Statens arbeidsmiljøinstitutt
P.B. 8149 dep
Gydas vei 8
0033 Oslo

2012/199 B Skiftarbeid og smerte
Vi viser til søknad om forhåndsgodkjenning av ovennevnte forskningsprosjekt. Søknaden ble behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk i møtet 08.02.2012.

Forskningsansvarlig: Statens arbeidsmiljøinstitutt
Prosjektleder: Dagfinn Matre

Prosjektomtale (revidert av REK):
Formålet med studien er å undersøke hvordan søvnmangel forårsaket av skiftarbeid virker på muskelskjelettplager og smertefølsomhet. Hovedproblemstillingene er å bestemme om skiftarbeid øker følsomheten ved standardiserte laboratorietester på smerte (eksperimentell del) og å bestemme om skiftarbeid øker klinisk muskelskjelettsmerte (epidemiologisk del). Deltakere er friske personer og deltakelsen bygger på informert samtykke til studien.

Komiteens vurdering
Komiteen har ingen forskningsetiske innvendinger til studien.

Informasjonsskriv og samtykkeerklæring
Komiteen etterlyser at det i informasjonsskrivet til deltakerne bør gis informasjon om tidsbruken, da godtgjørelsen for tapt arbeidsfortjeneste sannsynligvis ikke vil være dekkende.
For den epidemiologiske delen bør det beskrives i informasjonsskrivet hvorledes uttrekket av 200 deltakere for ytterligere informasjonsinnhenting skal foregå og informasjon om at man vil kunne bli kontaktet på nytt igjen for ytterligere oppfølgingsstudie.

Spørreskjema
Til søknaden er det vedlagt et ikke endelig formatert spørreskjema og komiteen ber derfor om at skjemaet sendes komiteen til orientering når det foreligger i endelig versjon.

Vedtak
Komiteen godkjenner at prosjektet gjennomføres, jf. helseforskningsloven § 10. Komiteen ber om at revidert informasjonsskriv og endelig versjon av skjema sendes komiteen til orientering.

Godkjenningen er for øvrig gitt under forutsetning av at prosjektet gjennomføres slik det er beskrevet i søknaden, og i samsvar med de bestemmelser som følger av helseforskningsloven med forskrift.

Godkjenning gjelder til 01.06.2015.

Forskningsprosjektets data skal oppbevares forsvarlig, se personopplysningsforskriften Kap 2 og Helsedirektoratets veileder for ”Personvern og informasjonssikkerhet i forskningsprosjekter innenfor helse- og omsorgssektoren”. Opplysningene skal ikke oppbevares lenger enn det som er nødvendig for å gjennomføre prosjektet, deretter skal opplysningene anonymiseres eller slettes.

Dersom det skal gjøres endringer i prosjektet i forhold til de opplysninger som er gitt i søknaden, må prosjektleder sende endringsmelding til REK. Prosjektet skal sende sluttmelding på eget skjema, senest et halvt år etter prosjektslutt, jf. helseforskningsloven§ 12.

Komiteens vedtak kan påklages til Den nasjonale forskningsetiske komité for medisin og helsefag, jf. helseforskningsloven § 10, 3 ledd og forvaltningsloven § 28. En eventuell klage sendes til REK sør-øst B. Klagefristen er tre uker fra mottak av dette brevet, jf. forvaltningsloven § 29.

Vi ber om at alle henvendelser sendes inn via vår saksportal: http://helseforskning.etikkom.no eller på e-post til: post@helseforskning.etikkom.no.

Vennligst oppgi vårt referansenummer i korrespondansen.

Med vennlig hilsen

Stein Opjordsmoen Ilner (sign.)
professor dr. med.
komiteleder

Tone Gangnæs
seniorrådgiver

Kopi til: Forskningsansvarlig Statens arbeidsmiljøinstituttt ved: pal.molander@stami.no,>

Norges miljø- og biovitenskapelig universitet
Noregs miljø- og biovitskapelege universitet
Norwegian University of Life Sciences

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NO-1432 Ås
Norway