The influence of irregular work hours on employees' health and well-being in the 24-hour society

Amber van Leeuwen
ANR: 454299

Master thesis
Communication- and Information Sciences
Specialization Data Science: Business and Governance

Faculty of Humanities
Tilburg University, Tilburg

Supervisor: A.T. (Drew) Hendrickson
Second reader: C.D. (Chris) Emmery MSc

August 2017

Abstract

Due to digitization and changing customer demand, working during traditional office hours (from 7 a.m. to 6 p.m.) have become the exception rather than the rule. Employers increasingly require their employees to work irregular hours to adapt production and service systems to meet customer demand and keep up with technological developments. Previous research has shown that working irregular hours has an adverse impact on health. To broaden the knowledge on this topic, this study aimed to answer the question whether employees' health is affected by working irregular hours. This study differentiates itself from other research by classifying three aspects of health: subjective health, physical health and mental health. The effect of mediating factors such as gender, age, education and the degree to which work is physically or mentally demanding is also assessed. The overall findings of this study suggest that the impact of irregular work hours on health is less detrimental than expected. Regarding the potential mediating factors, the influences were different for all three aspects of health.

Key words: *employees' health, working irregular hours, subjective general health, physical health, mental health*

Table of Contents

1. Introduction

1.1 Introduction to the trend

A trend that has been identified by multiple researchers is that in the coming years more people will have to work outside regular office hours (Tinnilä, 2012). Regular office hours include the hours between 7 a.m. and 6 p.m. from Monday to Friday. It is even argued that working during the traditional office hours is becoming an exception rather than the rule (Vogel, Braungardt, Meyer, & Schneider, 2012). This trend of working irregular hours will affect how the world around us is functioning with influences on national- and global economies (Tinnilä, 2012).

Multiple explanations exist for the increasing work outside regular office hours (Vogel et al., 2012). The advances in Information- and Communication Technologies (ICT) in combination with the new generation of smart phones enables mobile phone users to be online 24/7. Due to these advances, customers have the ability to use online services irrespective of time and place. Customers decide when to use services and with what frequency, which leads to irregular user patterns during irregular work hours. In accordance to their usage, customers expect 24/7 online service. (Tinnilä, 2012). Consequently, it is essential for online processes to be running round-the-clock (Vogel et al., 2012). For example, updates or process checks must take place during irregular hours, such as during the weekend or night, as that will affect the customers the least. In addition to that, economic disadvantages occur when system downtime occurs and when a company cannot offer continuous availability of their services (Hessman, 2013).

As a result, employers require their employees to work irregular hours to adapt production/service systems to meet the customer demand and technical and organizational innovations (Costa, Åkerstedt, Nachreiner, Balieri, Carvalhais, Folkard, Dresen, Gadbois, Gartner, Sukalo, & Härmä, 2004). It is important to mention that these irregular work hours imply planned work hours, not overwork. This type of labor flexibility, where the employer has full authority concerning the work schedules, is referred to as company-oriented flexibility by Costa et al., (2004). They also distinguish individual-oriented flexibility, where employees control their working time. Moreover, they show this flexibility to be beneficial to the employee, since they are able to adapt their work schedule to their personal needs which improves their work-life balance. However, when discussing irregular work hours in the current study, company-oriented-flexibility is the type of flexibility that is referred to.

Even though it is argued that company-oriented-flexibility and round-the-clock productivity contributes to economic development (Vogel et al., 2012), the exact effect of working irregular hours on employees' health and well-being remains unclear (Costa et al., 2004). It is therefore of interest to the whole society to perform scientific research on this topic.

1.2 Effects on health and well-being

Regarding the association between irregular work hours and health and well-being, a great amount of research has focused specifically on shift work. The term "shift work" is used differently among research, referring to both work schedules existing of varying and irregular hours, as rotating work (Wang, Armstrong, Cairns, Key, & Travis, 2011). However, for the current research, studies have been reviewed that focused on schedules including irregular work hours with no specific focus on rotating shifts.

Most research examining the relation between irregular work hours and health has focused on work hour schedules including night hours, since these hours are said to interfere with human health (Costa, 2015). A study investigating the relation between night shifts and the risk of breast cancer, found that women working as few as three night shifts per month for multiple years already have a moderately increased risk of breast cancer. Women working night shifts for 30 or more years even showed a significant increase of breast cancer compared to women who have never worked night shifts (Schernhammer, et al., 2001).

The reason for this and other severe consequences is that people working irregular hours do not have a regular sleep/wake cycle (Costa, 2015). This disruption of the sleep/wake cycle may lead to significant stress for the rhythm of biological functions. Additionally, people may experience more difficulties managing family and social life while adapting to the changing and/or rotating work hours when they work in irregular hours. This may eventually result in mental complaints, such as anxiety and nervousness (Costa, 2015).

However, research has shown that the effect on health and well-being is dependent on the regularity of work during irregular hours (Costa, 2015). More specifically, the consequences of working irregular hours depend on the specific work hours and the time span one has to rest in between. When assessing the effect of irregular work hours on health and well-being, it is essential to include personal and work characteristics that might mediate the effect of work hour schedule on health. It important to take into consideration that the consequences on health are possibly not the effect of a single factor, but might rather derive from interactions of those factors (Costa, et al., 2004).

1.3 Current study

In this study, it will be explored through exploratory data analysis how different aspects of health are influenced by work hour schedules while considering potential mediating factors. The research question is: *'Is employees' health and well-being affected by working irregular hours?'.*

Even though a great amount of research has already examined the effect of irregular work hours on health and well-being, they mostly focused on work hour schedules including night hours (Åkerstedt & Wright, 2009; Bara & Arber, 2009; Hakola, Härmä, & Laitinen, 1996; Kuhn, 2001; Smith, Folkard, &

Fuller, 2003; Schernhammer, Laden, Speizer, Willett, Hunter, Kawachi, & Colditz, 2001; Zhu, Hjollund, Boggild, & Olsen, 2003). Rather than focusing on specific hours (day/night) or days (Monday-Friday/Weekend), the current study focuses on the regularity of people working irregular hours instead. The regularities are identified as three groups: (1) never work outside regular office hours, (2) sometimes work outside regular office hours and (3) often work outside regular office hours (Table 1). Note that the data used to determine the regularity of working irregular hours are based on the type of flexibility where the employer is in control of the schedules.

Furthermore, studies mostly focused on either one of the two types of health with a predominant focus on physical health, instead of including both physical- and mental health aspects (Åkerstedt & Wright, 2009; Costa, 2015; Ha & Park, 2005; Hublin, Partinen, Koskenvuo, Silventoinen, Koskenvuo, & Kaprio, 2010; Karlsson, Knutsson, & Lindahl, 2001; Kuhn, 2001; Lipscomb, Trinkoff, Geiger-Brown and Brady, 2002; Moline, Pollak, Monk, & Lester, 1992; Smith et al., 2003; Vogel et al., 2012; Zhu et al., 2003). The current study focusses on both aspects of health. To assess the effect of work hour schedule on health, subjective general health and the number of visits to health services will be analyzed. Concerning the health services, attention will be paid to the physical and mental health services separately (Figure 1, Table 1).

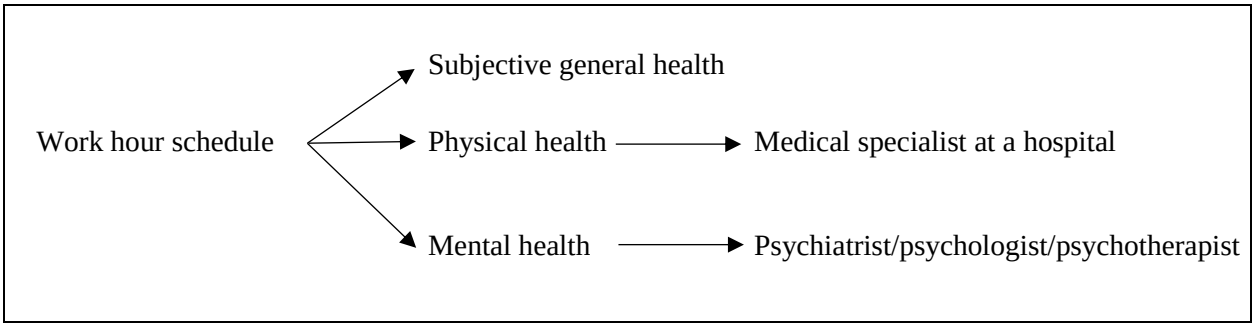


Figure 1. **Design of the independent variable (work hour schedule) and dependent variables (subjective general health, physical health and mental health).**

Additionally, related studies mostly focused on a limited amount of personal- or work characteristics. Studies for example included age in their analyses, though they solely assessed the effect on either men or women, instead of on both groups (Costa, 2015; Driesen et al., 2011, Moline et al., 1992; Zhu et al., 2003). For the current study, multiple characteristic will be included in the analyses that are expected to mediate the relation between the independent- and dependent variable (Table 1). As Figure 2 shows, the control variables are divided into two groups of factors that potentially mediate the effect of work hour schedule on health. The groups are personal characteristics and work characteristics. The first group includes gender, age and level of education. The second group, work characteristics, concerns information as to whether or not work is physically and/or mentally demanding.

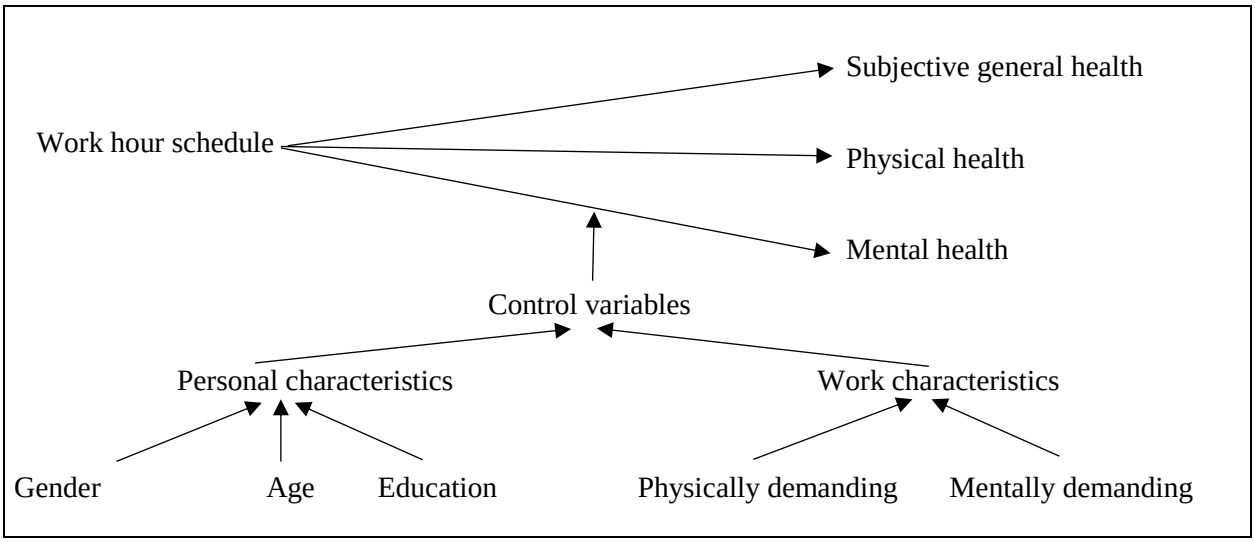


Figure 2. **Design of independent- and dependent variables including control variables.**

By including these potential mediating factors, more specific questions can be asked, such as whether an employee's age says something about the impact that irregular work hours will have, or whether gender plays a role when working specific hours. This information could be extremely relevant to employers. With the expansion of quick-response and round-the-clock service, the scheduling of employees has become a challenge, especially when taking personal preferences into account (Montreuil & Poulin, 2005).

Furthermore, the impact of work hour schedules on mental health is relevant, since depressive disorder is one of the most common disorders among the working population (Driesen et al., 2011). It is the main cause for long-term sickness absence and work disability and leads to high costs for society (Driesen et al., 2011). By providing employees the most appropriate work hour schedule, it can be expected that the potential detrimental consequences of working irregular hours for both physical and mental health can be controlled. This will in turn lead to more productivity, less costs for society and a better economy (Birnbaum, et al., 2010).

Table 1

Variables current research

Dependent variable	**Independent variable**	**Control variables**
Work hour schedule	Subjective general health	Personal characteristics
Never work irregular hours	Physical health services	Gender
Sometimes work irregular hours	Medical specialist at a hospital	Age
Often work irregular hours	Mental health services	Education
	Psychiatrist/psychologist/, psychotherapist	Work characteristics
		Physically demanding
		Mentally demanding

1.4 Structure

The remainder of this study is organized as follows. The second section reviews related work. First, the 24 hour society will be explained in more depth. Consequently, former research on the effects of working irregular hours on health will be reviewed. While discussing this effect, literature on the potential mediating effect of the factors age, gender, education and the degree to which work is physically or mentally demanding (the control variables) will be reviewed. The third section concerns the experimental setup. In order to answer the research question, three hypothesis tests will be performed for all three aspects of health (subjective general health, physical health and mental health). The hypothesis tests concern comparisons of models to determine what model performs best on the dataset. The first hypothesis test examines whether a logistic regression containing information about work hour schedule is preferred over the model excluding this information. The second hypothesis test concerns the question whether a logistic regression containing the potential mediating factors in addition to information about work hour schedule is preferred over the model that excludes this information. The third hypothesis test examines whether models including an interaction between any mediating factor and working hours is preferred over models without the interactions. The results are displayed in the fourth section. Section five discusses the findings and theoretical implications and provides a conclusion of the current study.

2. Related work

2.1 'The 24 hour society'

In the period of the industrial revolution, employees worked day-night schedules: they worked during the day and rested during the night (Vogel et al., 2012). However, due to technical developments and changes regarding production methods in industrialized countries, variable work schedules were introduced in order to ensure that operations could continue at all times (Knutsson, 1989). This phenomena has continued, and borders between work- and spare time have become less rigid in modern society, also called the '24 h society' (Costa, et al., 2004).

One of the main drivers of working during irregular hours is the customer's round-the-clock demand (Vogel et al., 2012). Customer demand has changed due to advances in ICT technology (Pantzar, 2010). Mobile devices have become more portable and instantly accessible (Radesky, Miller, Rosenblum, Appugliese, Kaciroti, & Lumeng, 2015). Mobile phone penetration in many countries is close to 100%, which enables customers to use services irrespective of time and place (Radesky, et al., 2015; Tinnilä, 2012). As a consequence, customers use services when they want, which leads to an irregular and fragmented pattern of time use (Pantzar, 2010). An example of the irregularity and fragmented way services are being used can be found in the research of Tinnilä (2012). He reviewed studies that were oriented towards future trends with a focus on banking services. Even though these analysis were mainly focused on the banking sector, it has been argued that these trends may lead to technical- and structural changes in multiple business areas. One important trend that could be identified was the "24/7/365 society''. It is argued that the daily rhythms of customers and society in general are changing, as can be concluded from the longer opening hours of shops and market. The irregularity and fragmented service usage also lead to expansion of opening hours of online services, which also has an impact on more traditional services. When it comes to the banking sector, customers use the evening and weekend to manage their routine payments. This round-the-clock demand of service results in pressure to banks, since they have not been open during evenings and weekends. Consequently, the availability of services is extended and does not have traditional office hours as limitation, leading to work during irregular hours.

This changing customer demand results in a technical and economical need for continuous processes (Vogel et al., 2012). Continuous processes offer companies real-time information of multiple aspects of their operations. It also offers customers up-to-date information about their purchases (Tinnilä, 2012). It is therefore essential that real time information systems are developed and kept up to date. Customers and companies use different channels for their activities, and it is essential to meet the need of technology (Tinnilä, 2012).

However, a study showed that 30% of manufacturers experienced unplanned downtime in the first

4 months of 2013. It was stated that companies with more than one billion dollars in revenue were even more likely to have downtime. When a downtime occurs, restoring the process and the data from backups might take hours or days which has great economic consequences. The average cost of each incident of downtime was found to be 17.000 dollar (Hessman, 2013). In order to ensure the maintenance of continuous processes and to be able to immediately restore if needed, employees are often required to work different hours than the traditional office hours (Vogel et al., 2012).

2.2 Irregular work hours and subjective general health

Society increasingly raises the question whether there exists an association between the demands of modern work and the increase of psychological and physical disorders (Vogel et al., 2012). Former studies indicate that irregular work hour schedules can negatively affect family, social life, body functioning and mental health (Costa, et al., 2004). Research has discussed multiple reasons why working irregular hours is associated with health risks.

Disruption of the sleep pattern is one crucial health consequence of irregular work hours (Hakola et al., 1996). It is argued that the lack of sleep or sleepiness can negatively influence people's general health and well-being (McClain, Lewin, Laposky, Kahle, & Berrigan, 2014). Hakola et al. (1996) examined the effect of work hour schedules on subjective sleepiness and studied whether gender had an effect on the adjustment to nightly work hours. They studied nine men and 11 women under controlled laboratory conditions. The subjects worked one day and three night shifts after they had one night of habituation. They found that the subjective sleepiness varied between different types of shift and also between men and women. Results showed that participants felt most alert during the day shifts, and most sleepy during the night shifts. Sleepiness decreased over the nights of the experiment, though it did not reach the level of alertness that was found during day shifts. Regarding gender, it was found that sleepiness of women decreased more than that of men, with a significant difference between the second and third night.

In addition to the potential relation between gender and sleepiness, research has focused on the association between age and sleepiness when working irregular hours (Bonnefond, Härmä, Hakola, Sallinen, Kandolin, & Virkkala, 2006). Bonnefond et al. (2006) examined the effect of age and different work hour schedules on subjective sleepiness while using data from 275 aircraft maintenance workers who worked different shifts (morning, night, evening). Results showed that irregular work hours did influence sleep and subjective sleepiness. However, age was only found to be related to changes in the amount of sleep and subjective sleepiness that were already explained by the effect of irregular work hours. Concluded, the results indicated no direct link between age and sleepiness when working irregular hours.

Kim and Young (2005) added the role of education when examining the relation between subjective sleepiness and age and gender. They used a sample consisting of 1562 women, and 1351 men with an

average age of 46.6. Results showed that women, employees of a younger age and lower educated people showed a significant increase of subjective sleepiness. An explanation for the fact that lower educated people are associated with increased sleepiness, could be that they also have less coping skills regarding diet-, exercise and sleeping habits, which are essential when working irregular hours (Devine, et al., 2009; Halpern-Manners, et al., 2016).

Based on the reviewed literature, it can be expected that the type of work hour does have an influence on subjective general health. However, there are more factors that potentially influence this relationship. As argued by Kim and Young (2005), gender, age and education might mediate the effect of work hour schedule on subjective general health. Additionally, an interaction between gender and age can be expected. Despite the accepted assumption that working non-traditional hours might interfere with health and well-being of employees, knowledge about the mechanisms in a human body and how they could be influenced by working these hours is far from complete (Vogel et al., 2012). In the section below, possible negative consequences of certain work schedules on both physical- and mental health are discussed.

2.3 Irregular work hours and physical health

Human beings have cyclic internal systems with a 24 hour (circadian) rhythm that control internal functions such as body temperature, fatigue, heart rate, blood pressure or hormone release (Kuhn, 2001; Rajaratnam & Arendt, 2001). All circadian rhythms normally show a fixed relationship to another (Smith et al., 2003). In their research, Smith et al. (2003) state various examples of this fixed relationship. For example, adrenaline reaches its peak level around midday and body temperature reaches a maximum at 8.00 PM. The same principle holds for various other internal processes.

At the occurrence of an occasional late night, these interrelated rhythms may be affected but will not disturb the circadian rhythms as a whole (Smith et al., 2003). However, when late nights happen on a frequent base, the likelihood for the circadian rhythm to become disturbed increases. As a result of the disrupted circadian cycle, misalignment occurs between internal circadian time and external cues, such as light and dark (Åkerstedt et al., 2009; Smith et al., 2003). The body is forced to re-adjust internal rhythms, which happens at different rates (Smith et al., 2003). This re-adjusting to new rhythms to environmental timing cues is called entrainment (Kuhn, 2001). While it is possible to entrain to new schedules and other environmental cues, the body requires sufficient time to adjust (Kuhn, 2001). For example, Weggmann & Klein (1985) note that body temperature related rhythms take one week on average to adjust to the new timing of internal rhythms.

One of the severe health consequences of disturbance of the circadian rhythm is an increased risk of cardiovascular disease (CVD) (Ha & Park, 2005). This risk emerges when a disturbance of the circadian rhythm leads towards the development of the metabolic syndrome which has found to be a significant risk

factor for CVD's (Karlsson et al., 2001). Other disturbances caused by irregular work hours comprising the metabolic syndrome are, among other things, obesity and often also impaired glucose tolerance (Karlsson et al., 2001). Previous research explaining metabolic syndrome and consequently CVD has largely focused on lifestyle factors, whereas recent studies specifically examine the role of a disturbed 24 hour rhythm (Ha & Park, 2005; Karlsson et al., 2001). In addition to CVD's, more severe health problems have been identified. Studies even discuss a risk of developing multiple types of cancer (Vogel et al., 2012). It is therefore preferable that once people start working irregular hours, they will work these hours on a permanent basis to prevent disturbance of the 24h rhythm (Smith et al., 2003).

Based on the discussed literature that underlined the urgency of a stable 24 hour rhythm, it is expected that irregular work hours do have an effect on physical health (Smith et al., 2003). However, it is essential to consider that the effect of these work hours on health may be strongly influenced by mediating factors (Costa, 2003). In the next section, the personal characteristics age, gender and education will be discussed as potential intervening factors on the relation between work hour schedules and physical health. In addition to that, the influence of physically demanding work will be taken into account as a work characteristic.

2.3.1 Gender, age and physical health

As mentioned earlier, obesity is one of the disturbances of the metabolic syndrome leading to CVDs (Karlsson et al., 2001). It is found that obesity is more common among employees who work irregular hours compared to traditional daytime workers, with differences in gender and age (Karlsson et al., 2001). Using data from a working population of 27.485 people, Karlsson et al. (2001) examined how metabolic risk factors for CVD differed between employees with traditional- or non-traditional work hours. Results of this research showed that obesity, high triglycerides and low concentrations of HDL cholesterol occur more frequently among employees working irregular hours than among traditional day workers. This indicated a relationship between irregular work hour schedules and the metabolic syndrome. Moreover, obesity was found to be more common among employees working irregular hours in all age groups for women (30, 40, 50 and 60), but only in two out of four age groups in men (30 and 40).

Other age differences were found by Moline, Pollak, Monk, and Lester (1992). They focused on young- and middle-aged men and found differences regarding the adjustment to new schedules. For 15 days, six healthy young men and eight early middle-aged men were isolated from environmental time cues. To approximate their daily patterns, their sleep and meals were scheduled for the first six or seven days. After these days, their daily routines were shifted six hours earlier and this new schedule had to be followed for eight to nine days. Moline et al. (1992) found differences in adjustment to the new schedules between the two groups. During the first four days, men in the middle aged group terminated sleep earlier than the

men in the younger group and they showed a larger increase of waking time in between sleep periods. Overall, decreases in alertness and well-being were found for the middle-aged men and they showed larger increases in sleepiness. Based on these findings, the researchers concluded that the negative consequences of working irregular hours for middle-aged men may be caused by difficulties sleeping at early times of their biological 24 hour rhythm.

Kuhn (2001) also found age differences but did not make a distinction for gender in her research. Studies were reviewed that focused on melatonin, which is a hormone closely linked with the circadian rhythm. Melatonin is synchronized with the 24 hour rhythm, by producing low concentrations of the hormone during the day and higher concentrations during the night. Melatonin in combination with the day-night rhythm creates a system that enables internal processes to resist minor disturbances of the circadian rhythm, while at the same time enabling the internal rhythms to respond to these disturbances and changes. While reviewing literature, it was observed that levels of melatonin decrease with aging, and that also the ability to sleep during the day decreases with advancing age. Based on the findings, it was suggested that the decreased levels of melatonin and the decreased ability to sleep during the day could explain why older employees experience more difficulties adjusting to irregular work hours.

Furthermore, literature has focused on the finding that long term irregular work hour schedules can lead to disturbance of women's hormonal and reproductive function (Costa, 2015). An altered menstrual cycle, premenstrual syndrome and menstrual pains are more frequently reported among females working irregular hours than among female traditional day-workers. Study outcomes also showed a higher occurrence of miscarriage and impaired fetal development, including preterm birth and low birth weight among women with irregular work hour schedules. These findings could be explained by hormonal disturbances caused by changes in circadian rhythm caused by working irregular hours (Zhu et al., 2003). However, findings concerning irregular work hours and fertility are contradicting. Zhu et al. (2003) examined if irregular work hours are associated with reduced fertility, estimated by time to pregnancy (TTP). To test for any association, data from 17 531 traditional daytime workers and 3907 non-traditional daytime workers who had planned to be pregnant were used. Results did not show evidence of a causal relation between irregular work hours (with or without night hours) and lower fertility.

The literature indicates that physical health of both men and women are potentially affected by working irregular hours (Karlsson et al., 2001). However, women might have an extra risk, since hormonal disturbances might have severe consequences such as an altered menstrual cycle (Costa, 2015). Additionally, it has been found that especially older people might have more difficulties adapting to working irregular work hours Kuhn (2001). Based on these findings, it is expected that the effect of work hour schedule on physical health is medicated by gender and age and by an interaction of the two.

2.3.2 Education and physical health

The strong association between lower levels of education and poorer health outcomes has been widely argued (van der Heide, et al., 2013). An explanation is that people that are higher educated are expected to have the capacity to understand basic health information to maintain or improve their health. Hublin et al. (2010) examined the association of shift work with mortality due to coronary heart disease (CHD), disability retirement due to CVD and incident hypertension while assessing level of education. In order to test this, they used data from a population of 20.142 adults in Finland. Results indicated that low levels of education were more common among people working irregular hours. However, no association between irregular work hours and CVD was found. Furthermore, no support was found for an increase in the risk of CHD mortality, disability retirement due to CVD or incident hypertension among employees working irregular hours compared to daytime workers during the 22-year follow-up.

However, even though the study of Hublin et al. (2010) did not find a direct relation between types of work hours, physical health and education, results did show that low social class and low level of education were more common among people working irregular hours (Hublin et al., 2010). Since other studies did find an association between level of education and health outcome, it is expected that education does mediate the effect of work hour schedule on health (van der Heide, et al., 2013).

2.3.3 Physically demanding work and physical health

Irregular work hour schedules and physically demanding jobs are found to have a negative influence on musculoskeletal disorders. Lipscomb, Trinkoff, Geiger-Brown and Brady (2002) examined the association between demanding work-schedule characteristics and reported musculoskeletal disorders in the neck, shoulders, and back. They selected a sample of 1163 subjects that was randomly selected from the list of nurses in the United States. Subjects were mailed an anonymous survey. It was found that four of the nine work-schedule characteristics, including "off hours" (≥2 weekends per month and "other than day shifts") were significantly related to musculoskeletal disorders. Moreover, results indicated that the association between musculoskeletal disorders and irregular work hour schedule could partly be explained by increased physical demands. The findings of this study suggest that in order to prevent musculoskeletal disorders, work hour schedules that promote balanced work-rest patterns and that reduce time of exposure to physically demanding work are required (Lipscomb et al., 2002).

Based on the finding that physically demanding work negatively affects physical health when people do not rest enough in between, it is expected that physically demanding work does have a mediating effect on the relation of type of work hour schedule on physical health outcomes.

2.4 Irregular work hours and mental health

As the section above points out, research indicates that irregular work hours can have severe health consequences (Haines III, Marchand, Rousseau, & Demers, 2008). However, most studies predominantly focused on physical health consequences, such as CVD and sleepiness, rather than on mental health consequences (Åkerstedt & Wright, 2009; Costa, 2015; Ha & Park, 2005; Hakola et al., 1996). Even though mental health has received less attention in association with irregular work hours than physical health, it is suggested that irregular work hours increase the risk of developing mental disorders (Cole, Loving, & Kripke, 1989). More specifically, psychological distress, depression, anxiety and burnout have found to be associated with irregular work hours (Haines III et al., 2008).

Two types of explanations have been given for the existence of an association between irregular work hours and mental health issues; a biological- and a social one (Haines III et al., 2008). Concerning the biological explanation, it is argued that the disturbance of the circadian rhythm may result in a decrease in sleep quality, which might in turn negatively affect one's ability to respond to stressors. This disability to adequately respond to stressors might result in mental health problems when the effect of stressors exceeds one's coping abilities. The second explanation given for the association concerns the social explanation. According to the social explanation, mental health issues derive from social interruptions or disturbances that are caused by working irregular hours. Employees might experience difficulties while maintaining relationships with family and friends, which might lead to negative influences on marital relations, care of children and to a decrease of social contacts (Costa, 1996). The basic assumption of this explanation is that work hour schedules including irregular hours conflict and interfere with the daily rhythm of the general population (Costa, 2003).

Based on the knowledge that people working irregular hours have difficulties managing their private live, it is expected that the type of work hour does have an influence on mental health (Haines III et al., 2008). The underlying assumption is that the more work hour schedules differentiate from the traditional work days, the more challenging the work-life balance will be. In turn, this will have an adverse consequence on mental health. However, as was the case with physical health, the impact of type of work hour schedule on mental health is a complex phenomenon which is dependent on individual- and work characteristics (Vogel et al., 2012). In this section, studies concerning work schedules including irregular hours and mental health will be discussed in combination with the potential moderating factors, gender, age, education and whether the work is mentally demanding.

2.4.1 Gender, age and mental health

Men and women have different roles in society and families and it is therefore argued that irregular work hours might influence them differently (Donnelly, et al., 2016). In general, it is expected that female

workers are more exposed to mental stress than male workers, since women have additional occupations next to their job that tend to add to their stress level, such as pregnancy and childbirth (Sato, Yonezawa, Ishizu, Suga, & Ikemoto, 2002). The assumption that work hour schedules would affect men's and women's health differently was supported by Bara and Arber (2009). They examined the impact of irregular work hour schedules on mental health by analyzing data of a subsample of people aged 21-73. They expected that the impact on health would depend on three factors: (1) duration of exposure, (2) type of irregular work hour schedule and (3) gender. Their results indicated that women's health was more negatively affected by varied irregular work hour patterns, whereas night work had a greater negative impact on men's mental health. More specifically, men working in night schedules for more than four years were associated with increased risk of having a mental ill health and reporting anxiety/ depression. Compared to men, women who worked varied irregular work hour patterns for 2-3 years and 4 years and more were significantly more likely to report anxiety/depression and to have a mental ill health. Based on the results, they concluded that mental health was affected differently depending on the type of irregular work hour schedule, and that this impact varied according to gender.

However, results from the study from Haines III et al. (2008) contrasted these findings and suggested that the experience of irregular work hours is quite similar for men and women with no significant differences. They investigated the mediating influence of work-to-family conflict in the association between working at times that are odd with social routines, and depression. Work-to-family conflict occurs when one cannot combine the work- and family role. Especially work during irregular hours is likely to cause work-to-family conflict. The stress that is the result of the pressure from participating in both roles may result in depressive symptoms. Haines III et al. (2008) examined the association by using a sample of 2981 Canadian respondents, from which close to 28% was involved in work including non-traditional hours. Results showed an influence of gender in sub-samples. However, overall results did not show significant differences regarding the experience of irregular work hour schedules between men and women.

In addition to gender, age is found to be a mediator in the association between irregular work hours and mental health. Driesen et al. (2011) examined the relationship between types of work hour schedules and depressive complaints, especially depressed mood. They used data from the ongoing Maastricht cohort study (1998-2008) for their analysis. Subjects were grouped regarding gender and age (<45 versus ≥ 45 years). The results indicated that the impact of irregular work hours on the development of depressed mood over a ten-year period was rather small. However, findings suggested that men with the age of 45 or older that are working irregular work hours did contribute to a higher risk of developing depressed mood compared to men working traditional work hours in the same age category. When correcting for demographic and work-related factors, results lacked significance.

Conway, Campanini, Sartori, Dotti and Costa (2008) also examined the impact of irregular work

hour schedules, ageing and work related stress on mental health. They argued that younger people might experience pressure while combining career, increasing efforts at work and the stage of their life cycle. At the same time, they argued that older people were likely to experience more difficulty adapting to changing work demands than younger people. The factors described could all influence mental health status (Conway et al., 2008). Associations were analyzed using a sample of 1842 predominantly female hospital workers in Northern Italy. Results showed that ageing was associated with lower mental health when comparing employees younger than 45, or 45 years and older.

While not all reviewed studies showed significant results between the mediating effect of gender and age, several associations were found. It can therefore be expected that both gender, age and the interaction between gender and age do have a mediating effect on the relation between type of work hour schedules and mental health.

2.4.2 Education and mental health

Even though multiple studies have included education as a mediating factor, they mostly did not discuss it separately, but rather referred to it as one element of the 'control variables' (Haines III et al., 2008). However, Fryers, Melzer and Jenkins (2003) were able to identify education a useful indicator for common mental disorders. They reviewed published evidence of studies that examine the relation between markers of social position, such as income and education, and common mental disorders in Western countries. Studies with less than 3000 adults of working age as subjects were excluded to be able to better generalize findings (Fryers et al., 2003). Based on the reviewed studies, Fryers et al. (2003) found that people of lower socio-economic often live in environments where common mental disorders are more common. These higher frequencies of common mental disorders result in a significant amount of suffering in working-age adults. Based on large-scale population studies, education is identified as a useful indicator when predicting someone's mental health (Fryers et al., 2003).

Even though research of Fryers et al. (2003) indicated education as a predictor for common mental disorders, it does not say anything about education, working irregular hours and mental health. However, Hublin, et al. (2010) found that especially lower educated people work irregular hours. Since, findings from Fryers et al., (2003) suggested that mental disorders are most common among lower educated people, it is expected that lower education will have a mediating effect on the association between type of work hour schedule and mental health.

2.4.3 Mentally demanding work and mental health

Significant effects of psychological demanding jobs and poor mental health have been found. Andrea, Bültmann, Beurskens, Swaen, Van Schayck and Kant (2004) examined possible associations between psychological job demands, anxiety and depression in both men and women using data of 7482 employees.

Questionnaires and self-formulated questions were used to determine the psychosocial work characteristics. Concerning the self-reported psychosocial work characteristics, partly differential cross-sectional associations were found for anxiety and depression (Andrea, et al., 2004). High psychological demands were found to have a significant effect on subclinical depression for men, also after adjusting for control factors. Women also showed a significant effect of psychological job demands on subclinical anxiety. As can be concluded based on these findings, psychologically demanding jobs influence mental health, for both men and women.

Even though literature has not focused on the relation between irregular work hours, mentally demanding work and mental health, it is found that psychologically demanding jobs influence mental health in general (Andrea, et al., 2004). Moreover, it is expected that a regular work-rest pattern is required for employees to be able to cope with psychological aspects of work and that irregular work hours have a negative effect on mental health.

3. Experimental setup

3.1 Data collection

Two datasets from the LISS Panel (Longitudinal Internet Studies for the Social sciences) were used for the current study[1]. The LISS Panel consists of a true probability sample of Dutch Households, with 4500 households, comprising 7000 individuals. Members of this Panel complete online questionnaires on a monthly basis.

The first dataset used for this study was collected during the eighth wave of the LISS Core Study method called 'Work and Schooling'. This dataset was based on a survey that focused on labor market participation, job characteristic, pensions, schooling and courses. The data collection consisted of two collection events, the first one starting on 06-04-2015 and ending on 28-04-2015. Only Panel members aged 16 years and older were asked to fill in the online survey. Two reminders were sent to people who did not fill in the survey. The second collection period lasted from 04-05-2015 to 26-05-2015 and only included non-respondents of the first measurement. Also during this period, two reminders were sent to non-responders. After the second collection period was completed, the selected number of household members concerned 7.340 (100%), with a response of 6.237 (85.0%), and a nonresponse of 1.103 (15.0%). 83.8% (6148) of this data was complete, and 1.2% (89) was incomplete.

The second dataset, which was collected during the eighth wave of the Health module of the LISS Core Study, was based on a survey that included topics as health, health perception and health related to job situation. The first data collection for this survey started on 06-07-2015, ending on 28-07-2015. Again, only people aged 16 years and older were asked to fill in the online survey, and non-respondents were sent a reminder twice. The second collection period took place between 03-08-2015 and 25-08-2015, with two reminders for the non-respondents from the first collection period. The total selected number of household members concerned 7.126 (100.0%) for this survey, with a response of 6.009 (84.3%), and a nonresponse of 1.117 (15.7%). 83.8% of this data was complete and 0.5% (34) incomplete.

3.2 Software

The scripting language for statistics, called R, is the software that was used to import data, to pre-process the features and to perform the analyses. R version 3.3.2 (2016-10-31) was used and the following packages were used: 'foreign' (version 0.8-67), 'dplyr' (version 0.7.1) , 'ggplot2' (version 2.2.1) , 'forcats' (version 0.2.0) and 'MASS' (version 7.3-45). The code written for this study can be accessed through following website: https://github.com/ambervleeuwen/Thesis-Health

[1] https://www.lissdata.nl/lissdata/Home

3.3 Pre-processing the dataset(s)

After the two datasets were imported into R ('Healtdata2015' and 'Workdata2015'), they had to be merged. However, the data had to be filtered first. The columns that would be included in the merged dataset were renamed to be able to refer to them more easily. Once the columns were renamed, they were selected to create datasets that only included columns that were relevant to the current study.

After the feature selection was completed, the two sets were merged based on ID to ensure that only people filled in both surveys were included. In total, 6009 respondents filled in both surveys. Since the current study examined the effect of work hour schedule, it was only relevant to include people that perform paid work. After filtering out people without a paid job, the merged dataset included 2702 respondents and 11 variables (Table 2).

Table 2

Features and descriptions

Original name	New name	Referred to as in text:	Label	Dataset
Nomem_ encr	ID	-	Encrypted number of the respondent	Healthdata2015, Workdata2015
cw15h000	PaidEmpl	-	Whether or not respondent has paid work according to household box data	Workdata2015
cw15h425	IrregularHours	WH Schedule	Respondent's work hour schedule	Workdata2015
ch15h004	SubGenHealth	SG Health	Respondent's description of own health ('moderate', 'good', 'very good', 'excellent')	Healthdata2015
ch15h208	MedSp	Medical Visits	Number of visits to Medical Specialist at the hospital	Healthdata2015
ch15h207	Psych	Psych Visits	Number of visits to Psychiatrist/psychologist/psychotherapist	Healthdata2015
ch15h001	Gender	Gender	-	Healthdata2015
ch15h002	Age	Age	-	Healthdata2015
cw15h005	Education	Education	Respondent's highest level of education completed with diploma or certificate	Workdata2015
cw15h416	Physdem	Physically Demanding	Degree to which degree work is physically demanding	Workdata2015
cw15h420	Mentdem	Mentally Demanding	Degree to which degree work is mentally demanding	Workdata2015

3.4 Outlier detection

Outliers were identified for the variables Age, WH Schedule, SG Health, Medical Visits and Psych Visits. Age was found to have a distribution with a minimum of 18, and a maximum of 92. However, only people from the age of 15 to 75 are indicated as working population in the Netherlands[2]. Since this group is of interest for the current study, people older than 75 were excluded. In total, this concerned seven respondents.

The variable WH Schedule was used as independent variable and it was therefore important to ensure there were no missing values (NA's) for this variable. However, 85 respondents were found to not have filled in their work hour schedule. Since the information on work hour schedule was essential for the current study, these respondents were excluded from the dataset.

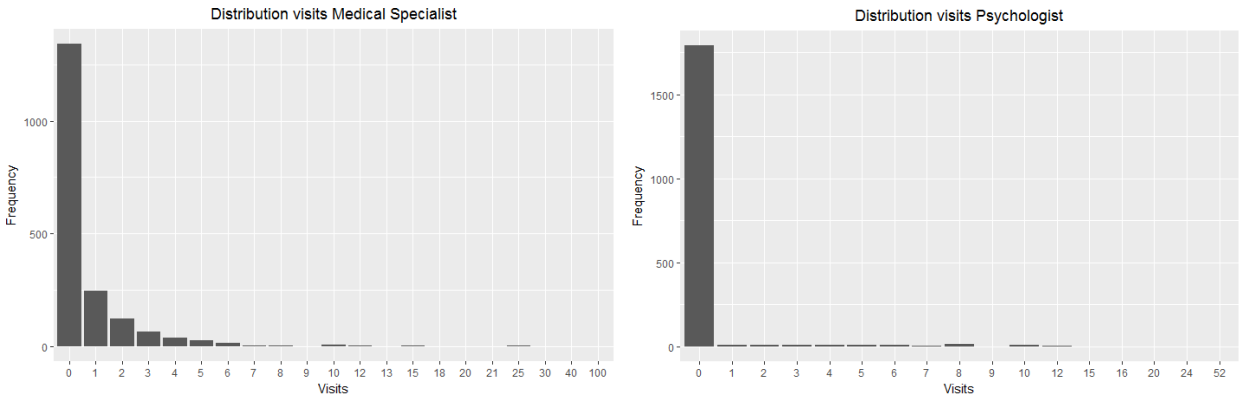
Additionally, the variables that contained information about subjective general health (SG Health), visits to a medical specialist and visits to a psychologist, were checked for NA's. No missing values were found for the variable SG Health, though 10 respondents had not filled in the questions concerning Medical Visits and Psych Visits. Data showed that it concerned the same 10 respondents that did not fill in either one of these questions and they were excluded from the dataset. The variable Gender also showed to have NA's, 702 in total. Even though this concerned a substantial part of the dataset (27%), it was decided to exclude these respondents from the dataset as gender was an important aspect of this study and missing values would bias the results. The bias could be explained by the fact that instances with missing values were omitted from analysis. This omission holds that analyses concerning Gender excluded 702 instances, resulting in a different population compared to analyses that did not include Gender. After omitting these instances, the dataset contained 1898 respondents.

In addition to controlling the missing values, the actual content of the variables was inspected. The distribution of the variable SG Health showed that only six out of 1898 respondents indicated to have a poor health, compared to 185 'moderate', 1189 'good', 411 'very good' and 107 'excellent'. It was decided to leave out these six people indicating a poor health. This decision was motivated by the fact that this group was not representative for the population, representing only 0.3% of the respondents. Their scores may have influenced the outcome for the whole population and thereby biased the results. The dataset now consisted of data from 1892 respondents

After cleaning the data based on the above findings, the distribution of the variables Medical Visits and Psych Visits was assessed. Figure 3a shows a distribution of the data from the variable Medical Visits. The minimum value was zero visits, which was also the mode. The maximum value was 100 visits. The plot showed an exponential distribution, with few occurrences of number seven and higher. Based on this distribution, it was decided to exclude the respondents that indicated to have visited a medical specialist

[2] https://www.cbs.nl/en-gb

seven or more times, since they would bias the results. Concerning the number of visits to a psychologist, the plot in figure 3b shows that the minimum value was 0 visits, which was again the mode. Compared to the value zero, all other values have a low frequency. Especially the occurrence of the values higher than 10 decline. Values higher than 10 would likely bias the results and were identified as outliers. After the process of outlier detection and deletion, the final dataset included data from 1850 respondents.



3a 3b

Figure 3. **Original distributions variables Medical Visits and Psych Visits.**

3.5 Pre-processing and description of the variables

This section describes the variables in more detail and elaborates on the pre-processing required for the analyses.

3.5.1 Independent variable

3.5.1.1 Work hour schedule

The variable WH Schedule was converted from a three level factor into an ordered factor with the levels ‘never’ < ‘sometimes’ < ’often’. The distribution of this variable can be seen in the plot below (Figure 4). The group most represented was the group who indicated to never work irregular hours (‘never’), which concerned 819 respondents (44.27%), followed by the groups who ‘sometimes’ work irregular hours (617 respondents, 33.35%) and ‘often’ work irregular hours (414 respondents, 22.38%).

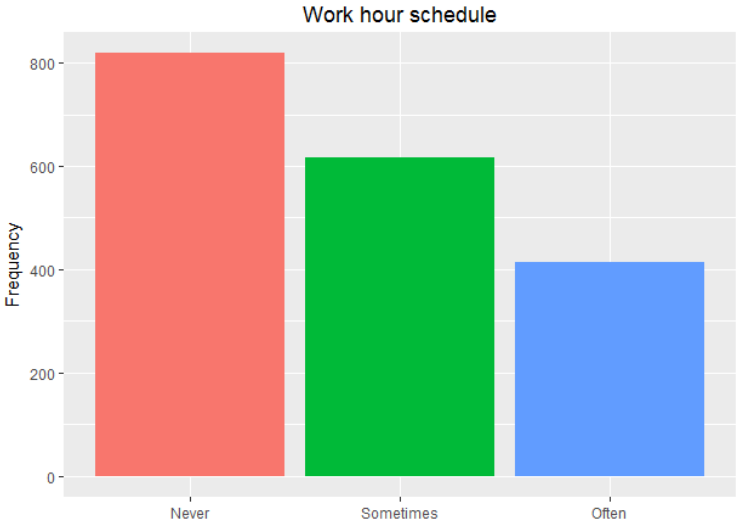


Figure 4. **Distribution of the answers for the variable WH Schedule.**

3.5.2 Dependent variables

3.5.2.1 Subjective General Health

The data for the variable SG Health was collected using a Likert scale. The Likert scale is often used to measure respondent's attitudes regarding particular statements. The responses of a Likert scale can be interpreted as stronger as or weaker than another, though the ranking does not imply that the interval between the categories is equal[3]. The variable SG Health included information about respondents' subjective general health, which was coded as a factor with the levels 'moderate', 'good', 'very good' or 'excellent'. For the analyses of the current study, the variable was converted into an ordinal factor: 'moderate' < 'good' < 'very good' < 'excellent'. From the 1850 people, 164 respondents (8.87%) described their health as 'moderate', 1171 respondents (63.30%) as 'good', 408 respondents (22.05%) as 'very good' and 107 respondents (5.78%) as 'excellent' (Figure 5).

[3] https://www.st-andrews.ac.uk/media/capod/students/mathssupport/OrdinalexampleR.pdf

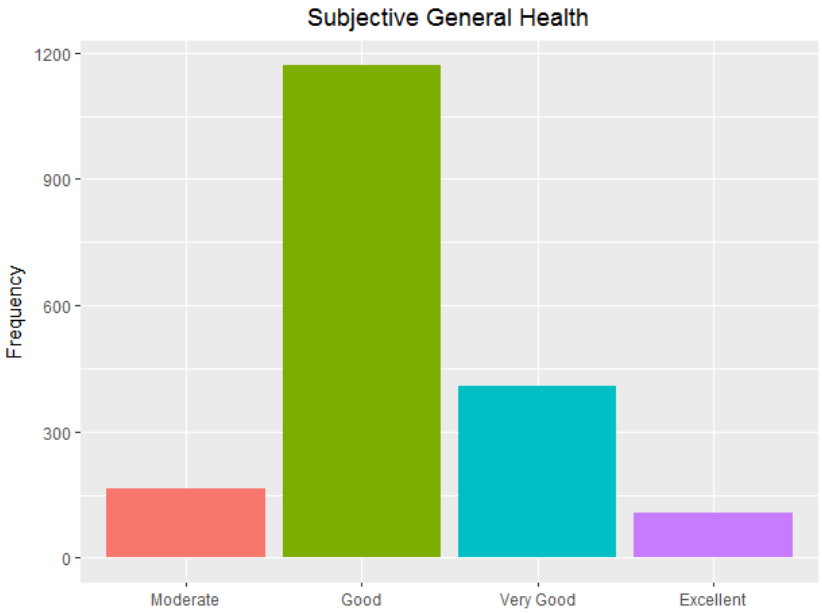


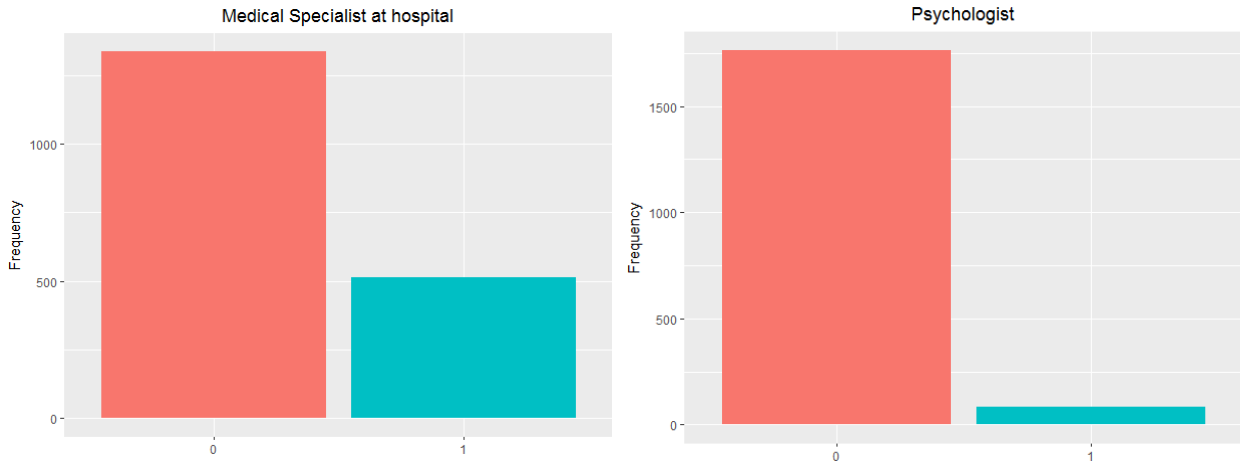
Figure 5. **Distribution of the answers for the variable SG Health.**

3.5.2.2 Physical health: Medical Specialist at the hospital

The number of visits to a medical specialist at the hospital was used to assess respondents' physical health. The median value of zero indicated that most people did not visit a medical specialist (1337 respondents, 72.27%). Since this concerned a substantial part of the whole population, decision was made to not further split the other 27.73% (513 respondents), as it would lead to small segmented groups that could bias the results. The group of people that did not visit a medical specialist were grouped as '0', and the values from 1 to 7 were all grouped into group '1' (Figure 6a).

3.5.2.4 Mental health: Psychiatrist/psychologist/psychotherapist

Visits to the psychologist were used to assess the mental aspect of health. Also for this variable, the median was zero visits, which concerned 1765 respondents (95.40%). The group of people who did not visit a psychologist were grouped as '0' and the other 49 respondents (4.6%) were grouped as '1'.



6a 6b

Figure 6. **Distribution of the answers for the variables Medical Visits and Psych Visits.**

3.5.3 Control variables

3.5.3.1 Gender

The variable Gender was converted from a numerical variable into a factor of two almost equally divided groups: ‘men’ (960 respondents, 51.89%) and ‘women’ (890 respondents, 48.11%) (Figure 7).

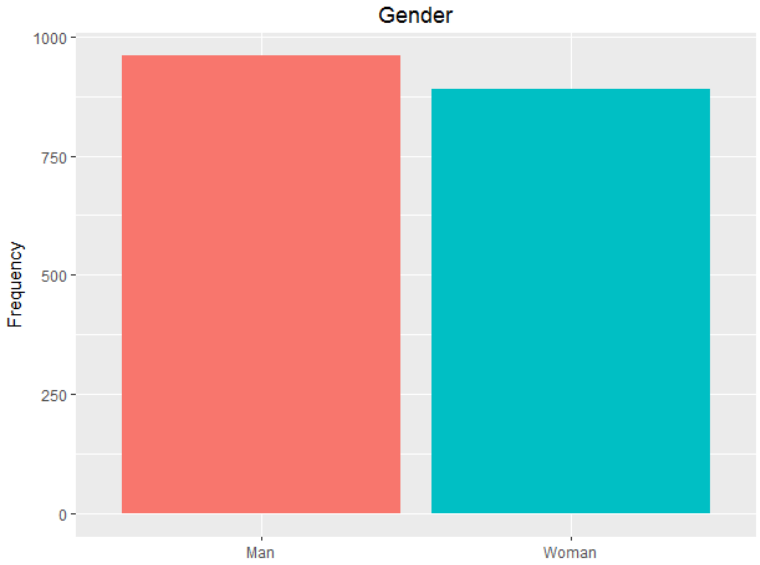


Figure 7. **Distribution of the variable Gender.**

3.5.3.2 Age

The variable Age was converted from a numerical value into a factor by cutting the age range (18 - 74) into five groups: 18-25, 26-35, 36-45, 46-55 and 55 plus. From the 1850 respondents, 84 respondents (4.54%) were grouped in the age range 18-25, 277 respondents (14.97%) in the range 26-35, 453 respondents

(24.49%) in the range 36-45, 545 respondents (29.46%) in the range 46-55, and 491 respondents (26.54%) were grouped in the range 55+ (figure 8).

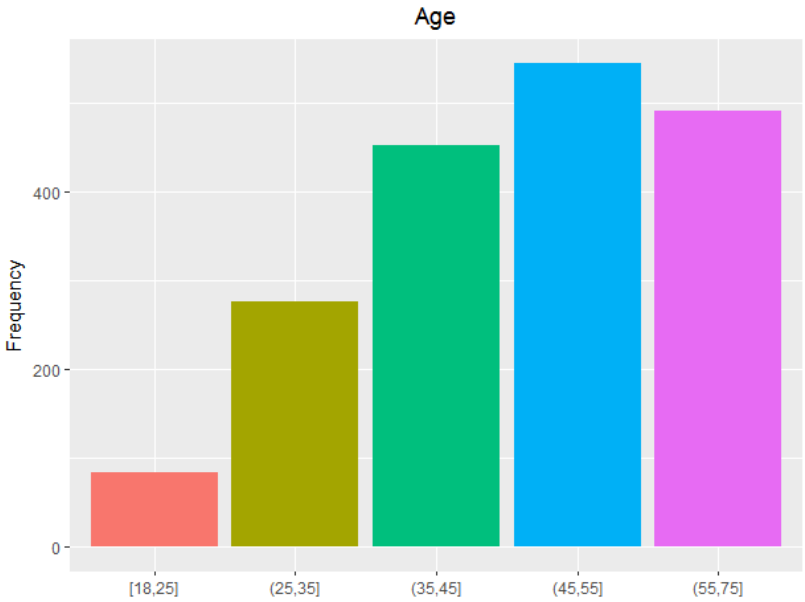


Figure 8. **Distribution of the variable Age.**

3.5.3.3 Education

The variable Education was originally a factor with 28 levels which was grouped into six groups based on the type/level of education (Table 1 of the Appendix). From the 1850 respondents, 26 respondents (1.41%) were non educated, 326 respondents (17.62%) had a VMBO diploma, 703 respondents (38%) had a HAVO diploma, 495 respondents (26.76%) a HBO diploma, 262 respondents (14.16%) had an academic degree and 38 respondents (2.05%) indicated ‘other’ (figure 9).

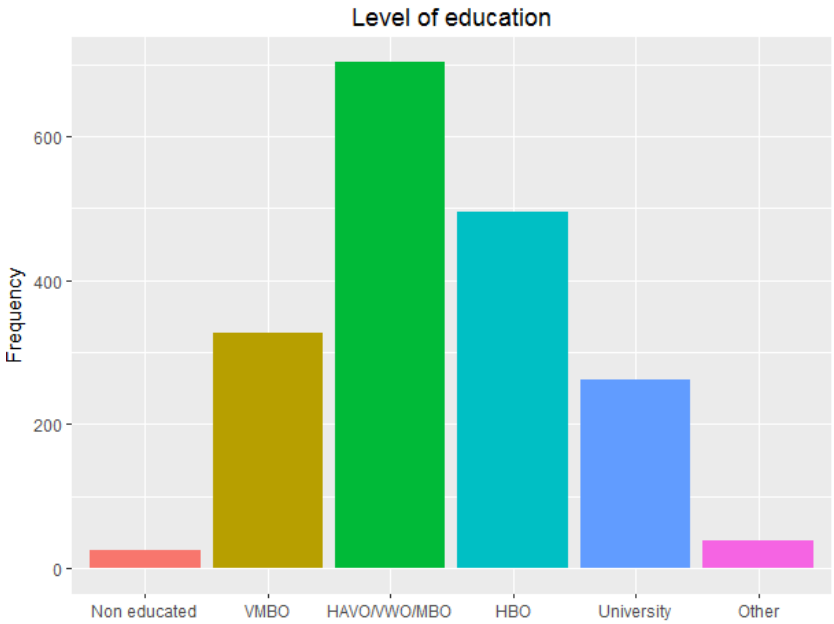


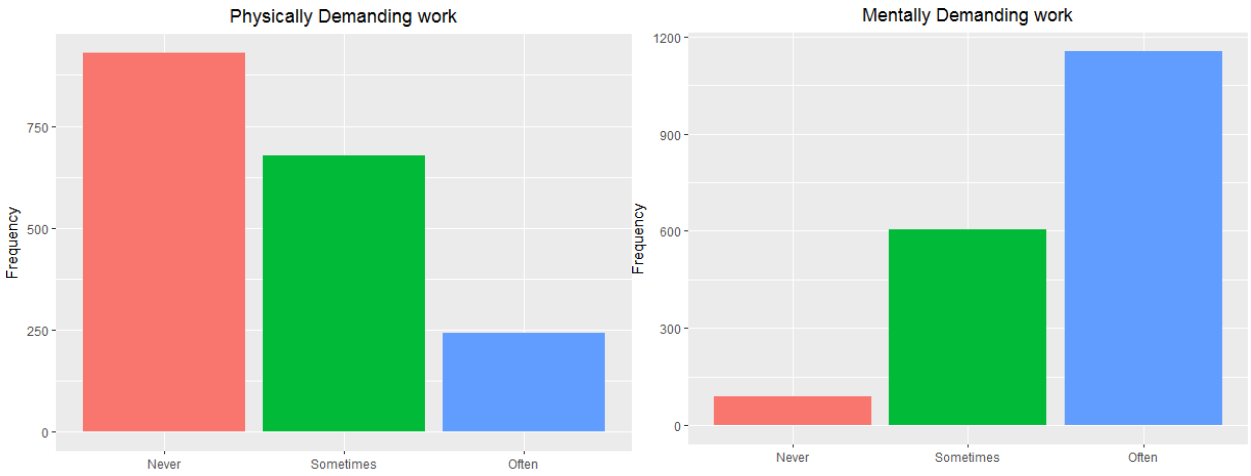
Figure 9. **Distribution of the variable Education.**

3.5.3.4 Physically demanding work

The variable Physically Demanding did not need any pre-processing as it already was a factor consisting of the levels ‘never’, ‘sometimes’ and ‘often’. Concerning the question to what degree the work was physically demanding, 930 respondents (50.27%) from the 1850 stated that their work was never physically demanding, 677 respondents (36.60%) indicated that their work was sometimes physically demanding and 243 respondents (13.13%) indicated that their work often was physically demanding (figure 10a).

3.5.3.5 Mentally demanding work

As for the variable Physically Demanding, the variable Mentally Demanding did not need any pre-processing and concerned a factor with the levels ‘never’, ‘sometimes’ and ‘often’. 89 respondents (4.81%) indicated that their work was never mentally demanding, 606 respondents (32.76%) said their work was sometimes mentally demanding and 1155 respondents (62.43%) indicated that their work was often mentally demanding (figure 10b).



10a 10b

Figure 10. **Distributions of control variables concerning work characteristics: Physically Demanding and Mentally Demanding.**

3.6 Tasks and evaluation

In order to examine the research question(s) of the current study, regressions were executed. The regressions are discussed in more detail when discussing the separate experiments below. To evaluate the models, the Akaike Information Criterion (AIC) was used. The AIC measures the quality of a model that performs predictions on a specific dataset and is based on the maximum likelihood estimate of the model parameters (Larget, 2003; Snipes & Taylor, 2014). The maximum likelihood estimation is a method of estimating parameters given observations, by finding the parameter values that maximize the probability of the observed data (Larget, 2003). The AIC score of a specific model can be determined using the following formula:

$$AIC = -2* ln(likelihood) + 2*K$$

'ln' is the natural logarithm, 'likelihood' is the value of the likelihood, and 'K' is the number of parameters in the model. The technique behind the AIC is that goodness-of-fit is rewarded, which is tested by the likelihood function. Furthermore, the AIC includes a penalty that is an increasing function of the number of estimated parameters ('2*K'). By including this function, an increase of complexity and potential overfitting is controlled by penalizing the number of parameters. The AIC score can be used to test if a model has a better performance when adding or excluding specific variables (Snipes & Taylor, 2014). The model with the lowest AIC score is preferred.

3.7 Experiments

3.7.1 Experiment 1. Irregular work hours and subjective general health

The first experiment tested whether work hour schedules had an effect on health. Due to the ordinal nature of the dependent variable SG Health (‘moderate’ < ‘good’ < ‘very good’ < ‘excellent’), the ordinal logistic regression technique was found to be most suitable to test this relation. The ordinal logistic regression is commonly used for questionnaires where respondents can answer questions using a Likert scale. In order to perform an ordinal logistic regression in R, the function polr() (proportional odds logistic regression) from the MASS package was used.

The first hypothesis test examined if the model including WH Schedule was favored over the NULL model by the AIC score. The NULL model is used to test whether an observed relation between variables exists without including additional information to the model. The second hypothesis test compared models including the ‘control’ variables. The model only including the control variables was compared to the model that also included WH Schedule to predict subjective general health. Furthermore, the AIC scores of these models were compared to the AIC score of the NULL model. The third hypothesis test assessed if models of interactions between control variables and WH Schedule would be favored over the models that included the variables as control variables in combination with WH Schedule.

3.7.2 Experiment 2. Irregular work hours and Medical Specialist at the hospital

The potential effect of work hour schedule on the number of visits to a medical specialist at the hospital was tested in the second experiment. Since the outcome of this variable was either a ‘0’ or a ‘1’, a binomial logistic regression was used: The Generalized Linear Model (glm).

The first hypothesis test examined whether the model including WH Schedule would be preferred over the model excluding WH Schedule (NULL model). The second hypothesis test compared models that included all the control variables. The model containing all control variables was compared to the model that also included WH schedule. The third hypothesis test assessed whether models of interactions between control variables and WH Schedule would be favored over the models that included the variables as control variables in combination with WH Schedule.

3.7.3 Experiment 3: Irregular work hours and Psychologist

In the third experiment, models were performed to assess the prediction performance for mental health (Psych Visits). Also these outcomes were coded as either ‘0’ (no visits) or ‘1’ (visits), and a binomial logistic regression was performed.

The first hypothesis test examined whether or not the model including WH Schedule would be preferred over the model excluding WH Schedule (NULL model). In the second hypothesis test, it was assessed whether the AIC value would favor the model of all control variables with or without inclusion of

WH Schedule. The third hypothesis test assessed whether models of interactions between variables and WH Schedule would be favored over the models that included the variables as control variables in addition to WH Schedule.

4. Results

4.1 Experiment 1. Irregular work hours and subjective general health

4.1.1 First hypothesis test SG Health

The first hypothesis test examined whether the model including WH Schedule would be preferred by the AIC score over the NULL model when predicting subjective general health:

SGHealthMo:	$SG\ Healh = \beta o$
SGHealthM1:	$SG\ Health = \beta o + \beta 1 WH\ Schedule$

Results showed that the NULL model received the lowest score (*SGHealthMo*, AIC = 3715.279) compared to the model including WH Schedule (*SGHealthM1*, AIC = 3715.616) (Figure 11). This outcome indicated that the NULL model was preferred over the *SGHealthM1* model based on the AIC scores, with a difference of 0.337.

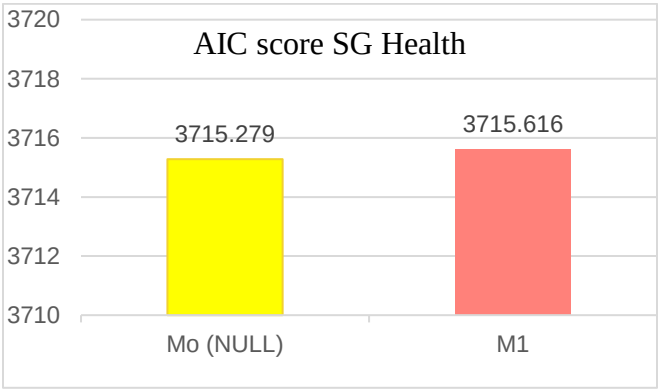


Figure 11. **AIC scores of first hypothesis test, experiment 1.**

4.1.2 Second Hypothesis test SG Health

The second aspect that was tested was whether or not the model including both all control variables and WH Schedule would be preferred over the model that excluded WH Schedule:

SGHealthM2:	$SG\ Health = \beta o + \beta 1 Gender + \beta 2 Age + \beta 3 Education$
SGHealthM3:	$SG\ Health = \beta o + \beta 1 Gender + \beta 2 Age + \beta 3 Education + \beta 4 WH\ Schedule$

The AIC values favored the model including WH Schedule (*SGHealthM3*, AIC = 3612.294) over the model that excluded the variable (*SGHealthM2*, AIC = 3615.796) (Figure 12). Table 3 shows the coefficients and intercepts of the model *SGHealthM3*. The level 'never' work irregular hours was the baseline group, and the estimates of the other two levels indicate a difference with that group as reference level. The estimate for the level 'sometimes' work irregular hours (estimate = -0.1205) suggests that it is negatively related to the outcome for SG Health, indicating a lower rating compared to the baseline group. The level 'often' work irregular hours shows a positive relation with SG Health (estimate = 0.1738), indicating a higher rating for SG Health compared to the baseline group. Moreover, both models did receive a substantially better score compared to the NULL model.

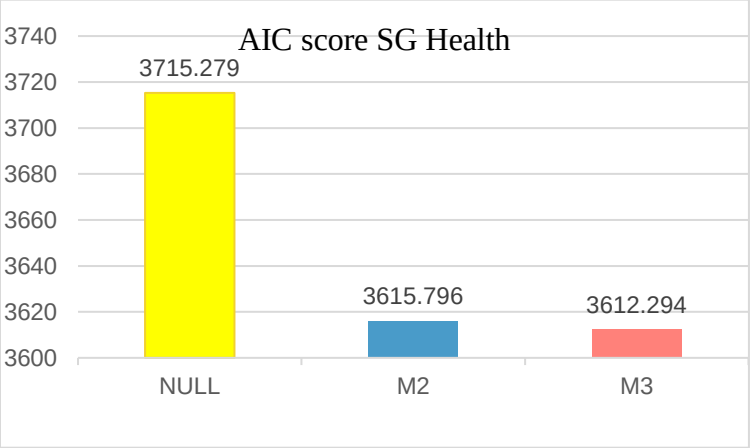


Figure 12. **AIC scores of second hypothesis test, experiment 1.**

Table 3

Output summary SGHealthM2

Coefficients	**Estimate**
Sometimes work irregular hours	-0.1205
Often work irregular hours	0.1738
Intercepts	**Estimate**
Moderate|Good	-2.5907
Good|Very good	0.8627
Very good|Excellent	2.7767

4.1.3 Third hypothesis test SG Health

The final hypothesis test concerned examining whether interactions between the control variables and WH Schedule and received a better AIC score than the models that included the variables as control variables in combination with WH Schedule:

SGHealthM4a: SGHealth = βo + β1Gender + β2WH Schedule

SGHealthM4b: SGHealth = βo + β1Gender + β2WH Schedule + β3(Gender:β2WH Schedule)

SGHealthM5a: SGHealth = βo + β1Age + β2WH Schedule

SGHealthM5b: SGHealth = βo + β1Age + β2WH Schedule + β3(Age:WH Schedule)

SGHealthM6a: SGHealth = βo + β1Gender + β2Age + β2WH Schedule

SGHealthM6b: SGHealth = βo + β1Gender + β2Age + β3WH Schedule + β4(Gender:Age:WH Schedule)

SGHealthM7a: SGHealth = βo + β1Education + β2WH Schedule

SGHealthM7b: SGHealth = βo + β1Education + β2WH Schedule + β3(Education:WH Schedule)

The AIC scores indicated that regarding all variables, the models without interactions were preferred. Moreover, as figure 13 shows, the NULL model was preferred over both models containing Gender.

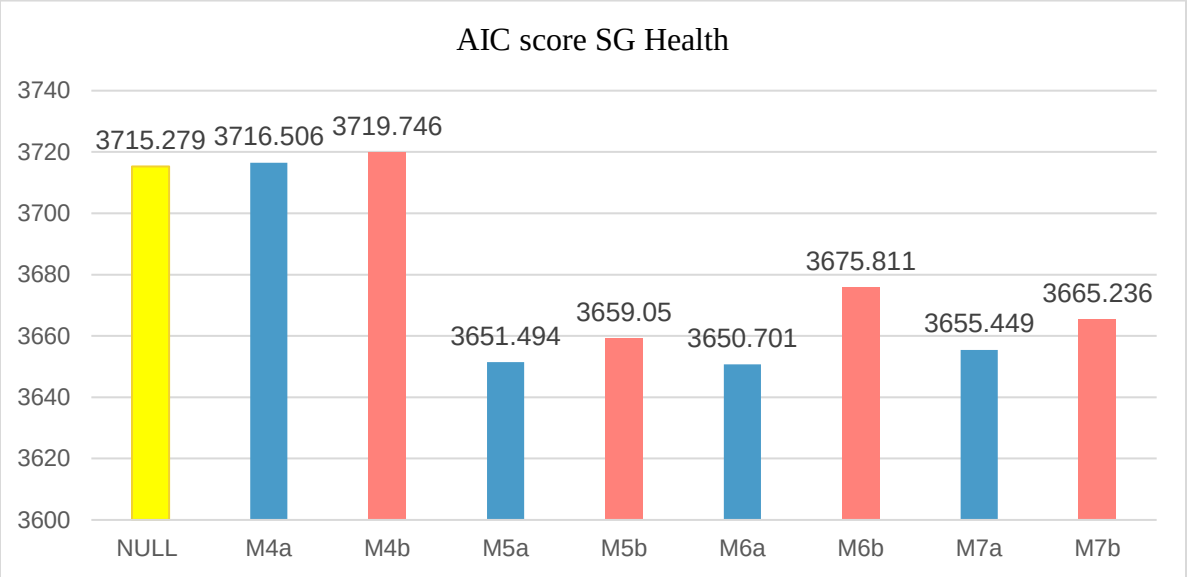


Figure 13. **AIC scores of third hypothesis test, experiment 1.**

4.2 Experiment 2. Irregular work hours and Medical Specialist at the hospital

4.2.1 First hypothesis test Medical Visits

The first hypothesis test for Medical Visits examined whether the model including WH Schedule would be preferred by the AIC score over the NULL model when predicting visits to a medical specialist at the hospital:

MedicalVisitsMo: Medical Visits = Bo

MedicalVisitsM1: Medical Visits = βo + β1WH Schedule

Results showed that the NULL model received the lowest score (*MedicalVisitsMo*, AIC = 2186.4) compared to the model including WH Schedule (*MedicalVisitsM1*, AIC = 2190.2) (Figure 14). This outcome indicated that the NULL model was preferred over the model that included WH Schedule, with a difference of 3.8.

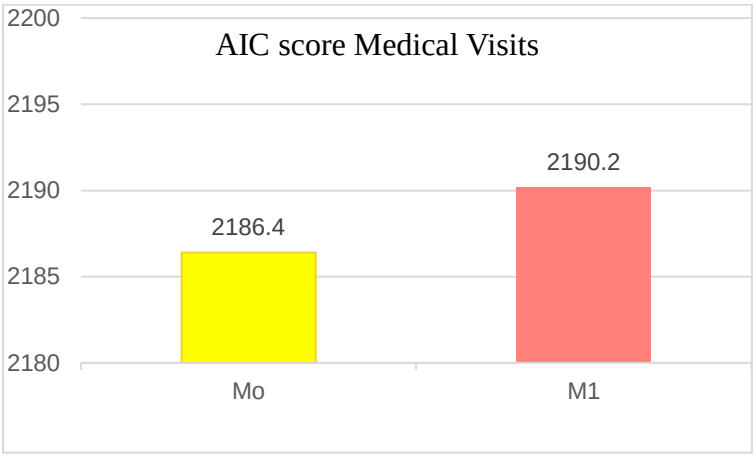


Figure 14. **AIC scores of first hypothesis test, experiment 2.**

4.2.2 Second hypothesis test Medical Visits

Secondly, the performance of the model including all control variables was assesses and compared to the performance of the model including the type of work hour schedule:

MedicalVisitsM2: Medical Visits = βo + β1Gender + β2Age + β3Education + β4Physically Demanding

MedicalVisitsM3: Medical Visits = βo + β1Gender + β2Age + β3Education + β4Physically Demanding + β5WH Schedule

The results of the second hypothesis test indicated that *MedicalVisitsM2* (AIC = 2167.1) was favored over the model including WH Schedule (*MedicalVisitsM3,* AIC = 2159.6) (Figure 15). Furthermore, both models were preferred over the NULL model (AIC = 2186.4).

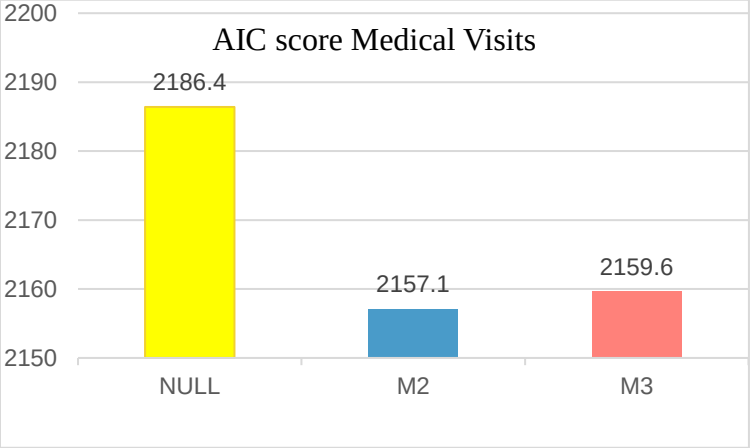


Figure 15. **AIC scores of second hypothesis test, experiment 2.**

4.2.3 Third hypothesis test Medical Visits

The third and last hypothesis test concerned examining if interactions between the control variables and WH Schedule would be favored over models that included the variables as control variables in addition to WH Schedule:

MedicalVisitsM4a: Medical Visits = βo + β1Gender + β2WH Schedule

MedicalVisitsM4b: Medical Visits = βo + β1Gender + β2WH Schedule + β3(Gender:WH Schedule)

MedicalVisitsM5a: Medical Visits = βo + β1Age + β2WH Schedule

MedicalVisitsM5b: Medical Visits = βo + β1Age + β2WH Schedule + β3(Age:WH Schedule)

MedicalVisitsM6a: Medical Visits = βo + β1Gender + β2Age + β2WH Schedule

MedicalVisitsM6b: Medical Visits = βo + β1Gender + β2Age + β3WH Schedule + β4(Gender:Age:WH Schedule)

MedicalVisitsM7a: Medical Visits = βo + β1Education + β2WH Schedule

MedicalVisitsM7b Medical Visits = βo + β1Education + β2WH Schedule + β3(Education:WH Schedule)

MedicalVisitsM8a: Medical Visits = βo + β1Physically Demanding + β2WH Schedule

MedicalVisitsM8b Medical Visits = βo + β1Physically Demanding + β2WH Schedule + β3(Physically Demanding:WH Schedule)

The results showed that for the variable Physically Demanding, the interaction with WH Schedule was preferred over the model that included Physically Demanding as a control variable (2191.5 < 2192.9). However, the NULL model was preferred over the both models regarding the variables Education and Physically Demanding (*MedicalVisitsM7a, MedicalVisitsM7b, MedicalVisitsM8a* and *MedicalVisitsM8b*). The models of all other variables were favored over the NULL model with the best values for the models including the variable as a control variable.

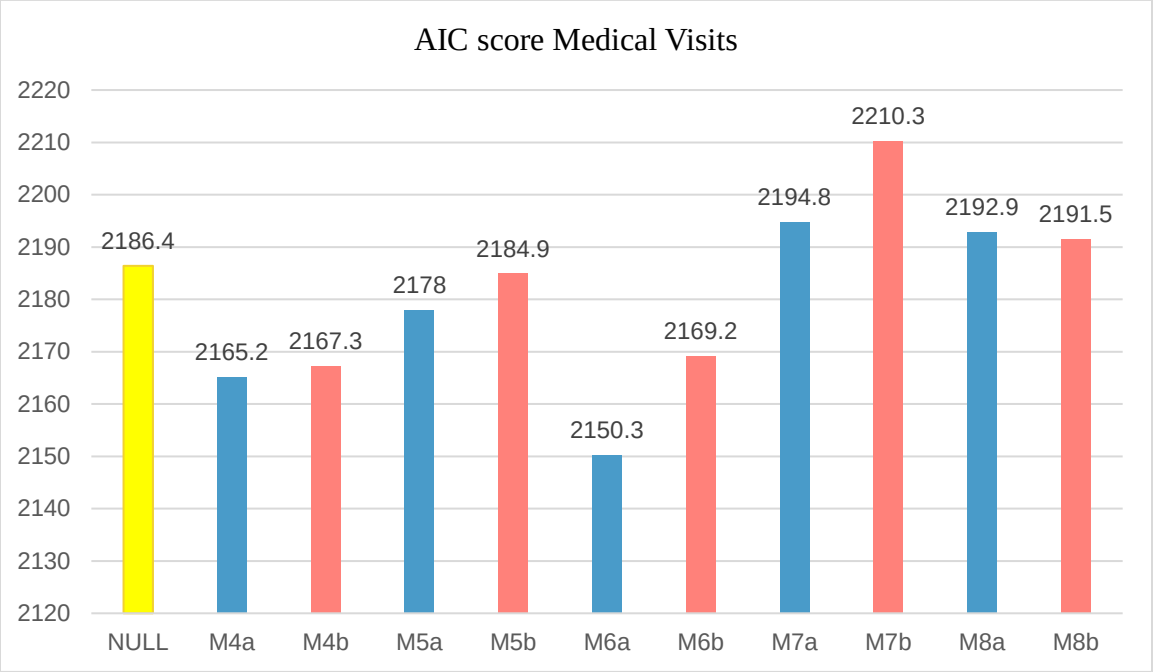


Figure 16. **AIC scores of third hypothesis test, experiment 2.**

4.3 Experiment 3. Irregular work hours and Psychologist

4.3.1 First hypothesis test Psych Visits

The first hypothesis test assessed if the model including WH Schedule would be preferred by the AIC score over the NULL model:

PsychVisitsMo:	*Psych = βo*
PsychVisitsM1:	*Psych = βo + β1WH Schedule*

As can be seen in Figure 21, the NULL model received a lower score (AIC = 691.68) compared to the model including the type of work hour schedule (AIC = 695.51), with a difference of 3.83 (Figure 17).

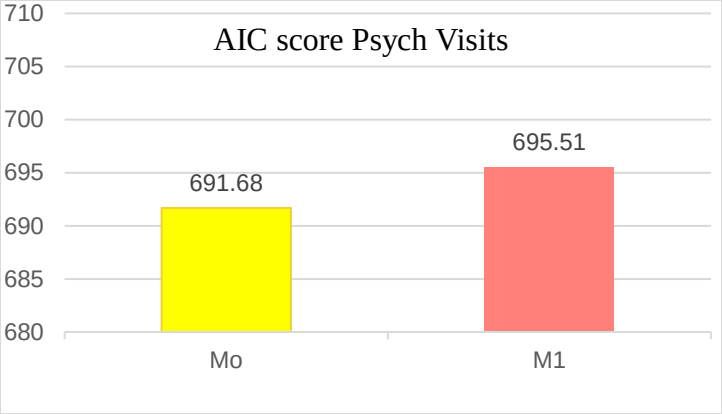


Figure 17. **AIC scores of first hypothesis test, experiment 3.**

4.3.2 Second hypothesis test Psych Visits

The second hypothesis test concerned testing the performance of the model including all control variables and comparing it to the performance of the model when WH Schedule was added:

PsychVisitsM2:	*Psych Visits = βo + β1Gender + β2Age + β3Education + β4MentallyDemanding*
PsychVisitsM3:	*Psych Visits = βo + β1Gender + β2Age + β3Education + β4MentallyDemanding + β5WH Schedule*

M2 received an AIC score of 701.14, compared to a score 705 for *PsychVisitsM3* (Figure 18). These score indicated that the AIC preferred the model excluding WH Schedule. However, the AIC preferred the NULL model over both *PsychVisitsM2* and *PsychVisitsM3.*

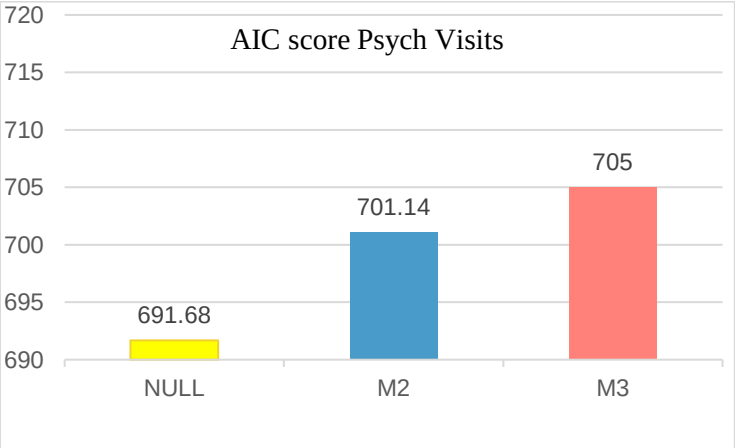


Figure 18. **AIC scores of second hypothesis test, experiment 3.**

4.3.3 Third hypothesis test Psych Visits

The third and last hypothesis test concerned examining if interactions between the control variables and WH Schedule would be favored over models that included the variables as control variables in addition to WH Schedule:

PsychVisitsM4a: PsychVisits= βo + β1Gender + β2WHSchedule
PsychVisitsM4b: PsychVisits= βo + β1Gender + β2WHSchedule + β3(Gender: WHSchedule)
PsychVisitsM5a: PsychVisits= βo + β1Age + β2WHSchedule
PsychVisitsM5b: PsychVisits= βo + β1Age + β2WHSchedule + β3(Age:WHSchedule)
PsychVisitsM6a: PsychVisits= βo + β1Gender + β2Age + β2WHSchedule
PsychVisitsM6b: PsychVisits= βo + β1Gender + β2Age + β3WHSchedule + β4(Gender:Age:WHSchedule)
PsychVisitsM7a: PsychVisits= βo + β1Education + β2WHSchedule
PsychVisitsM7b PsychVisits= βo + β1Education + β2WHSchedule + β3(Education: WHSchedule)
PsychVisitsM8a: PsychVisits= βo + β1MentallyDemanding + β2WHSchedule
PsychVisitsM8b PsychVisits= βo + β1MentallyDemanding + β2WHSchedule + β3(MentallyDemanding:WHSchedule)

The AIC scores showed that for the variable Mentally Demanding, the model containing the interaction was preferred over the model where the variable was used as a control variable in addition to WH Schedule (698.13 < 704.26) (Figure 19). However, the NULL model was preferred over both models for all variables, including Mentally Demanding.

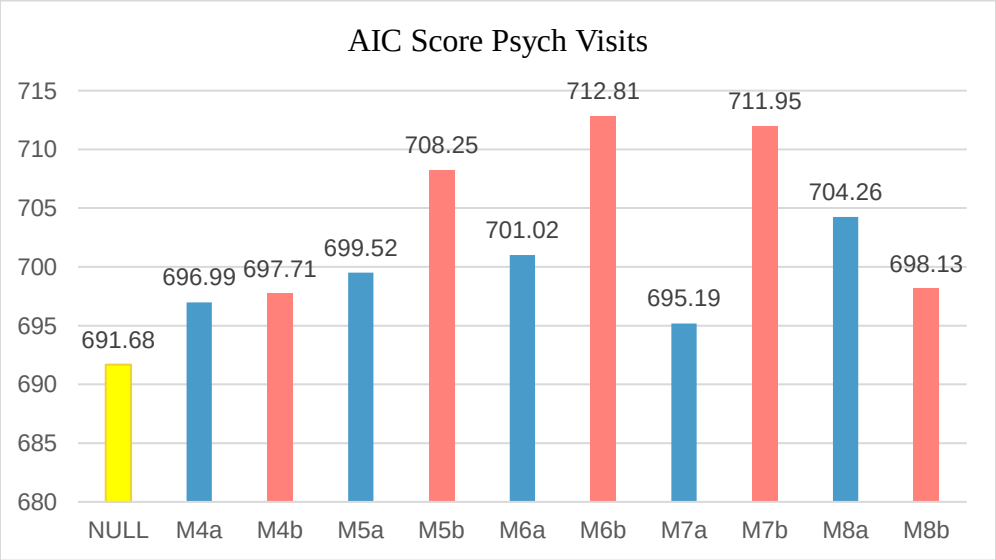


Figure 19. **AIC scores of third hypothesis test, experiment 3.**

5. Discussion and Conclusion

5.1 Discussion

The current study aimed to answer the question whether employees' health and well-being is affected by working irregular hours. This topic is increasingly relevant for society, since more people will have to work outside regular office hours due to the upcoming 24-hour society. Even though individual-oriented flexibility is found to be beneficial for employees' health, the effect of the flexibility where the employer is in control, which is the focus of this study, remains unclear (Costa et al., 2004). Research has indicated that the effect of irregular work hours on health is dependent on the regularity of work during these hours (Costa, 2010). In order to test whether types of work hour schedules have a different health outcome, three regularities were included in the current research: (1) never work irregular hours, (2) sometimes work irregular hours and (3) often work irregular hours. In total, three aspects of health were assessed: subjective general health, physical health and mental health. Subjective general health was indicated from 1 (poor) to 5 (excellent), physical health was assessed by the number of visits people made to a medical specialist at the hospital and physical health was assessed by the number of visits to a psychologist. Potential mediating factors and interactions were included. The variables that were included were gender (Gender), age (Age), education (Education) and whether work was physically- and or mentally demanding (Physically Demanding, Mentally Demanding).

Subjective general health was the first aspect of health that was assessed. One important indicator of subjective general health was sleepiness (Hakola et al., 1996). When the regular sleep/wake cycle is disrupted, significant stress for the rhythm of biological functions is created (Costa, 2010). It is argued that the lack of sleep can eventually negatively influence people's general health and well-being[4]. Based on the findings from the reviewed literature, the expectation for the current finding was that irregular work hours would be a predictor for someone's subjective general health. However, when assessing whether information about work hour schedule increased prediction performance compared to the NULL model in the first hypothesis test, it was found that the AIC values favored the NULL model. Even though the difference was only minor (0.337), it was a surprising finding since it contradicted the findings from earlier research that irregular work hours did affect subjective general health (Costa, et al., 2004; Hakola et al., 1996; Karlsson et al., 2001). However, this finding can be explained by two factors. The first explanation could be that the AIC penalized the model including WH Schedule for having more parameters, leading to the NULL model with a better AIC score. Secondly, it can be expected that WH Schedule only adds information to the model when the factors Age, Gender and Education are controlled.

The second hypothesis test examined whether the model with WH Schedule controlling for Gender,

[4] https://sleepfoundation.org/excessivesleepiness/content/excessive-sleepiness--health-impact

Age and Education would be preferred over the model that excluded WH Schedule. The results supported the assumption that the model including WH Schedule was preferred over the model that excluded this variable, while it also scored substantially better than the NULL model. This finding was in line with earlier findings from Hakola et al. (1996) and Kim and Young (2005), who argued that sleepiness and subjective general health were influenced by gender, age and education. Moreover, the level 'sometimes' work irregular hours showed a negative relation with SG Health compared to the level 'never' work irregular hours, which was the baseline group. This was in accordance with findings from earlier studies, suggesting that irregular hours may negatively influence people's general health and well-being (McClain, Lewin, Laposky, Kahle, & Berrigan, 2014). However, the level 'often' work irregular hours indicated a positive relation with SG Health compared to the baseline group, which contradicted earlier studies (Hakola et al., 1996; McClain, Lewin, Laposky, Kahle, & Berrigan, 2014). There are two possible explanations for the fact that often working irregular hours can be positively associated with SG Health. The first one could be that if employees work the same irregular hours on a frequent base, their internal rhythms are only required to entrain once, which does not disturb the circadian rhythms as a whole (Smith et al., 2003). However, that does not explain why these people would score better on subjective general health than people who never work irregular hours. A possible explanation could be that people working outside regular work hours are at home during the culturally-appropriate times to spend time with their children (Garey, 1995).

The third hypothesis test assessed the effect of the individual variables in combination with WH Schedule on subjective general health. Two models were executed for every variable: one in which the variable was used as a control variable in the relation between WH Schedule and SG Health, and one model contained the interaction between the variable and WH Schedule. Results showed that the AIC values favored the models where the variable was used as a control variable instead of included in the interaction with WH Schedule. However, when comparing the AIC scores with the NULL model, it was found that both models for Gender received a lower AIC score than the NULL model. This finding was opposite as to what was expected, since outcomes of the study from Hakola et al. (1996) and Kim and Young (2005) did suggest that gender did have a mediating effect.

The second aspect of health that was assessed was physical health. It is argued that irregular work hours affect health, since internal systems must constantly be re-adjusted to new rhythms (Åkerstedt et al., 2009). This disrupted cycle leads to significant stress for the rhythm of biological functions potentially leading to physical complaints (Costa, 2010; Ha & Park, 2005). Based on the findings that working irregular hours might lead to physical complaints, the expectation for the current study was that WH Schedule did affect the visits to a medical specialist at the hospital. However, the first hypothesis test showed that the NULL model was preferred over the model including WH Schedule. This was opposite as expected, since this finding suggested that WH Schedule did not increase prediction performance.

The second hypothesis test showed that, when adding the variables Gender, Age, Education and the variable Physically Demanding, the AIC score favored the model excluding WH Schedule. This finding indicated that even when adding the control variables, WH Schedule did not improve prediction performance. However, both models scored substantially better compared to the NULL model. This finding was expected, since results from earlier studies had indicated that the variables in combination with the type of work hour schedule did influence physical health outcome
(Costa, 2015; Karlsson et al., 2001; Kuhn, 2001; Lipscomb et al., 2002; Moline et al., 1992). A possible explanation for the fact that the model excluding WH Schedule received a better AIC score, was that the model including the variable was penalized for having too many parameters.

The third hypothesis test assessed the influence of the individual variables in combination with WH Schedule. It was found that both models for the variables Gender, Age and the combination of Gender and Age were favored by the AIC value. As opposed to what was expected, the results showed that the models including the variables as control variables were favored over the models where they were used as an interaction. However, an explanation could be that the interaction included too many parameters that were penalized, leading to a higher value compared to the model where the variable was included as control variable.

The final aspect of health that was assessed was mental health. Two main explanations have been found for the association between irregular work hours and mental health (Haines III et al., 2008). The first explanation is that sleepiness caused by disturbance of the circadian rhythm might negatively affect one's ability to respond to stressors leading to mental health problems (Haines III et al., 2008). The other explanation is that mental health issues derive from social interruptions or disturbances that are caused by working irregular hours (Haines III et al., 2008). Based on the findings from earlier studies, the expectation for the current study was that WH Schedule does have an influence on mental health. However, the results from the first hypothesis test showed that the NULL model was preferred over the model including WH Schedule when predicting Psych Visits. This was contradicting the expectation that irregular work hours influence mental health (Costa, 2014; Haines III et al., 2008).

The second hypothesis test concerned models that included all control variables (Gender, Age, Education and Mentally Demanding). The results showed that the AIC value favored the model excluding WH Schedule. However, the NULL model was preferred over both the model including and excluding WH Schedule. The AIC scores suggested that both models did not improve the prediction of the mental health. This was opposite as to what was suggested by earlier research, since studies found that mental health outcomes were mediated by both the control variables and irregular work hour schedules (Bara & Arber, 2009; Conway et al., 2008; Driessen et al., 2011; Sato et al., 2002).

The outcomes of the third hypothesis test for Psych Health showed that only for the variable

Mentally Demanding the interaction was favored over the model where the variable was used as control variable. However, no conclusions can be based on this finding, since the NULL model was preferred over all models, including the models for the variable Mentally Demanding. This was a striking finding, since earlier research showed that the discussed variables in combination with WH schedule did mediate mental health outcomes (Bara & Arber, 2009; Conway et al., 2008; Driessen et al., 2011; Sato et al., 2002). However, the outcomes for Psych Visits were highly skewed, which may have biased the results since unbalanced groups may cause problems for logistic regressions that are difficult to overcome

5.2 Theoretical Implications

The results in this research should be interpreted in the context of its limitations. First of all, the sample size and distribution of the outcomes should be discussed. Overall, the population size was sufficient to execute the regressions. However, it was planned to add a hypothesis test to compare models that contained an interaction of all the control variables and to compare it with the interaction that also included WH Schedule. Unfortunately, this hypothesis test could not be examined, as this caused the model to have a perfect separation of cases which halted convergence. Although a perfect separation can be the optimal outcome, in this case it indicated that the sample size was too small to observe specific events with low probabilities. Additionally, even though the dataset used contained data of 1850 respondents, the outcomes for the independent- and dependent variables were not evenly divided. To start with, the outcomes of the variable WH Schedule (‘never’, ‘sometimes’ and ‘often’) were not evenly distributed over the population. 22.38% indicated to ‘often’ work irregular hours, whereas 44.27% indicated to ‘never’ work irregular hours. The dependent variables also showed unevenly distributed outcomes, especially the variable Psych Visits had a skewed distribution: 95.40% made one visit and 4.6% were grouped as one visit. These distributions might have biased the results of the current study. For further research, it might be relevant to analyze data with more evenly distributed outcomes.

Furthermore, the pre-processing of the variables might have influenced the outcomes. Especially for the outcomes of Medical Visits and Psych Visits it could be argued that the pre-processing could have been done differently. The final grouping of visits to both the medical specialist as to a psychologist was either ‘0’ or ‘1’. This grouping was motivated by the fact that further separation would lead to groups with insufficient inputs. However, the group ‘1’ for Medical Visits included values from 1 to 6, and Psych Visits 1 to 10. It could be argued that an employee visiting a psychologist 10 times has more potential mental health issues compared to an employee visiting a psychologist once.

The evaluation used in this study also has some limitations. By using the AIC to compare models, the analyses were focused on quantifying the tradeoff between adding parameters to the model and improving the amount of variance, while controlling for complexity. By doing this, it did not quantify

prediction errors by itself. Nonetheless, for the aim of the current study, it was argued that AIC would be an appropriate evaluation method. This was motivated by the fact that the data of this study had relative small amounts of instances for some events. It was therefore essential to use a model that would not be too complex, but complex enough to capture the relationships between variables. However, by evaluating the models using AIC, it could not be assesses how the coefficients differed across groups. For further research it might be interesting to interpret the coefficients to make more specific expectations, such as what group of age would be most affected by working a specific regularity of irregular hours. Moreover, when a larger sample and a more complex model would be used, it would be possible to predict new dependent values given new cases.

5.3 Conclusion

This exploratory study examined how different aspects of health were influenced by irregular work hour schedules. Regarding the aspects of health, this study distinguishes between subjective general health, physical health and mental health. In accordance to earlier findings, this study also examined the effect of mediating factors such as gender, age, education and the degree to which work is physically or mentally demanding.

By examining the association between work hour schedules and health, this research contributed to the knowledge on how irregular work hours affect employees in the 24-hours society. While the reviewed literature suggested that irregular work hours affect all three aspects of health, the findings from this study indicated that all aspects of health were best predicted by the model excluding information about work hour schedules. This either indicated that the model including that information was penalized for having too many parameters, or it indicated that solely information about work hour schedule was not enough to predict health outcomes. When adding the control variables to the model, it was found that only for subjective general health the model including information about work hour schedule improved prediction compared to the model excluding this information. The final element for all aspects of health concerned assessing the effect of the mediating factors in combination with information on work hour schedule individually. As opposed to what was expected based on the literature, the interactions between the mediating factors and types of work hour schedules did not show to improve the prediction performance for any aspect of health. The overall findings of this study suggest that the impact of irregular work hours on health is less detrimental as expected. Regarding the potential mediating factors, the influences were different for all three aspects of health. For further research, it would be interesting to explore the effect of irregular work hours and the mediating effect of multiple variables in more depth by using a larger sample size and a different evaluation method.

6. References

Åkerstedt, T. (2003). Shift work and disturbed sleep/wakefulness. *Occupational medicine,* 89-94.

Åkerstedt, T., & Wright, K. (2009). Sleep loss and fatigue in shift work and shift work disorder. *Sleep medicine clinics,* 257-271.

Andrea, H., Bültmann, U., Beurskens, A. J. H. M., Swaen, G. M. H., Van Schayck, C. P., & Kant, I. J.H. (2004). Anxiety and depression in the working population using the HAD Scale. *Social psychiatry and psychiatric epidemiology,* 637-646.

Bara, A., & Arber, S. (2009). Working shifts and mental health–findings from the British Household Panel Survey (1995–2005). *Scandinavian Journal of Work, Environment & Health,* 361-367.

Birnbaum, H. G., Kessler, R. C., Kelley, D., Ben-Hamadi, R., Joish, V. N., & Greenberg, P. E. (2010). Employer burden of mild, moderate, and severe major depressive disorder: mental health services utilization and costs, and work performance. *Depression and anxiety,* 78-89.

Bonnefond, A., Härmä, M., Hakola, T., Sallinen, M., Kandolin, I., & Virkkala, J. (2006). Interaction of age with shift-related sleep-wakefulness, sleepiness, performance, and social life. *Experimental aging research,* 185-208.

Cole, R. J., Loving, R. T., & Kripke, D. F. (1989). Psychiatric aspects of shiftwork. *Occupational medicine (Philadelphia, Pa.),* 301-314.

Conway, P. M., Campanini, P., Sartori, S., Dotti, R., & Costa, G. (2008). Main and interactive effects of shiftwork, age and work stress on health in an Italian sample of healthcare workers. *Applied Ergonomics,* 630-639.

Costa, G. (1996). The impact of shift and night work on health. *Applied ergonomics,* 9-16.

Costa, G. (2003). Shift work and occupational medicine: An overview. *Occupational Medicine,* 83-88.

Costa, G. (2015). Sleep deprivation due to shift work. *Handbook of clinical neurology,* 437-446.

Costa, G., Åkerstedt, T., Nachreiner, F., Baltieri, F., Carvalhais, J., Folkard, S., Dresen, M.F., Gadbois, C., Gartner, J., Sukalo, H.G., & Härmä, M. (2004). Flexible working hours, health, and well-being in Europe: some considerations from a SALTSA project. *Chronobiology international,* 831-844.

Devine, C. M., Farrell, T. J., Blake, C. E., Jastran, M., Wethington, E., & Bisogni, C. A. (2009). Work conditions and the food choice coping strategies of employed parents. *Journal of nutrition education and behavior,* Volume 41, 365-370.

Donnelly, K., Twenge, J. M., Clark, M. A., Shaikh, S. K., Beiler-May, A., & Carter, N. T. (2016). Attitudes toward women's work and family roles in the United States. *Psychology of Women Quarterly,* 41-54.

Driesen, K., Jansen, N., van Amelsvoort, L., & Kant, I. (2011). The mutual relationship between shift work and depressive complaints–a prospective cohort study. *Scand J Work Environ Health*, 402-410.

Fryers, T., Melzer, D., & Jenkins, R. (2003). Social inequalities and the common mental disorders. *Social psychiatry and psychiatric epidemiology*, 229-237.

Garey, A. I. (1995). Constructing motherhood on the night shift: "Working mothers" as "stay-at-home moms". *Qualitative sociology*, 415-437.

Haines III, V. Y., Marchand, A., Rousseau, V., & Demers, A. (2008). The mediating role of work-to-family conflict in the relationship between shiftwork and depression. *Work & Stress*, 341-356.

Hakola, T., Härmä, M., & Laitinen, J. (1996). Circadian adjustment of men and women to night work. *Scandinavian journal of work, environment & health*, 133-138.

Halpern-Manners, A., Schnabel, L., Hernandez, E. M., Silberg, J. L., & Eaves, L. J. (2016). The Relationship between Education and Mental Health: New Evidence from a Discordant Twin Study. *Social Forces*, 107-131.

Ha, M., & Park, J. (2005). Shiftwork and metabolic risk factors of cardiovascular disease. *Journal of occupational health*, 89-95.

Hessman, T. (2013). *Manufacturer IT Applications Study: Finding the Real Cost of Downtime.* [Online] Available at: http://www.industryweek.com/information-technology/manufacturer-it-applications-study-finding-real-cost-downtime?page=1

Hublin, C., Partinen, M., Koskenvuo, K., Silventoinen, K., Koskenvuo, M., & Kaprio, J. (2010). Shift-work and cardiovascular disease: a population-based 22-year follow-up study. *European journal of epidemiology*, 315-323.

Karlsson, B., Knutsson, A., & Lindahl, B. (2001). Is there an association between shift work and having a metabolic syndrome? Results from a population based study of 27 485 people. *Occupational and environmental medicine*, 747-752.

Kim, H., & Young, T. (2005). Subjective daytime sleepiness: dimensions and correlates in the general population. *Sleep*, 625-634.

Knutsson, A. (1989). Shift work and coronary heart disease. *Scandinavian Journal of Social Medicine. Supplementum*, 1-36.

Knutsson, A., & Boggild, H. (2000). Shiftwork and cardiovascular disease: review of disease mechanisms. *Reviews on environmental health*, 359-372.

Kuhn, G. (2001). Circadian rhythm, shift work, and emergency medicine. *Annals of emergency medicine*, 88-98.

Larget, B. (2003). *AIC and BIC(PDF).* [Online] Available at: http://www.stat.wisc.edu/courses/st333-larget/

Lipscomb, J. A., Trinkoff, A. M., Geiger-Brown, J., & Brady, B. (2002). Work-schedule characteristics and reported musculoskeletal disorders of registered nurses. *Scandinavian journal of work, environment & health,* 394-401.

McClain, J. J., Lewin, D. S., Laposky, A. D., Kahle, L., & Berrigan, D. (2014). Associations between physical activity, sedentary time, sleep duration and daytime sleepiness in US adults. *Preventive medicine,* 68-73.

Moline, M., Pollak, C. P., Monk, T. H., & Lester, L. S. (1992). Age-related differences in recovery from simulated jet lag. *Sleep,* 28-40.

Pantzar, M. (2010). Future Shock – Discussing the Changing Temporal Architecture of. *Journal of Futures Studies,* 1-22.

Radesky, J., Miller, A. L., Rosenblum, K. L., Appugliese, D., Kaciroti, N., & Lumeng, J. C. (2015). Maternal mobile device use during a structured parent–child interaction task. *Academic pediatrics,* 238-244.

Rajaratnam, S. M. & Arendt, J. (2001). Health in a 24-h society. *The Lancet,* 999-1005.

Reilly, T., Waterhouse, J., & Atkinson, G. (1997). Aging, rhythms of physical performance, and adjustment to changes in the sleep-activity cycle. *Occupational and Environmental Medicine,* 812-816.

Sato, M., Yonezawa, H., Ishizu, M., Suga, K., & Ikemoto, R. (2002). The relationship between cumulative fatigue and subjective feeling of sleepiness in nurses working three consecutive shifts. *J Jpn Soc Nurs Health,* 28-35.

Schernhammer, E. S., Laden, F., Speizer, F. E., Willett, W. C., Hunter, D. J., Kawachi, I., & Colditz, G. A. (2001). Rotating night shifts and risk of breast cancer in women participating in the nurses' health study. *Journal of the National Cancer Institute,* 1563-1568.

Scott, A. (2000). Shift work and health. *Primary Care: Clinics in Office Practice,* 1057-1078.

Selvi, Y., Özdemir, P. G., Özdemir, O., Aydin, A., & Besiroglu, L. (2010). Influence of night shift work on psychologic state and quality of life in health workers. *Düşünen Adam: The Journal of Psychiatry and Neurological Sciences,* 238-243.

Smith, C. S., Folkard, S., & Fuller, J. A. (2003). Shiftwork and working hours. *Handbook of occupational health psychology,* 163-183.

Snipes, M., & Taylor, D. C. (2014). Model selection and Akaike Information Criteria: An example from wine ratings and prices. *Wine Economics and Policy,* 3-9.

Tinnilä, M. (2012). Impact of future trends on banking services. *Journal of Internet Banking and Commerce,* 1-15.

van der Heide, I., Wang, J., Droomers, M., Spreeuwenberg, P., Rademakers, J., & Uiters, E. (2013). The relationship between health, education, and health literacy: results from the Dutch Adult Literacy and Life Skills Survey. *Journal of health communication,* 172-184.

Vogel, M., Braungardt, T., Meyer, W., & Schneider, W. (2012). The effects of shift work on physical and mental health. *Journal of neural transmission,* 1121-1132.

Wang, X. S., Armstrong, M. E. G., Cairns, B. J., Key, T. J., & Travis, R. C. (2011). Shift work and chronic disease: the epidemiological evidence. *Occupational medicine,* 78-89.

Zhu, J., Hjollund, N., Boggild, H., & Olsen, J. (2003). Shift work and subfecundity: a causal link or an artefact? *Occupational and environmental medicine*, 12-17.

7. Appendix

Table 1

Grouping levels of education

Education levels
Non educated
Did not complete any education
Did not complete primary school
Primary school
Lower and continued special education
VGLO (continued lower education)
VMBO
LBO (lower professional education)
Lower technical school, household school
MULO, ULO, MAVO (lower/intermediate secondary education; US: junior high school)
VMBO vocational training program (preparatory intermediate vocational school)
VMBO theoretical or combined program (preparatory intermediate vocational school)
HAVO/VWO/MBO
MMS (intermediate girls' school)
HBS (former pre-university education, US: senior high school)
HAVO (higher general secondary education; US: junior high school)
VWO (pre-university education, US: senior high school)
Gymnasium, atheneum, lyceum (types of pre-university education programs)
KMBO (short intermediate professional education MBO), VHBO (preparatory higher professional education)
MBO professional training program (intermediate professional education) (BOL)
MBO professional training program (intermediate professional education) (BBL))
MBO-plus to access HBO, short HBO education (less than two years) (higher professional education)
HBO
HBO (higher professional education), institutes of higher education, new style
Teacher training school
Conservatory and art academy

University

Academic education (including technical and economic colleges, former style) bachelor's degree (kandidaats)

Academic education (including technical and economic colleges, former style) master's degree (doctoraal)

Academic education, bachelor

Academic education, master

Doctor's degree (Ph.D, including doctoral research program to obtain Ph.D)

Other
