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Towards an Integrated Model: The Joint Effect of Work Shift Design and Organizational Policies in Preventing Shift Work Disorder

Sofia de Lima Valentim

MSc in Social and Organizational Psychology

Advisor:

Doutor Nelson Campos Ramalho, Associate Prof., ISCTE Instituto Universitário de Lisboa

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CIÊNCIAS SOCIAIS
E HUMANAS

Department of Social and Organizational Psychology

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Resumo

O trabalho por turnos é uma necessidade para o funcionamento da sociedade atual, contudo, pode influenciar o relógio circadiano natural e conduzir ao Distúrbio do Trabalho por Turnos (SWD), um distúrbio caracterizado por sintomas de insónia e sonolência associados ao horário de trabalho e que acarreta diversas consequências negativas para a saúde e segurança dos indivíduos. Até então a literatura tem-se dedicado a estudar diferentes preditores de natureza individual e organizacional que podem representar um maior risco para a prevalência da SWD, contudo, apenas de forma paralela. É desta lacuna na literatura que surge o modelo proposto nesta dissertação, que procura perceber exatamente qual o papel moderador do desenho dos turnos e o papel das políticas organizacionais na relação entre características como o sexo, idade e tempo de sono, e a SWD. Para tal, 212 enfermeiros preencheram voluntariamente um questionário que incluiu estes diferentes conceitos, tendo-se verificado que o sexo e o tempo de sono estão significativamente associados à SWD. Adicionalmente, o desenho dos turnos e as políticas organizacionais revelaram ser moderadores significativos na relação entre a idade e a SWD. Já as políticas organizacionais não demonstraram moderar o papel do desenho dos turnos entre nenhuma das variáveis individuais e a SWD. Estes resultados alertam para a importância de um bom desenho dos turnos e da implementação de boas práticas organizacionais para os trabalhadores mais velhos, enquanto compreendemos que estas podem não ser suficientes para mitigar os efeitos negativos de um mau desenho de turnos.

Palavras-chave: relógio circadiano, distúrbio do trabalho por turnos, desenho dos turnos, políticas organizacionais

Códigos de Classificação da APA:

3365 Promotion & Maintenance of Health & Wellness

3670 Working Conditions & Industrial Safety

Abstract

Shift work is a need for the functioning of today's society, however, it can influence the natural circadian clock and lead to "Shift Work Disorder" (SWD), which is characterized by insomnia and sleepiness symptoms associated with work schedule and that carries several negative consequences for individuals' health and safety. So far, the literature has been focused on studying different predictors of individual and organizational nature that may pose a higher risk for SWD prevalence, but only in a parallel way. It is from this gap in the literature that the model proposed in this dissertation emerges, which intends to understand the moderating role of shift design and the role organizational policies may play in the relationship between characteristics such as gender, age, and sleep time, and SWD. For this purpose, 212 nurses voluntarily completed a questionnaire that included these different concepts, and it was found that gender and sleep time are significantly associated with SWD. Additionally, shift design and organizational policies proved to be significant moderators in the relationship between age and SWD. Organizational policies, on the other hand, were not shown to moderate the role of shift design between any of the individual variables and SWD. These results alert us to the importance of a proper shift design and the implementation of good organizational practices for older workers, while we also understand that these may not be sufficient to mitigate the negative effects of poorly design work shifts.

Keywords: circadian clock, shift work disorder, shift design, organizational policies

APA Classification Codes:

3365 Promotion & Maintenance of Health & Wellness

3670 Working Conditions & Industrial Safety

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Introduction

One of the consequences of modernity is the extension of natural daylight by means of artificial illumination and concomitantly the introduction of night activities linked to leisure or work. In large metropolis the organization of society produced a 24/7 work productive activity that forcefully pushes individuals to work rhythms that may conflict with natural circadian rhythms (James et al., 2017). Shift work has been researched as regards its consequences mostly upon health and sleep rhythms and quality (Pallesen et al., 2021). The negative consequences have been so greatly found that experts coined a nosological entity: Shift Work Disorder (SWD, Wright Jr, Bogan, & Wyatt, 2013).

SWD is characterized by a circadian rhythm sleep disorder associated with work shifts that occur in normal sleeping time, which is observable by sleepiness or insomnia (AAoSM, 2005, 2014). To keep the 24/7 production strategy, mostly in manufacture, organizations have all the interest in tackling SWD to which they strategically design shifts and establish policies aimed to mitigate its effects or eventually prevent its emergence.

Literature has been exploring this topic researching which individual and organizational factors predispose or increase SWD prevalence (e.g., Chen et al., 2020; Vedaa et al., 2016). Papers produced on this topic suggest its complex nature and tend to focus on individual factors, work design factors, and on some organizational factors. However, despite authors acknowledge SWD as a joint product of individual and organizational factors, extant models tend to treat them as parallel predictors. This is not fully in line with the joint effects idea which would better match an interaction effect. Thus, we reason there is a research gap in further exploring such interactional models.

Additionally, SWD has been treated as a clinical disorder, i.e., as a nosological expression of a set of symptoms that has been measured as a binary variable (e.g., Pallensen et al., 2021). This is consistent with clinical research, but it may not fully depict the reality because SWD may occur with different intensities until it eventually reaches clinical expression. It is in the best interest of individuals and organizations to be able to measure SWD intensity before it achieves any extreme value that matches a nosological classification. This too is a research opportunity that can be easily made by operationally defining SWD in a non-binary scale.

With this in mind, this thesis is designed to test individual-organizational interaction effects to explain SWD intensity. For this purpose, we will start by reviewing literature that shows the evolution from natural rhythms to the rhythms created in today's society, the importance of sleep in the regulation of the circadian rhythm, and the challenge that work shifts represent. In this context, SWD and the main individual and organizational factors that seem to increase individuals' vulnerability to this disorder are presented. Based on this, a conceptual model is proposed that crosses individual factors with organizational factors to explain SWD, in an attempt to understand the role of organizations in managing shift work. The thesis proceeds by showing the methods used to empirically test this model followed by findings pertaining to direct and interaction effects. Findings are discussed at the light of theory reviewed and conclusions drawn highlighting both contributions for theory and application.

CHAPTER 1

The Circadian Imperative

1.1. Natural Rhythms and Human Made Rhythms

Light is essential to detect objects (Palczewski, 2012) but also for the regulation of certain behavioral and physiological functions that relate to the internal circadian clock to light and changes in sleep and alertness (LeGates et al., 2014). Organisms developed through evolution their own temporal systems in order to anticipate and adapt to daily and seasonal light cycles (Potter et al., 2016). Individuals have in-built temporal programs that create approximately a 24-hour rhythm (Roenneberg & Merrow, 2016) including a repair sleep so that it occurs at a particular time in the day/night cycle, while a homeostatic mechanism tracks the need for sleep (LeGates et al., 2014).

The circadian clock is related to different functions, including sleep/wake cycles and the metabolic cycle, as well as different hormonal changes (Fuhr et al., 2014). In turn, a proper adjustment between light, the circadian clock and all the behaviors associated with it, produces a temporal order in organisms that proves essential to ensure survival (Hastings et al., 2003).

However, one of the most important inventions in History, Thomas Edison's electric light bulb, in 1879, seems to have disturbed the circadian rhythm (Potter et al., 2016). Electric lighting led to a reduction in exposure to natural light during the day and to increased exposure to light after sunset, and the circadian rhythm continues to synchronize with solar time such that the beginning of the internal biological night occurs at sunset and the end of it occurs before the time of awakening, immediately after sunrise (Wright Jr, McHill, et al., 2013). According to a review by Stevens and Zhu (2015) there is indication that such disruption is not without serious negative consequences. One of the focal points of the research conducted on this issue is sleep. Therefore, researchers have been interested in understanding the influence sleep has on the circadian clock because sleeping is mostly the only time individuals are expected to be exposed to real darkness (Roenneberg et al., 2013).

1.2. Sleep and its Importance

Since sleep is shown to be a crucial factor in the circadian clock, it becomes necessary to understand why it is so important and what phases it comprises. Sleep deprivation has been associated with several negative health outcomes. Namely, it has been related with several causes of death, such as cardiovascular disease, malignant neoplasm, cerebrovascular disease, diabetes, hypertension, and sepsis (Kochanek et al., 2014) as well as with driving or work accidents (Moradi et al., 2019; Åkerstedt et al., 2002). It has also been associated with negative social outcomes including compromised performance at school and work (Mehta, 2022).

Based on the International Classification of Sleep Disorders (ICSD-3, AAoSM, 2014), insufficient sleep is defined as "a curtailed sleep pattern that has persisted for at least three months for most days of the week, along with complaints of sleepiness during the day" (Chattu et al., 2019, p.2). According to these same authors, it is also important not to confuse insufficient sleep with insomnia, as the first concerns the lack of opportunity to sleep, while the last is characterized by the inability to sleep despite the opportunity to do so.

Sleep can be divided into two major phases: REM sleep (rapid eye movement sleep, also called paradoxical sleep) and non-REM sleep. This the last phase can be divided into more phases, called N1, N2 and N3, with the last one corresponding to the deep sleep phase (Brown et al., 2012). Additionally, the time, depth, and duration of sleep are controlled by the interaction of the time of the day (circadian control) and the duration of the previous waking period (homeostatic control), as proposed in Borbély's revised two-process model (Borbély et al., 2016). Therefore, a proper coordination between circadian and homeostatic mechanisms improves sleep quality (LeGates et al., 2014).

1.3. Challenging the Circadian Rhythms: Work Shifts

Research has been focusing on sleep deprivation consequences for individual performance in various tasks, including in the workplace. However, it has also questioned to which extent the working conditions themselves cause insufficient sleep or even a sleep disorder. Several studies converge on showing that shift work and night work have a very detrimental impact on health, performance, and safety (Pallesen et al., 2021). In a 24/7 society this becomes a critical issue as artificial light and counter-natural night rhythms become a certainty for a large part of the population, namely individuals working in operations that work for public safety and health (e.g., police and hospitals) (James et al., 2017; Wagstaff & Lie 2011).

The European 2003/88/EC Directive (EU Parliament & EU Council, 2003) states that shift work can be defined as work in different shifts, e.g., morning, evening, and night, and may differ in different dimensions, such as in intensity and speed of rotation. In turn, Sallinen and Kecklund (2010) refer to shift work as “a wide range of work hour arrangements involving two or more teams (shifts) that differ in terms of the starting and finishing times of their work.” (p.121).

Pallesen et al. (2010) indicate that shift work and night work have several negative consequences on the health of individuals and several authors show us the different diseases associated with these working arrangements, such as cancer (Pahwa et al., 2018), impaired reproductive health (Stocker et al., 2014) and mental health (Torquati et al., 2019), among others. In turn, these can also lead to fatigue, which consequently is at the origin of several work accidents (Fischer et al., 2017; Williamson et al., 2011). In addition, other authors also show us that shift and night work are associated with other negative outcomes for the organization, such as low job satisfaction and low organizational commitment (Jamal, 1981), burnout (Kandonlin, 1993), and turnover or turnover intention (Flinkman et al., 2008). Harmful consequences extend also to the individuals' social and family life (Demerouti et al., 2004), as working irregular hours means that shift workers have limited time to spend with their families and friends, which can lead to work-family/social conflict (Shiffer et al., 2018)

The truth is that the mechanisms underlying the negative consequences of shift work and night work are not fully understood, however, and in line with what was mentioned regarding the existence of a natural circadian cycle that regulates human functioning, Kecklund and Axelsson (2016) believe that these mechanisms may involve circadian disruption leading to neuroendocrine and cardiometabolic stress and reduced and disturbed sleep, leading to altered immune functioning and cellular stress, and risky behaviors and psychosocial stress with cognitive impairment and poor emotional regulation. Other authors reinforce these claims by reporting that shift work impacts sleep as it is closely related to circadian rhythm and that disruptions or changes in work schedules lead to disruptive sleep patterns and can cause sleep disturbance (e.g., Booker et al., 2018; Linton et al., 2015).

CHAPTER 2

Shift Work Disorder

As a consequence of the circadian disruptions due to work shift, the first edition of the International Classification of Sleep Disorders (American Sleep Disorders Association, 1990) coined the term "shift work sleep disorder", nowadays called "Shift Work Disorder" (SWD).

According to Wright Jr, Bogan, and Wyatt (2013), SWD is believed to occur in a "subset of shift workers who are especially vulnerable to shift work schedules and thus they demonstrate clinically significant levels of sleepiness during the work shift, clinically significant sleep disruption before or after the work shift, or both sleepiness and insomnia" (p.45) and can have negative consequences for the health, performance and safety of individuals at work and during commuting time, as well as impacting other aspects of individuals' quality of life. Thus, SWD is a circadian rhythm sleep-wake disorder, and it is "characterized by sleepiness and insomnia, which can be attributed to the person's work schedule" (Flo et al., 2012, p.1). In turn, Pallensen et al. (2021) conducted a systematic review in which they checked the prevalence of this disorder in 29 different studies, leading to an overall value of 26.5% prevalence of SWD. The authors report that the prevalence was relatively high across studies and suggest that approximately one in four shift workers are affected by it.

According to the second edition of the International Classification of Sleep Disorders (ICSD-2, AAoSM, 2005), the diagnosis of SWD is based on four fundamental criteria. These are: (1) complaint of insomnia or excessive sleepiness that is related, temporally, to a recurring work schedule that requires the individual to work during usual sleeping time; (2) symptoms are associated with shift work schedule over the course of a month (3) sleep log or actigraphy monitoring for at least seven days demonstrates a circadian misalignment and disturbance in sleep timing; and (4) the sleep disturbance is not better attributable to another current sleep disorder, medical or neurological disorder, mental disorder, medication use, or substance use disorder .

However, with the release of the third edition of the International Classification of Sleep Disorders (ICDS-3, AAoSM, 2014), three major changes were made with regard to these criteria, namely: (1) complaint of insomnia/sleepiness must be combined with a reduction in total sleep time; (2) the duration of symptoms must persist for at least three months; and (3) sleep log or actigraphy monitoring must be conducted for at least 14 days (instead of seven) and need to include not only work days but also days off.

Taking into account the negative consequences that shift work can lead to, and given its undeniable need in today's world, it is important that organizations understand and seek to know more about the predictors that can make people more susceptible to SWD, in an attempt to identify the best alternatives and strategies to overcome its negative impact on the individuals' lives, on the organization itself, and on the lives of all those who benefit from the services provided by such entities. Thus, considering its nature, we can divide the variables that influence SWD into individual and organizational factors.

From the Organizational Psychology perspective, we are mainly interested in understanding the organizational factors, to understand what organizations can change and where they should focus their efforts to reduce the prevalence and implicit effects of SWD.

As such, the next sections aim to summarize the main predictors of SWD portrayed in the literature, with a particular focus on nurses, who are a population with special attention in the study of this topic, since they provide services that, in most cases, provide 24-hour care, including night work (Korompeli et al., 2014).

2.1. Individual Factors

2.1.1. Physiological Predictors

Although there are several individual physiological variables studied throughout the literature, we highlight four major predictors: gender, age, circadian chronotype/circadian preference (morningness or eveningness type), and circadian flexibility/languidity. With regard to *gender*, many studies have been conducted to understand the impact that being male, or female may have on the adaptation to work shifts. In turn, the results have been diverse, and there is no consensus regarding the relationship between this variable and SWD. While some authors found no association of gender with insufficient sleep/ sleep quality (e.g., Chan, 2008), Flo et al. (2012), for example, conducted a study with a group of nurses where they found that being female reduced the risk of developing SWD and, accordingly, other authors found that being male was associated with a higher risk of developing SWD (e.g., Flo et al., 2014; Waage et al., 2014).

On the other hand, Saksvik et al. (2011) conducted a systematic review where they demonstrated that, generally, men have a higher tolerance for shift work, and, for example, Rouch et al. (2005) demonstrated that there was a significant increase in sleep disturbance scores among women working shifts, but this increase was not significant in men. In turn, Winwood et al. (2006) conducted a study with nurses, where they mention that gender influences the ability of individuals to manage the pressure of shift work, with women showing greater intolerance to this work format than men, which Fullick et al. (2009) and Sack at al. (2007) associate with social factors, stating that women tend to be more involved in domestic and household obligations.

Additionally, literature shows that *age* seems to be positively associated with SWD (e.g., Waage et al., 2014). That said, insufficient sleep was found to be positively linked with older age (Chan 2008) and it is also positively associated with sleep disturbances (Costa et al., 2014). Likewise, older workers appear to be less able to adapt to the circadian changes that shift work requires (Härmä et al., 1994) and, accordingly, age seems to be a risk factor for individuals' tolerance to shift work (Sack et al., 2007). Insomnia is also positively associated with age, which, according to Wickwire et al. (2017), may increase older workers' vulnerability to SWD. The same authors indicate that, although the neurophysiological mechanisms are unclear, it seems that the increased vulnerability associated with age is related to several changes affecting the homeostatic and circadian sleep-wake systems.

According to Di Milia et al. (2005), circadian rhythms differ with respect to phase, amplitude, and stability. Keeping this in mind, each individual's *circadian preference* (morning-type vs. evening-type), as well as the *levels of stability* (flexibility/rigidity) and *amplitude* (languidity/vigorousness) of their circadian rhythm, may be predictors of SWD. These variables are part of everyone’s circadian rhythm and seem to impact how each individual responds to shift work. In accordance with Wickwire et al. (2017), an individual's level of morningness/eveningness refers to the period (or periods) of the day when they feel most active and awake. Individuals who have a greater tendency toward morning-type are more awake and function better in the early morning hours. Conversely, individuals who have a greater tendency toward evening-type are those whose period of greatest functioning and awakening is at the end of the day or at night. In turn, flexibility refers to the ability of individuals to sleep and work at "unconventional" times of the day, while languidity demonstrates the difficulty that individuals have in overcoming sleepiness and lethargy following a reduction in sleep period (Di Milia et al., 2005). That said, several studies (e.g., Chen et al., 2020; Flo et al., 2012) have shown that shift workers with higher level of morningness, i.e., who are characterized as morning-type, have a higher susceptibility/vulnerability to SWD, while those that have higher levels of flexibility have been associated with a greater ability to adjust to this work mode (acting as a protective factor), and, lastly, higher levels of languidity seem to be associated with a greater intolerance to different work schedules (acting as a risk factor).

2.1.2. Behavioral Predictors

In addition to the individual physiological predictors, literature places a focus on some behavioral habits that may impact the way shift workers cope with work shifts. We can then highlight coffee consumption, alcohol consumption, physical exercise, and the number of hours of sleep (sleep time) that individuals get per day.

About *coffee consumption*, Lowden et al. (2010) state that shift workers may increase their consumption of coffee or other drugs in an attempt to help them stay awake at night (acting like a coping strategy). This, however, may bring consequences for their health. According to a systematic review conducted by Clark and Landolt (2017), caffeine has been shown to prolong sleep delay, as well as reduced individuals' total sleep time and efficiency, and even worsened participants' perceived sleep quality.

As for *alcohol consumption*, Chen et al. (2020) conducted a raw analysis where they found that after six months of shift work, drinking alcohol between one and three times per month was associated with a higher risk of having SWD. Furthermore, Härmä et al. (1998) found that alcohol consumption did not essentially increase daytime sleepiness or insomnia in daytime workers, but that these increased in individuals who worked three shifts and that, in addition, insomnia also increased in individuals who worked irregular shifts. Richter et al. (2021) also conducted a systematic review where they show that shift work is associated with disorders related to excessive alcohol consumption in different occupations, and that this consumption may act as "self-medication" for sleep problems or as a way to deal with stress and some psychosocial problems that are associated with shift work, reinforcing the importance of these results for prevention programs against sleep disorders.

On the other hand, *physical exercise* has been portrayed in the literature as a protective factor. Similar to the study on the impact of alcohol consumption, Chen et al. (2020) focused on the role physical exercise plays in shift workers and found (also in a raw analysis) that weekly physical exercise worked as a protective factor against SWD. In addition, they found that healthier nurses exercised more than nurses with SWD. In the same vein, Barger et al. (2004) showed that physical exercise can facilitate the readaptation to an altered light-dark and sleep-wake cycle, which allows us to believe that this practice may be an important factor in preventing SWD.

With regard to the number of hours that individuals sleep per day, i.e., the *duration of sleep*, it is important to note that, as a general rule, sleeping less than seven hours a day can bring negative consequences for health and safety (Banks & Dinges, 2007). In turn, we realize that sleep problems are common among shift workers, with SWD being triggered precisely by changes in circadian rhythm, leading to symptoms of sleepiness and insomnia (Wright Jr, Bogan, & Wyatt, 2013). With this in mind, sleep duration is a plausible key predictor for SWD, and it is important that shift workers sleep in their free time, even though Costa et al. (2006) show that this can sometimes be difficult due to the conflict between work-life, since some factors, such as social pressure (e.g., domestic obligations, spending time with family, etc.) and having some leisure time, may contribute to short sleep duration in shift workers.

2.1.3. Contextual Predictors

Finally, and because each person is involved in different environments and circumstances, it is important to highlight some of the individual contextual variables that may be associated with SWD. Literature reports some of these variables, however, we highlight: commuting time between work-home, and having (or not) children aged three years old or younger.

Regarding *commute time* (between home-work and vice versa), Hirsch-Allen et al. (2014) conducted a study with a sample of nurses to unsurprisingly found an increase in commute time resulted in a reduction in sleep time. In fact, each minute in the commute to and from work was related to a 0.84-minute reduction in the individuals' sleep duration, stating that measures to increase sleep duration and reduce sleep deprivation may include some efforts to reduce these commute times. Similarly, other authors (e.g., Christian, 2012; Kim et al., 2019) have found that long commuting times were significantly associated with sleep problems. Thus, since this variable is particularly related to sleep, we believe that it may have an impact on the long-term onset of SWD in shift workers.

Having children also seems to be related to sleep quality, since Chan (2008) found that having children was positively associated with insufficient sleep, and Kurumatani et al. (1994) showed that having children was associated with shorter sleep duration compared to those without children. In turn, Bax (1980) reports that during the first five years of children's lives, their waking rates are about 20% in the first two years of life, with a slight decline at ages three and four, but a major problem in perhaps 10% of families with children aged four and a half.

Keeping in mind all the mentioned variables, and from an organizational viewpoint, it is age and gender the ones that can be firstly addressed and thus we intend to highlight those in this study. Also, these two variables seem to be associated with some of the others. For example, some authors found gender differences in morningness–eveningness preference (e.g., Adan & Natale, 2002; Randler, 2007) and Marcoen (2015) verified that there were gender differences in subjective circadian flexibility. In turn, some authors found that there were age differences in the morningness–eveningness preference (Paine et al., 2006) and with alcohol consumption

(Chan et al., 2007). For these reasons, and despite the literature not being consensual regarding the role of gender in SWD, keeping in mind the context in Portugal where the role of women is still more traditional, we hypothesize that:

$H1_{gender}$: Gender is positively associated with SWD in such a way that women have higher SWD than men.

$H1_{age}$: Worker's age is positively associated with SWD.

Likewise, we are interested in focusing on sleep time, since sleepiness is one of the most important aspects when we talk about SWD. Therefore, we hypothesize that:

$H1_{sleep\_time}$: Sleep time is negatively associated with SWD.

As such, all the other mentioned predictors were considered as control variables.

2.2. Organizational Factors

2.2.1. Shift Work Design

Although we have already seen that shift work carry negative consequences "per se", the truth is that work shifts differ from one another in the direction of the clock rotation, and the rest interval between shifts, leading some authors to study certain practices when designing shifts that may be more/less harmful to individuals. With this in mind, there are several aspects of shift design that can be taken into account and that, jointly, may represent a greater or lesser risk of shift workers experiencing SWD. Therefore, this section will review different aspects of shift design.

With regard to the *number of different shifts* performed, Kandolin (1993) found that, although male nurses did not differ in burnout and stress levels in two and three-shift work systems, female nurses reported more stress symptoms, as well as no longer enjoying their work more often on three-shift work than those who worked only two-shift schedules. In turn, since the healthcare industry is a sector that is dominated mostly by women (Booker et al., 2018), this should be a factor to consider when designing work shifts.

Thus, we believe that a shift design that includes three or more different shifts may be more detrimental to individuals, as their circadian clock will have to adapt to more distinct work schedules.

According to Garde et al. (2019), *night work* refers to a specific modality of shift work and is acknowledged whenever an individual works at least three hours between 11p.m and 6 a.m. Thus, several studies point out that the overall sleep quality of nurses is significantly worse when they work at night compared to those who work during the day and whose shifts do not go through the night (e.g., Garde et al. 2009; Waage et al., 2014). In turn, Gumenyuk et al. (2014) report that nighttime work hours, which the authors consider generally to occur between 9 p.m. and 8 a.m., are related to a chronic reduction in sleep time, i.e. < 7 hours per 24 hours. This leads to increased sleepiness, impaired functioning, and disturbed sleep for these individuals, which suggests that work shift designs that include night shifts represent a greater vulnerability to develop SWD, considering that these should be avoided whenever possible.

Related to night work, another aspect that we can consider when we talk about shift design is the *number of rest days after night shifts*. Totterdell et al. (1995) found that almost all the well-being measures assessed (e.g., alertness, social satisfaction, happiness) had the worst levels on the first rest day after a night shift and were better on the following rest days. Therefore, they state that the results for rest days and following shifts imply that, whenever possible, two consecutive rest days should be given in order to increase the positive effects of the workers' rest period. In the same line, Haluza et al. (2019) suggest that after two consecutive 12-hour night shifts, at least three days off are needed for full recovery. With this in mind, we believe that providing at least two rest days after night shifts for workers is beneficial for them.

Although we are talking about rest days after shifts, it is also relevant to mention the importance of an adequate *time interval between shifts*, one of the most addressed aspects in the literature. Several authors have shown a significant positive association between "quick returns" (i.e., less than 11 hours of rest/no work between shifts) and symptoms of insomnia, fatigue, and other negative outcomes (Eldevik et al., 2013; Ferri et al., 2016; Vedaa et al., 2016), which shows that it is crucial that care be taken to provide workers with appropriate rest time between shifts.

The *duration of work shifts* is also an aspect to be considered when designing shifts. Rosa (1995) highlights that some of the negative aspects mentioned regarding 12-hour shifts are related to the fact that they promote fatigue, as well as the fact that they compromise the level of alertness and performance of workers, reflected in a reduction of work efficiency or safety. Also, Banakhar (2017) performed a systematic review where they found that poor sleep quality was more associated with 12 hours shift schedules. Åkerstedt and Wright Jr (2009) refer that one of the factors that may negatively impact work shift sleepiness, as well as work accidents, is the length of shifts, namely shifts longer than 12 hours. Accordingly, Drake and Wright Jr

(2011) propose the reduction of the length of work shifts, namely to less than 12 hours, as a measure to manage SWD. Consequently, given the emphasis on the negative role of long shifts, we believe that shifts that last 12 hours or more may be more harmful for individuals, possibly increasing the risk of SWD.

In addition to the length of work shifts, we can also refer to the *number of consecutive shifts* individuals do. In fact, one of the ergonomic recommendations regarding the sequence of shifts presented in the article by Knauth and Hornberger (2003) is to do a maximum of three consecutive shifts, which the authors state minimizes circadian rhythm adaptation problems in the case of night shifts, as well as reduces the accumulation of sleep deficits (in the case of night and morning shifts) and increases social contacts in the case of evening shifts. In turn, James et al. (2021) conducted a study with 94 nurses who worked 12-hour shifts and found that after working three consecutive shifts, their levels of sustained attention and predicted cognitive efficiency decreased, unlike subjective sleepiness, which increased. Thus, we realize that more than three consecutive shifts can be detrimental to individuals, and that this is another factor that should be considered when thinking about designing work shifts.

Finally, it is also important to mention that the *direction of work shifts* (clock or counterclock wise) is pointed out as one of the guidelines for SWD management, more precisely the adoption of clockwise in shift rotation (Drake & Wright Jr, 2011). Additionally, Shiffer et al. (2018) conducted a study in which they compared the effects of clockwise and counterclockwise rotation of work shifts on the sleep and work-life balance of nurses working in hospitals and found that workers in clockwise rotation reported feeling more rested at the beginning of the shift, as well as nurses in counterclock wise rotation perceived more often a greater difficulty in maintaining attention levels during working. Regarding work-life balance, more workers on counterclock wise shifts stated that work had more influence on their private lives, in addition to perceiving it as disruptive to their family and social relationships.

Considering all the aspects presented, we trust that, when poorly designed, shifts can represent an even greater risk for workers, and increase their vulnerability to SWD. Thus, we hypothesize that:

$H2_{gender}$: There is an interaction between worker's gender and shift design risk in explaining SWD in such a way that when the shift design risk is higher the association between gender and SWD is stronger.

$H2_{age}$: There is an interaction between worker's age and shift design risk in explaining SWD in such a way that when the shift design risk is higher the association between age and SWD is stronger.

H2$_{sleep\_time}$: There is an interaction between worker's sleep time and shift design risk in explaining SWD in such a way that when the shift design risk is higher the association between sleep time and SWD is weaker.

2.2.2. SWD Management Strategies

Considering all the negative consequences that shift work brings with it, Wright Jr, Bogan, and Wyatt (2013) stress that, when it is not possible for the patient to stop working shifts, the management of SWD involves strategies that help circadian adaptation, promote sleep, and help maintain alertness vigilance, in order to improve health and ensure safety. However, we believe it is important that such strategies be used not only as a way to manage this disorder, but also as a form of prevention.

Thus, one possible way to manage SWD is to educate/encourage about good sleep hygiene habits, such as encouraging the use of eye masks, earplugs, and shades that help block out light during daytime sleep, in order to maintain a good sleep environment (Weatherly, 2020), since we understand that light has a great impact on the circadian clock (Wright Jr, McHill, et al., 2013). In addition to the importance of creating a dark environment favorable for sleep, it is also crucial that organizations educate on the need for sleep before and after work shifts (Wright Jr, Bogan, & Wyatt, 2013), and several authors suggest adopting "anchor" sleep, which consists of a period between three to four hours in which the shift worker should always sleep, regardless of whether it is a working day or a day off, which aims to increase total sleep time and, consequently, reduce sleepiness (e.g., Cheng & Drake, 2019).

In addition to good sleeping habits, it is necessary to consider other factors that may contribute to the health and safety of individuals. In fact, poor eating habits in shift workers may be a factor for increased illness (Morikawa et al., 2008), and Drake and Wright Jr (2011) point out that improving healthy eating habits, particularly regarding their regularity and timing in relation to the main sleep period (not between two to four hours before bedtime), can be used as a SWD management strategy. The same authors also recommend reducing inadequate substance use and increasing exercise to five hours per week at appropriate times, i.e., not between two and four hours before bedtime. According to the ICSD (American Sleep Disorders Association, 1990), inadequate sleep hygiene is defined as a " sleep disorder due to the performance of daily living activities that are inconsistent with the maintenance of good quality sleep and full daytime alertness" (p. 73), and Thorpy (2012) notes that such activities may include substance use (e.g., drinking alcohol, smoking cigarettes, drinking coffee) and engaging in stimulating and alerting activities before bedtime.

In addition to the various suggestions for a better management of shift work, there are also several coping strategies that seem to be used by nurses on shift work with the purpose of maintaining vigilance and reducing the symptoms of sleepiness. These include taking a nap, a break and eating a snack during the shift, as well as other strategies to avoid mistakes resulting from sleepiness, such as using a notebook, double checking, among others (Pélissier et al., 2020). That said, several authors found that taking a nap during night shifts is indeed beneficial for individuals (e.g., Ruggiero & Redeker, 2014; Smith-Coggins et al., 2006) and Geiger-Brown et al., 2012 showed that when naps were implemented, this was well accepted by nurses and that they also found them useful. In the same line, Tucker et al. (2003) found that regular rest breaks during shift work in an industrial setting are beneficial in decreasing the risk of accidents. Literature is very convergent one this topic.

That said, Pélissier et al. (2020) state coping strategies that help maintain alertness and wakefulness should be facilitated. Therefore, we believe that organizations should promote and encourage such coping strategies and practices and incorporate them as organizational policies to reduce the risk of errors that may impact patients, but also to promote the health of shift workers. That said, we hypothesize that:

$H3_{gender}$: There is an interaction between worker's gender and organizational policies in explaining SWD in such a way that the more protective organizational policies there are, the weaker the association between gender and SWD.

$H3_{age}$: There is an interaction between worker's age and organizational policies in explaining SWD in such a way that the more protective organizational policies there are, the weaker the association between age and SWD.

$H3_{sleep\_time}$: There is an interaction between worker's sleep time and organizational policies in explaining SWD in such a way that the more protective organizational policies there are, the stronger the association between sleep time and SWD.

2.3. Towards an Integrated Model

The hypotheses established from the literature review offer a conceptual model where organizational policies can both play the role of direct interaction with the independent variables, as they can be seen as coping strategies, as well as a double interaction (moderating the moderation) with shift work design, since, when implemented, organizational policies can play a protective role for individuals, which we think can moderate the negative effects that poor shift design can carry. This implies the conceptual model previews both roles simultaneously and thus the result is depicted in Figure 2.1. Therefore, we also hypothesize that:

H4$_{gender}$*:* Organizational policies interact with the interaction effect between worker's gender and shift design risk in explaining SWD in such a way that the more protective organizational policies there are, the weaker the interaction between shift design risk and gender.

H4$_{age}$*:* Organizational policies interact with the interaction effect between worker's age and shift design risk in explaining SWD in such a way that the more protective organizational policies there are, the weaker the interaction between shift design risk and age.

H4$_{sleep\_time}$*:* Organizational policies interact with the interaction effect between worker's sleep time and shift design risk in explaining SWD in such a way that the more protective organizational policies there are, the weaker the interaction between shift design risk and sleep time.

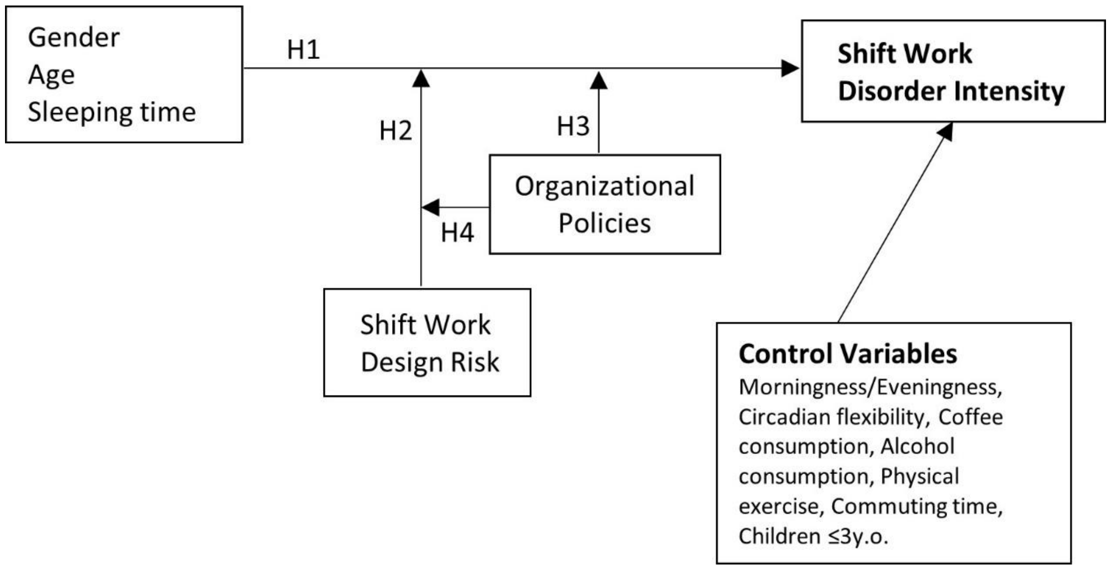

Figure 2.1: *Conceptual Model*

CHAPTER 3

Method

3.1. Procedure

Nurses working in hospitals were invited to participate in this study via direct professional network. A link with an online questionnaire in Qualtrics was made available to any nurse that voluntarily wanted to participate.

An informed consent was firstly showed that included full information about the context of the study (MSc in Social and Organizational Psychology in ISCTE), its objective, the voluntary nature of the participation, its anonymity and confidentiality of the data, the fact that the participant could drop out at any time without consequences, and the expected time to fill in. After being informed, participants would progress to the questionnaire only after explicitly indicating their agreement with the participation.

Data collection occurred between the 14th of March and the 24th of May.

3.2. Data Analysis Strategy

Data analysis started by testing the psychometric quality of the measures, namely their validity and reliability. Validity pertained to construct validity which was tested with confirmatory factor analysis (CFA) judged on fit indices (Hair et al., 2019) namely: Normed Chi-square below 3, confirmatory fit index (CFI) above .95, Tucker-Lewis Index (TLI) above .95, Root Mean Square of Error Approximation (RMSEA) below .07, and Standardized Root Mean Square Residual (SRMR) below .08. This requirement is cumulative with convergent validity where the extracted average variance (AVE) should attain at least .50 (Fornell & Larcker, 1981), and whenever a given construct comprehends more than two latent variables, discriminant validity is tested via HeteroTrait-MonoTrait (HTMT, Henseler et al., 2015), which should not go over .85. As a cumulative requisite, reliability was evaluated based on Cronbach Alpha which is expected to attain at least .70 to be considered acceptable.

Once measures are confirmed to be valid and reliable, they can be used for hypothesis testing. This was done via Macro PROCESS (Hayes, 2017) that tests simple moderations, double moderations, moderated moderations, mediations, parallel mediations, sequential mediations, and moderated mediations. The conceptual model matches Hayes Model 3.

3.3. Sample

The sample comprises 212 nurses working in at least two different work shifts, mostly females (88.7%), with ages averaging 30.3 (*SD*=9.5) but mostly comprehended between 22 and 27 years-old (58.5%) thus being a young sample. The participants are mostly from Metropolitan Lisbon area (75%) while the remaining are scattered across the territory.

3.4. Measures

Gender was measured as a dichotomous variable where "0" indicates Male and "1" Female. In turn, *Age* was measured as a continuous variable where respondents indicated their age as an integer number.

Circadian Preference (morningness-eveningness) was measured with Smith et al. (1989) Composite Morningness Scale, which comprises 13 items. The items address either preferred hours to do specific behaviors or subjective experiences individual have at waking hours or sleeping hours. These items used either a 4-point or a 5-point scale (e.g., "Considering only your own "feeling best" rhythm, at what time would you get up if you were entirely free to plan your day?" "5:00-6:30am (5), 6:30-7:45 am (4), 7:45-9:45 am (3), 9:45-11:00 am (2), 11:00-12:00 (noon) (1)). Three items comprehend 5-point scale, and the remaining 10 items a 4-point scale. Questions vary as well as options. The answers are converted into the matching points (1-4 or 1-5) and the sum gives a full score. The score ranges from a minimum of 13 (extreme eveningness) to a maximum of 55 (extreme morningness). Chen et al. (2020) states that scores below 22 points express evening type while scores above 44 express the morning type. The Cronbach alpha is .83 which indicates consistent responses across the scale.

Circadian Type was measured with the 11-item scale from Di Milia et al. (2005) that comprehends two factors: flexibility (5 items, e.g., "Would you be just as happy to do something in the middle of the night as during the day?", "Do you find it as easy to work late at night as earlier in the day?") and languidity (6 items, e.g., "Do you tend to need more sleep than other people?", "If you go to bed very late do you need to sleep in the following morning?"). The participants were required to signal their answer in a frequency scale ranging from 1 (almost never) to 5 (almost always). Flexibility scale ranges from 5 to 25 points where higher values indicate easier adjustment to non-standard schedules. Conversely, languidity scores indicate difficulty in overcoming drowsiness with the highest values being 30 points. A CFA showed valid fit indices ($X^2(43)= 59.979$, p =.044, X^2/df=1.395, CFI=.97, TLI=.96, RMSEA=.043 90% CI [.007, .069] PClose=.647, SRMR=.06) and flexibility has both acceptable reliability (CR=.852) as well as convergent validity (AVE=.539). However, languidity composite reliability (CR=.686) as well as convergent validity (AVE=.290) failed to achieve the minimum thresholds. Even excluding two items comprised in languidity that had low loadings ("Do you find it difficult to ''wake-up'' properly if you are awoken at an unusual time?", and "Do you rely on an alarm clock, or someone else, to wake you up in the morning?"), we could not improve reliability nor convergent validity to acceptable levels. Thus, we dismissed this subscale from ensuing analyses and kept only the flexibility subscale (Figure 3.1) which, per se, has good fit indices ($X^2(5)$ =9.779, p =.082, X^2/df=1.956, CFI=.98, TLI=.97, RMSEA=.067 CI90 [.000, .130] PClose =.269, SRMR=.03).

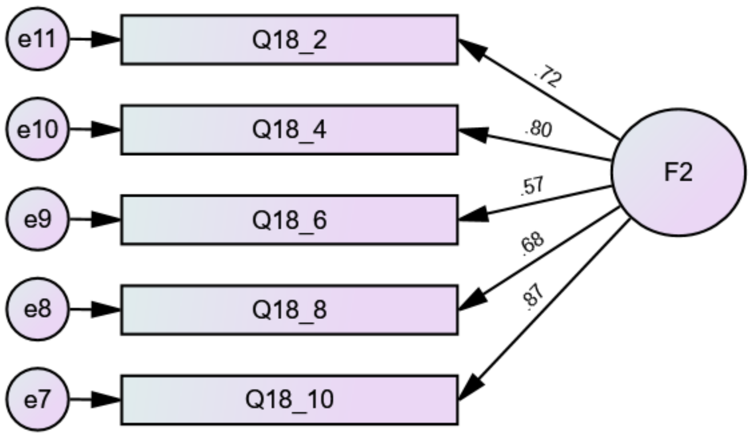

Figure 3.1: *CFA for Flexibility-Rigidity in Circadian Type*

Behavioral Habits comprehend physical exercise, daily coffee consumption, alcohol consumption, and daily sleeping hours. These variables have been measured each with a single item. Namely, physical exercise was measured with "On average, how often do you exercise?" to which the participant would signal their choice in a 4-point scale (1=Never; 2=1 to 3 times per week, 3=more than 3 times a week; 4=everyday). Coffee consumption was measured with "On average, how many cups of coffee do you consume per day?" to which the participant would signal their choice with an integer value. If they consume no coffee at all, then it should be a zero. Alcohol consumption was measured with "On average, how often do you drink alcohol?" to which participants should signal their choice in a 4-point frequency scale (1=never, 2=1 to 3 times a month; 3=1 to 3 times per week, 4=everyday). Lastly, average sleeping hours was measured with “On average, how many hours do you sleep per day?” to which participants should signal their choice with an integer value.

Contextual Variables of a Personal Nature covered two aspects, which have been measured each with a single item: under 3-year-old children (“Do you have children under 3 years old?” 1=Yes, 2=No) and average commuting time (“On average, how long (in minutes) does it take you to commute between work-home/home-work?”), to which participants should signal their choice with an integer value.

Work Shift Design covered seven aspects: number of shifts per month (“How many different shifts do you do at your workplace in a typical month? (consider different shifts those that have different start and end times, do not consider overtime)”, night shifts (“Do you perform night shifts?”), resting days after night shifts (“How many resting days do you have after those shifts?”), shift duration (“How long are your work shifts?”), consecutive shifts (“How many days in a row do you perform the same work shift?”), between-shifts resting hours (“How many hours of rest do you have between shifts?”), and direction of shift (clockwise or counter-clockwise, “Do your work shifts rotate clockwise - i.e., morning, evening, and night?”). Based on literature, each one of these aspects was categorized according to its detrimental effect for the individual. The coding consisted of scoring 1 whenever the level of the category is taken as sufficiently detrimental to exert effects, and 0 in case it falls below:

The number of different shifts was considered detrimental when it reaches three or above (Kandolin, 1993), which was given a score of 1. Otherwise, 0.

Having to do night shifts is considered more detrimental than day shifts (e.g., Garde et al. 2009; Waage et al., 2014). Therefore, all participants that reported doing night shifts were given a score of 1. All the others, 0.

According to Knauth and Hornberger (2003), the consecutive number of shifts should not overpass three, and therefore whenever a participant indicates to have sequenced four or more shifts, we scored 1. Otherwise, 0.

The duration of shifts was considered detrimental if it reaches 12 or more hours (e.g., Åkerstedt and Wright Jr, 2009; Rosa, 1995). In such case, the score of 1 was given. Otherwise, 0.

The intervals between shifts were considered detrimental if they do not reach 11h (e.g., Vedaa et al., 2016). In such case we scored 1, otherwise, 0.

The shift rotation is more detrimental when it is counterclockwise (Shiffer et al., 2018), which was given a score of 1. The clockwise was scored as 0.

After night shifts, the days of resting are considered insufficient if they are less than two (Totterdell et al., 1995), in which case we scored 1. Otherwise, 0.

The index for shift design risk was calculated as the sum of these scores, thus ranging from 0 (zero shift design risk) up to 7 (maximum shift design risk).

Organizational Policies comprehend eight actions organizations may apply to prevent negative effects from shiftwork that were identified through the literature review, combining proposed practices by some authors to manage shift work, and also some coping strategies that seem to be used by nurses to combat sleepiness. Namely: to incentivize the use of day sleeping helping equipment ("Encourages the use of eye masks, earplugs, and light-blocking shades during daytime sleep") (Weatherly, 2020), to incentivize a snack ("Encourages you to have a snack during your shift") (Pélissier et al., 2020), to incentivize a short break ("Encourages you to take a break during your shift") (Pélissier et al., 2020), to incentivize a nap ("Encourages you to take a mid-shift nap") (Pélissier et al., 2020), educate to sleep protective periods ("Educates about the need to take time to sleep before and after work shifts") (Wright Jr, Bogan, & Wyatt, 2013), educate on healthy feeding habits ("Educates about healthy eating habits regarding the regularity and timing of meals in regard to the main sleeping period") (Drake & Wright Jr, 2011), educate on preventing consuming harmful substances and exercising ("Educates about the importance of reducing inappropriate substance use and increasing exercise 5 h per week at appropriate times") (Drake & Wright Jr, 2011), and educate on coping strategies ("Educates on strategies that can be used to avoid mistakes that come from drowsiness – e.g., using a notebook") (Pélissier et al., 2020). Participants used a 5-point Likert scale (1=Strongly disagree to 5=Strongly agree). The answers were dummy coded to 0 (below 4) and 1 (4 or 5) and the score was computed by summing all the values in the dummy variable. Thus, the score ranges from 0 (no policy implemented) to 8 (all the policies are in effect).

SWD Syndrome was measured based on the measures used by Chen et al. (2020) that aggregates insomnia symptoms, Epworth Sleepiness Scale (ESS) and one specific question pertaining to the attribution of reported symptoms. Insomnia Symptoms were measured based on three items derived from DSM-V (APA, 2013) that express this specific sleep disorder (i.e., in the past three months how often to you: "had difficulties falling asleep", "had difficulties maintaining sleep", and "woke up early and could not fall asleep again"). Participants were requested to signal their answer in a 4-point frequency scale (1=none, 2=less than once a week, 3=once or twice a week, and 4=more than three times a week). We consider that participants have insomnia symptoms whenever they signaled any of these items as "more than three times a week".

The ESS (John, 1991) measures the likelihood of falling asleep or take an involuntary small nap in eight different situations (e.g., “Watching TV”, “As a passenger in a car, for an hour without a break”). Participants were requested to signal their answer in a 4-point scale (i.e., 0=no probability, to 3=high probability) and summing the eight individual scores will produce an overall score ranging from 0 to 24 where 11 or more points indicates excessive daytime sleepiness.

Chen et al. (2020) added a complementary item that is intended to ascertain if the reported symptoms (if any) were attributed by the participants to their work (i.e., “Have you had this sleep or sleepiness problem relate to the work schedule for at least three months?). This is a technical requirement by ICSD-3 (AAoSM, 2014) and respondents were asked to answer with a simple “Yes” or “No”.

SWD syndrome was computed based on the dichotomized insomnia, ESS and work attribution. A syndrome is by definition a configuration of symptoms and in this case SWD requires the concomitant presence of insomnia symptoms, sleepiness, and attribution to work (ICSD-3, AAoSM, 2014). Any participant that cumulatively has signaled presence of the three symptoms is coded as having SWD (SWD=1) while all the other cases as not having SWD (SWD=0). The formula used was dichotomous insomnia * dichotomous ESS * work attribution.

SWD Intensity expresses the degree with which SWD might be present. We recoded the three items comprised in the insomnia symptoms by transforming all cases of “4” into 1, and all the remaining as zero, averaging the three items. The resulting score for this component of the formula ranged from 0 (none of the items with indication of insomnia symptom) to 1 (all the items indicating insomnia symptoms present). To accompany this range (of insomnia), we average the ESS score by dividing it by 24. The formula used was “(Insomnia average $_{[0-1]}$ * ESS/24$_{[0-1]}$) *Attribution to work $_{[0-1]}$”. This formula produces a zero value in case the participants have no insomnia symptoms at all, or absolutely no sleepiness symptoms or fail to attribute to work symptoms they might have reported. The maximum value of this formula is 1, which represents the maximum level of SWD intensity. The exact expression used in SPSS was Insom0_1conti*ESS0123/24*SWDxt.

CHAPTER 4

Results

4.1. Descriptive and Bivariate Statistics

As shown in Table 4.1, the sample comprises individuals that have distinct circadian types. The mean circadian flexibility (*M*=13.98, *SD*=4.5) is relatively modest, close to the scale midpoint. Another expression of circadian type, morningness, shows a generally neutral sample as to the conspicuous presence of either eveningness or morningness types. With a mean of 31.16 (*SD*=6.29) only 1.9% fall in the morning type and 8% fall in the evening type, with values ranging from 15 to 48.

Within the variables in the conceptual model, the mean sleep time (6.57, *SD*=1.07) falls within the regular reports, although there are extreme values (4 hours up to 10 hours average). The shift disorder risk index averages 3.35 (*SD*=1.04) ranging from 0 to 6 thus indicating there are participants that report shift situations with no risk for sleep while others report very high risk (none matches an extreme value of 7 points).

Perceived organizational policies to mitigate shift work negative effects have a mean index score of 1.75 (*SD*=1.95) which evidence that, as perceived by the participants, there are very few policies implemented in their respective organizations. Still, some cases do show all policies have been implemented, albeit most the organizations seem to have 2, 1 or no policy at all.

SWD is not intensively felt by the participants as the mean of .10 (*SD*=.15) indicates this is not a widespread phenomenon (as expected) but applying SWD criteria does show that 19.8% achieves the threshold. Still, SWD intensity shows extreme cases of SWD as evidenced by its maximum score found in the sample (.88 in a maximum of 1).

Interestingly, sociodemographic and other variables that we took as control, show scarce number of cases where correlations occur with the conceptual model variables. Such is the case of morningness score which has two positive correlations with age and organizational policies. Likewise, morningness is negatively associated with shift risk (r=-.166, $p < .05$). Coffee intake is associated with less sleep time (r=.268, $p < .01$) and higher in older individuals (r=.161, p<.05). All the remaining correlations have a weak magnitude. Overall, to the exception of morningness, the incidence of significant correlations between control variables and those in the conceptual model is rather low. As a complementary finding it is encouraging that morningness score negatively correlates with flexibility (*r*=-.329, $p < .01$) which is expectable in a consistent group.

Two typical sociodemographic variables have the status of predictors: age and gender. In this model gender indeed has a positive correlation with SWD intensity (*r*=.181, $p < .01$) suggesting females show higher mean values (corroborated with an ANOVA, F (1, 210) =7.1, $p < .01$). Age, however, shows no significant correlation with SWD intensity. Individuals that report longer sleep time have lower SDW intensity (*r*=-.159, $p < .05$) and older participants also report lower work shift risk. Curiously, work shift design risk and organizational policies are not correlated (*r*=-.065, $p > .05$) which suggest they are not equally taken into consideration as a joint strategy used by organizations. Also surprising is the absence of associations between these an SWD intensity. This lack of relation may be in line with the assumed interaction effects as established in the conceptual model and thus it does not discourage it.

Table 4.1 – *Descriptive Statistics and Bivariate Correlations*

	N	*Min-Max*	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. Morningness Score	212	15-48	31.16	6.29	1											
2. Flexibility	212	5-25	13.98	4.50	-.329**	1										
3. Physical Exercise	206	1-3	1.54	.57	.144*	-.051	1									
4. Coffee Consumption	206	0-7	1.87	1.61	-.092	.195**	-.041	1								
5. Alcohol Consumption	206	1-4	2.00	.61	-.163*	.066	.041	.230**	1							
6. Children ≤3 y.o.	205	1-2	1.95	.21	-.213**	.061	.056	.025	.146*	1						
7. Commute time	205	1-130	30.02	23.07	.094	-.006	.053	-.103	-.053	.051	1					
8. Gender	212	0M-1F	0.89	.31	-.069	-.127	.001	-.113	.000	-.082	-.071	1				
9. Age	212	20-63	30.25	9.53	.211**	-.015	.041	.161*	-.049	-.057	-.144*	-.027	1			
10. Sleep Time	206	4-10	6.57	1.07	-.001	-.048	-.013	-.268**	.055	.016	-.071	-.053	-.203**	1		
11. Shift Design Risk	180	0-6	3.35	1.04	-.166*	.156*	.072	.035	-.018	.151*	-.073	.019	-.210**	-.084	1	
12. Organizational Policies	183	0-8	1.75	1.95	.285**	-.029	.046	-.017	.017	.015	.124	-.132	.110	.024	-.065	1
13. SWD Intensity	212	0-.88	.10	.15	.059	-.109	.009	-.096	.006	-.129	-.064	.181**	.044	-.159*	.074	-.102

*p<.05; **p<.01

4.2. Hypotheses Testing

As shown in Table 4.2, the first group of hypotheses ($H1_{gender}$, $H1_{age}$, $H1_{sleep\_time}$) tests the direct effect of these independent variables on SWD intensity. Findings support $H1_{gender}$ (B=.080, *p*<.05, 95% CI [.016; .144]) indicating that women have higher SDW intensity. Findings also support $H1_{sleep\_time}$ (B=-.023, *p* < .05, 95% CI [-.043; -.004]) indicating that higher sleeping time is associated to lower SDW intensity. Conversely, $H1_{age}$ is not supported (B=.003, *p*= .06, 95% CI [-.001; .005]) indicating that SDW intensity is not particularly stronger at any age period.

Table 4.2 – *Main and Interaction Effects*

	Coef.	SE	*t*	*p*	LL 95% CI	UL 95% CI	Hypotheses
Gender	.080	.038	2.077	.039	.016	.144	$H1_{gender}$ supported
SDRisk	.016	.011	1.392	.165	-.003	.035	-
Gender*SDRisk	.021	.042	0.509	.611	-.048	.091	$H2_{gender}$ rejected
OrgPol	-.007	.006	-1.108	.269	-.017	.003	-
Gender*OrgPol	-.003	.016	-.224	.822	-.031	.024	$H3_{gender}$ rejected
SDRisk*OrgPol	-.004	.005	-.874	.383	-.013	.004	-
Gender* SDRisk*OrgPol	-.007	.019	-.362	.717	-.040	.025	$H4_{gender}$ rejected
Age	.003	.001	1.895	.060	-.001	.005	$H1_{age}$ rejected
SDRisk	.016	.012	1.361	.176	-.007	.039	-
Age*SDRisk	.002	.001	2.079	.039	.001	.004	$H2_{age}$ supported
OrgPol	-.006	.006	-.925	.356	-.019	.007	-
Age*OrgPol	-.001	.001	-2.215	.028	-.002	-.001	$H3_{age}$ supported
SDRisk*OrgPol	-.004	.006	-.623	.534	-.015	.008	-
Age* SDRisk*OrgPol	-.001	.001	-1.152	.251	-.001	.001	$H4_{age}$ rejected
Sleep_time	-.023	.012	-1.967	.051	-.043	-.004	$H1_{sleep\_time}$ supported
SDRisk	.015	.012	1.272	.205	-.004	.034	-
Sleep_time*SDRisk	-.003	.013	-.267	.790	-.024	.018	$H2_{sleep\_time}$ rejected
OrgPol	-.006	.006	-.914	.362	-.017	.005	-
Sleep_time *OrgPol	-.004	.007	-.664	.508	-.015	.006	$H3_{sleep\_time}$ rejected
SDRisk*OrgPol	-.005	.005	-.844	.400	-.014	.004	-
Sleep_time * SDRisk*OrgPol	.008	.006	1.185	.238	-.003	.018	$H4_{sleep\_time}$ rejected

As regards the interaction effects, gender has neither any interaction with shift design risk (B=.021, $p > .05$, 95% CI [-.031; .024]) nor with organizational policies (B=-.003, $p > .05$, 95% CI [-.031; .024]) thus rejecting $H2_{gender}$ and $H3_{gender}$. In the same vein no interaction effect was found for sleep time with neither shift design risk (B=-.003, $p > .05$, 95% CI [-.024; .018]) nor organizational policies (B=-.004, $p > .05$, 95% CI [-.015; .006]) thus rejecting $H2_{sleep\_time}$ and $H3_{sleep\_time}$, respectively. Conversely, age interacts with both shift design risk (B=.002, $p < .05$, 95% CI [.001; .004]) and organizational policies (B=-.001, $p < .05$, 95% CI [-.002; -.001]) thus supporting $H2_{age}$ and $H3_{age}$ respectively. In these cases, the exact interaction effect between age and shift design risk is depicted in Figure 4.1. Likewise, Figure 4.2 depicts the interaction between age and organizational policies.

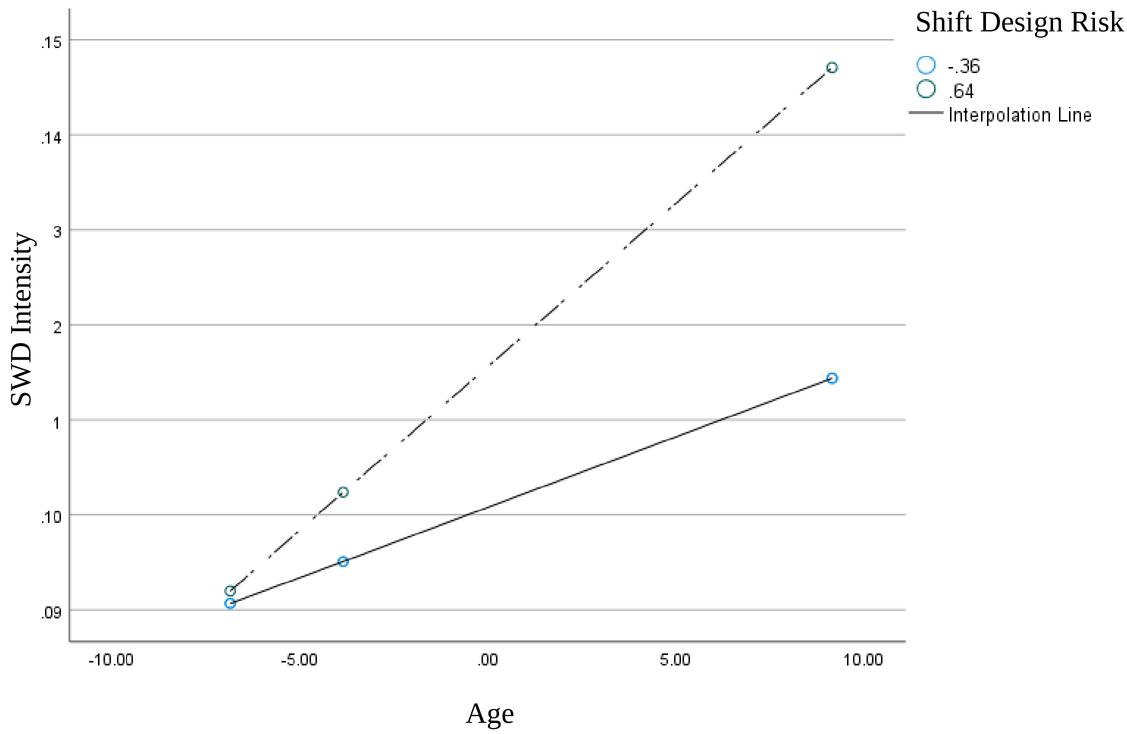

Figure 4.1: *Moderation Graph for Age * Shift Design Risk*

Table 4.3 - *Conditional Effects of the Focal Predictor at Values of Shift Design Risk*

SDRisk	I_Shift	Effect	SE	*t*	*p*	LL 95% CI	UL 95% CI
Low risk	-.355	.001	.001	1.128	.260	-.0011	.0041
High risk	.644	.003	.001	2.230	.027	.0004	.0065

As shown in Table 4.3, the slope for low shift design risk is non-significant (95% CI [-.001; .004]) while for high shift design risk is significant positive (95% CI [.0004; .0065]) indicating that the vulnerability due to age is increased by a wrongful shift design.

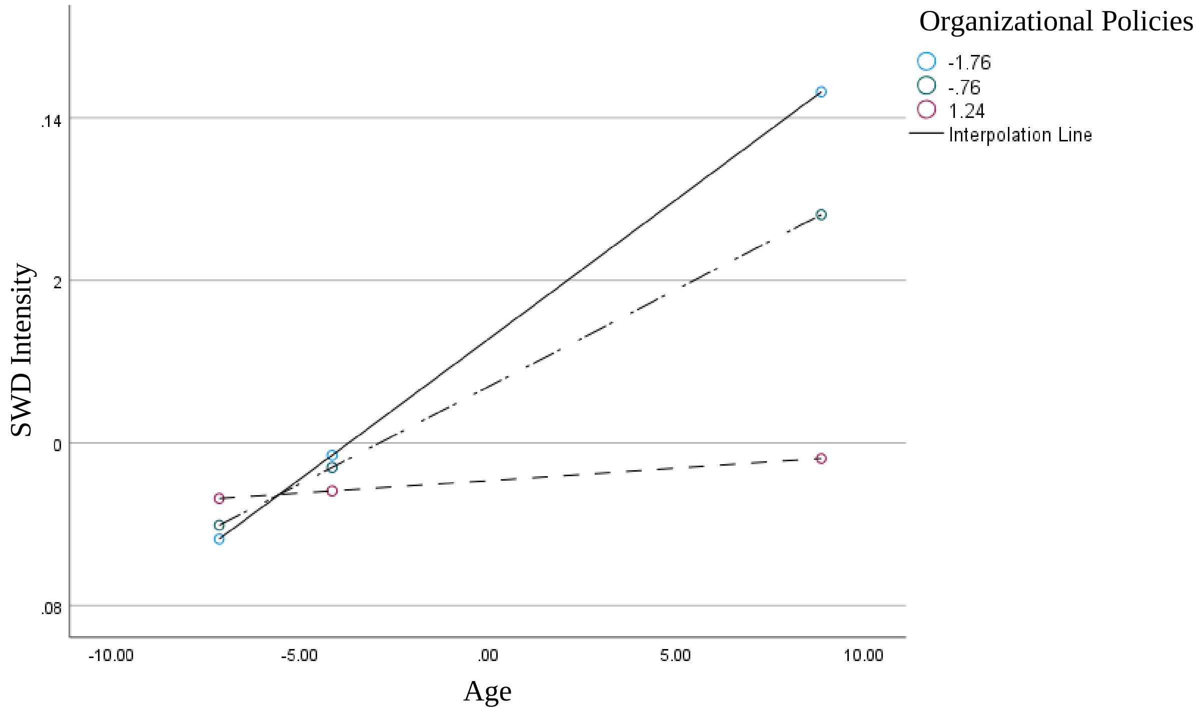

Figure 4.2: *Moderation Graph for Age * Organizational Policies*

Table 4.4 - *Conditional Effects of the Focal Predictor at Values of the Moderator(s)*

Policies	I_Pol	Effect	SE	*t*	*p*	LL 95% CI	UL 95% CI
Less policies	-1.759	.003	.001	2.051	.041	.0001	.0067
More policies	1.240	.001	.001	.232	.816	-.0023	.0029

As shown in Table 4.4, the slope for less organizational policies is significant positive (95% CI [.0001; .0067]) while for more organizational policies is non-significant (95% CI [-.0023; .0029]).

The moderated moderation effects were not observed in any of the hypothesized cases, i.e., shift design risk interaction with organizational policies interacting with gender is not significant (B=-.007, $p > .05$, 95% CI [-.040; .025]), as well as with age (B=-.001, $p > .05$, 95% CI [-.001; .001]) and with sleep time (B=.008, $p > .05$, 95% CI [-.003; .018]) rejecting $H4_{gender}$, $H4_{age}$, and $_{sleep\_time}$.

CHAPTER 5

Discussion and Conclusion

The main objective of this study was to propose an integrated model that brings together the different aspects portrayed in the literature as predictors or influence factors of SWD prevalence and risk. This integration is intended to understand the moderating effect of different organizational variables (such as shift design and certain organizational policies) on the relationship between some individual variables (gender, age and number of hours of sleep per day) and SWD. That said, we sought to understand what direct effects gender, age, and the number of hours of sleep per day have on SWD, as well as the moderating role shift design risk may have on the direct relationship between these variables and SWD.

In addition, we also tested the moderating role that some organizational policies may have on the direct relationship between gender, age, and number of hours of sleep per day on SWD, and the moderating role that these may have on the moderating effect of shift design between such variables and SWD.

5.1. Main Findings

Regarding the direct effects of the predictor variables on SWD, we found that, as hypothesized, gender proved to be a significant predictor, with women presenting SWD with higher intensity compared to men. However, we should be careful when generalizing these results, since most of the sample was composed of women (88.7%). Similarly, the number of hours of sleep was also negatively and significantly associated with SWD, meaning that more total sleep time seems to decrease the intensity of SWD experienced.

However, contrary to expectations, age was not shown to be a significant predictor, which can be explained by the fact that more than half of the sample comprised ages between 22 and 27 years, which imply restricted range that makes impossible a comparison between younger and older nurses. In fact, Costa and Di Milia (2008) refer that the critical age for an increase of shift work and night work intolerance seems to occur between 45 and 50 years, so a more heterogeneous sample in terms of age could have led to different results. Another possible reason could be that older workers may have already improved their coping strategies to overcome shift work consequences (Eldevick et al., 2013).

With regard to the role of shift design risk and organizational policies, contrary to what was hypothesized, these did not prove to be significant moderators of the relationship between gender and the total of sleep time with SWD, which may indicate that the role these variables play in SWD is hardly mitigated by shift work design or by organizational policies aimed to reduce the negative effects of shift work. However, there is once again the question that the sample may not be representative since, although the responses to shift work design range from 0 (minimum risk) to 6 (close to maximum risk), the average is at 3.35 points, which corresponds to an intermediate risk of shift work design, as do organizational policies, which have an average of 1.75, meaning that, within the sample collected, most participants consider that very few actions/policies are implemented.

With this in mind, it would have been important to obtain more diverse results, in order to be able to compare more objectively the difference for shift workers in organizations that have few policies implemented in organizations contrasting with those that have full implementation of such policies. Furthermore, we can also justify such results regarding the role of organizational policies in the sense that encouraging and educating workers to adopt certain behaviors does not mean they actually put them into practice.

However, shift design risk proved to be a significant moderator of the relationship between age and SWD. This is a particularly interesting result since age did not have a significant effect on SWD on its own. According to Figure 4.1 we see that especially when shift design risk is higher, it has a greater and significant impact on the relationship between age and SWD, which suggests to us that although age does not have a significant direct relationship with SWD, the fact that work shifts are poorly designed may cause older workers to be at greater risk of suffering from higher SWD intensity than younger workers. Furthermore, organizational policies also appear to play a protective role with respect to the relationship between age and SWD, with Figure 4.2 showing that fewer policies significantly increase the risk of older workers having higher SWD intensity, while more policies remove this age vulnerability factor lowering SWD intensity to a minimum. Policies are thus effective as regards age vulnerability.

As a caveat, it should also be taken into account that all hypotheses were tested considering SWD intensity, something that, according to our knowledge, has not been done before. Thus, the rejection of some hypotheses may also be attributable to this fact, since they may be associated with the prevalence or risk of having SWD, but not necessarily with the intensity with which shift workers perceive it. So, unsupported hypotheses in this study do not necessarily contradict previous findings concerning SWD. We think they add to the understanding of how strongly SWD is building up.

At last, the absent effect found for the moderated moderation effect of organizational policies with shift design risk for the relationship between all the predictor variables and SWD is very informative because shift design risk was found to amplify the age factor in experiencing SWD. However, by not being able to mitigate or nullify the negative effect of a bad shift design, organizational policies seem ineffective to counter such wrongdoing. Being so, a wrongful design concerning how shifts should turn (clockwise or counterclockwise), how many shifts workers can endure, how long they should rest between shifts (if more or less than 11 hours), or how long shifts should last (longer or shorter than 12 hours) will produce negative effects that protective organizational policies are not able to mitigate. Thus, these finding suggests that it is preferable to avoid taking risk in designing shifts than trying to do corrective policies to remediate that ultimately will result in no protection at all.

5.2. Strengths and Limitations

The main strength of this study lies in its innovative character, by aggregating the different individual and organizational variables studied in the previous literature and their relationship with SWD while proposing also a model that takes into account the different role they can play in SWD.

That said, to our knowledge, this study introduces the concept of "Shift Design Risk" by bringing together different aspects related to shift design into a composite index that reflects the greater or lesser risk that shift design represents for workers according to what is portrayed in the literature as being better or worse for them (e.g., Drake & Wright Jr, 2011; Shiffer et al., 2018; Vedaa et al., 2016). Adding to this, the model was also extended by the introduction of organizational policies, which bridges previous literature regarding proposed initiatives to manage SWD (e.g., Wright Jr, Bogan, & Wyatt, 2013) to coping strategies adopted by nurses (e.g., Pélissier et al., 2020). Finally, the concept of "SWD Intensity" is also added, which seeks to reflect not only whether workers have SWD, but to what extent they perceive and experience this disorder in their lives.

Nevertheless, there are some limitations one should take into account. One of the main limitations of this study is related to the sample, both regarding the number of participants and the heterogeneity of responses (as mentioned), which makes it difficult to generalize these results with assurance, since the sample is not representative of the target population.

In turn, another possible limitation is related to the questionnaire design, since some of the questions could have had closed/multiple choice answers, such as the number of shifts performed or the number of hours of break between shifts, in order to avoid misinterpretation or errors in typing the answers. In addition, the questions regarding organizational policies were asked at the end of the questionnaire, which may have been one of the reasons why fewer participants answered them (but if done otherwise, we could have been inducing the subsequent answers).

In addition, SWD was assessed considering only the subjective perception of the participants, and no sleep log or actigraphy monitoring was performed, which is one of the required criteria for the diagnosis of SWD (ICDS-3, AAoSM, 2014). Similarly, although the participants were asked whether their insomnia and sleepiness problems were due to their work schedule over the past 3 months, as well as whether their use of substances such as alcohol and coffee was controlled, they were not asked whether they were taking any medication that could interfere with their sleep, or whether they had any medical, neurological, or mental disorder unrelated to their work shifts that could also impact their sleep.

Still in the context of the SWD assessment, since we tried to measure the intensity with which this disorder is experienced by the participants, we could have also directly questioned how much they believe that the work shifts influence their sleep and, consequently, other aspects of their lives.

Finally, we considered all participants who performed more than one different work shift, regardless of whether or not they performed night shifts, which may interfere with the diagnostic criteria for SWD, since the ICDS-2 (AAoSM, 2005) and ICDS-3 (AAoSM, 2014) indicate that one of the diagnostic criteria is that the complaints of insomnia and excessive sleepiness are related to the individual's work schedule during their usual sleeping time. Thus, this issue leads us to the question raised by Pallesen et al. (2021), which relates to who can actually be diagnosed, as we have found that each individual's circadian preference can vary from one another, with eveningness-type individuals having a greater preference to go to bed and wake up later and are more awake and alert at later hours than early in the morning (Wickwire et al, 2017). This is why we considered important to also include shift workers who did not work night shifts.

5.3. Future Research

Considering that this was an exploratory study regarding the moderating role of organizational variables on SWD (shift design risk, and organizational policies), further study on the role of these variables is needed by testing the effect of the variables considered in this study on larger samples, but also by studying the effect of variables that were not tested in this paper and that may impact the effect of shift work design such as, for example, questioning whether the shifts performed are regular or irregular, since the last one varies in terms of start and end times, rest periods between shifts, etc., being more difficult to manage than regular shifts (Sallinen & Kecklund, 2010).

In this context, taking into account other policies that organizations may adopt may also be useful to better understand their role in preventing and managing SWD. Among these one can consider initiatives that may help shift workers with the work-family/social life conflict, since the policies previewed in this study mostly focus on things that the shift workers can do, and not so much on what the people around them can also learn/do. Thus, initiatives focusing on educating the shift workers' family about the need for them to take time to sleep before and after their shifts could promote wakefulness (Wright Jr, Bogan, & Wyatt, 2013) and, at the same time, help combat the social pressure felt by shift workers as highlighted by Costa et al. (2006). Therefore, it would be important that, when testing new interaction models, future research considers these, and other possible aspects uncovered in this study.

In line with what was mentioned in the limitations section, it is also necessary that further studies focusing on interactional models and intending to understand the impact of different variables on SWD intensity consider the use of actigraphy monitoring as a complement to the individuals' perception of their insomnia and sleepiness symptoms.

In addition, it would also be interesting to conduct a longitudinal and field study, applying in a given context (e.g., in a hospital) the "ideal" shift design (i.e., to design the work shifts with the lowest possible risk), as well as to put into place several organizational policies for SWD management, comparing the prevalence and intensity of SWD before and after a given time after the intervention.

Finally, we suggest that future studies consider not only the role of organizational practices in managing SWD but combine this approach with a pharmacological approach as well, as proposed by Cheng and Drake (2019).

5.4. Conclusion

Despite all the limitations and questions that findings from this study raise, the overall conclusion of this research concerns how age interacts with shift design risk and separately with organizational policies thus evidencing the importance of a good shift design as well as protective organizational policies. However, most important is the conclusion that the absence of the moderated moderation effect supports, which strongly suggest a bad shift design has primacy over organizational protective policies. This was not in line with our hypotheses, quite the opposite, but it showed factors may not have the same status in explaining SWD intensity, because they may not only operate jointly, as they may operate in a hierarchical way. As a parallel conclusion, more focused on the contribution for theory, it is noteworthy pointing out that – in spite of all the limitations – interactional models seem to add to extant knowledge on this topic as proven by the couple significant moderations found with age.

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