International Journal of Occupational and Environmental Safety

Shift-work: a review of the health consequences

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Article History

Received 03 July 2019
Accepted 01 September 2020
Published 30 November 2020

Keywords

Shift work
Impacts
Health Consequences
Circadian Rhythm

DOI:
10.24840/2184-0954_004.002.0005

ISSN:
2184-0954

Type:
Review Article

Open Access
Peer Reviewed

Abstract

Shift work has become a common practice across many sectors during the past decades as a result of the growing demands of human life. There are many possibilities to organize shift schedules, however, all of them, some more than others, impose serious impacts on the individual´s health, social life and organization level. Thus, we conducted a review using Scopus, Science Direct and Web of Science, and using the keywords and criteria deemed appropriate, with the main objective of identifying the main consequences that have been positively associated with shift work at several domains to this day. The results of this review indicated that shift work and everything that this type of work implies, can lead to severe health consequences, namely sleep disorders, psychiatric disorders, gastrointestinal disturbances, metabolic disorders, cardiovascular disease, urologic disorders and even some types of cancer. These health consequences arise due to the disruption of the circadian clock system, which is associated with alterations at genetic level. Moreover, shift work also causes impacts in social life, as the individual may experience more difficulties in socializing with family and friends, which may lead to isolation and organization level, as excessive sleepiness, stress and dissatisfaction may lead to a detriment of the performance and alertness, which may result in more accidents. In conclusion, considering the nefarious effects that this type of organization of working time can impose, primarily for the worker, but also for the worker's family and also organization in which this works, it is crucial that the organization seek to protect the worker safety and health, which can be achieved by consultation the working physician but also with the use of tools that allow monitoring the worker health and general cognitive state.

1. INTRODUCTION

Shift workers have existed since ancient times, among them the watchmen of ancient kingdoms and the military. The history of shift work can be traced back to the invention of fire, when the man discovered the possibility to cook hot meals and started to stay outside the shelters for longer periods. The early nomadic tribes also had the need for “shift workers”, as they usually had camp guards and shepherds awake and vigilant during normal sleeping hours (White & Keith, 1990). Although the evidence of shift work existed long before the invention of the lamp, it was the discovery and use of artificial light, initially with fire and later with electric lamps, created by Thomas Edison in 1879, which allowed workers to perform their tasks during the necessary periods, even during night time (Gordon, Cleary, Parker, & Czeisler, 1986; Grossman, 1997). The industrial revolution, followed by the urbanization, was the fact behind the development of shift work and night work. The gas and light bulbs made this form of this temporal organization of work more common, and factories recognized a bigger profit as they used this type of practice (Gordon et al., 1986; White & Keith, 1990). However, the context of shift work has been changing, and in comparison, with previous centuries, individuals involved or forced to work in shifts are spread across many different sectors. Industries, such as, agriculture, telecommunications, financial, securities, printing, health, broadcasting, food production and transportation, which are heavily influenced by accelerated urbanization, also use shift work as a mean of satisfying customer demands and increasing productivity (Frost, Kolstad, & Bonde, 2009).

According to Escribá-Aguir (1992), the main reasons that justify this necessity can be divided into three categories: economy, to capitalize the high cost of technology and respond to the market requirements; technology, certain industrial processes of production need to be maintained continually, such as, the production of electric energy and social, to increase the number of jobs in the service sector, such as in health, transports, communications and safety.

Shift work is defined by the International Labour Organization (ILO), as a method of organisation of working time in that workers follow one after the other in the workplace, so that the establishment can operate more than the hours of work of individual workers at different times during the day and night (International Labour Organization, 2004). On the other hand, the night work, is defined by the ILO, as all work performed during a period of not less than 7 consecutive hours, including the interval from 00:00 to 5:00 hours. Night work schedules should be determined by the employer after consulting the most representative organizations of employers and workers or by collective agreement (International Labour Organization, 2004).

There is an increasing evidence that shift work can lead to very serious consequences. Beside these consequences, the working conditions such as physical work environment (temperature, luminosity and noise); physical and mental charge (fatigue); accomplishments (salary and rewards); safety at the workplace (risk of accident, damage risks caused by toxic products, gas, smoke, dust and others); development of human capacities (initiative, responsibility, use and development of knowledge and qualification) and social integration (interaction opportunities and communication) are crucial variables that affects individuals in their performance. These conditions have a significant impact on social and professional life and more specifically in shift workers (Silva, 2007).

A study executed by Linton et al. (2015), evaluated the impact of work factors on sleep disturbances. The results showed that the psychosocial work variables of social support at work, control and organizational justice were related to fewer sleep disturbances, while high work demands, job strain, bullying and effort-reward imbalance were related to more future sleep disturbances. Moreover, working a steady shift was associated with disturbances while exiting shift work was associated with less disturbed sleep. It was concluded that psychosocial work factors and the scheduling of work have an impact on sleep disturbances, and this might be used in medical context as well as for planning work environments.

The main purpose of this study was to research the main consequences to shift workers at health level, however while we were researching, we also found that this type of work also impacts social and family life and companies on the organizational context, thus we felt the need to mention some of these impacts even though this wasn't the focus of the study.

2. METHODS

The present article represents an assessment of the evidence, thus a form of knowledge synthesis that follows a systematic approach to map evidence on a topic and identify main concepts, theories, sources and knowledge gaps (Tricco et al., 2018). This review followed some of the guidelines of the PRISMA Statement for a scoping review (Tricco et al., 2018).

In order to conduct this research, the authors defined a group of objectives to focus the research on the theme:

- Define the concept of shift work and characterize the different systems that exist;
- Define the chronobiology and biological rhythms;
- Characterize and describe the sleep/wake cycle;
- Identify the main consequences in workers' health that shift work can provoke;

To perform this research, the following data bases were used: Scopus[1], Science Direct[2] and Web of science[3] and used a group of keywords, such as, "shift work", "shiftwork", "health consequences", "consequences", and "impacts". The articles were selected after applying some filters, such as, the article types were systematic reviews and journal articles, the languages were English, Portuguese, French and Spanish, and the year gap consider on the initial research were 2014 to 2019.

[1] https://www.scopus.com (accessed in 04/12/2018)
[2] https://www.sciencedirect.com (accessed in 04/12/2018)
[3] http://apps.webofknowledge.com (accessed in 04/12/2018)

The research lead to the following Boolean expression: TITLE-ABS-KEY (("shiftwork" OR "shift work") AND "health consequences") AND (LIMIT TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBYEAR , 2019) OR LIMIT TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT TO (PUBYEAR , 2016) OR LIMIT TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR , 2014)).

The researchers also did research using the terms of each consequence, to discover specific authors that proved the existence of a relation between shift work and each consequence.

3. SHIFT WORK SYSTEMS

The shift work systems as a form of temporal organization of work presents a diversity of types and models, and there are numerous possibilities of scheduling arrangements (Fischer, 1981; Rutenfranz, Knauth, & Fischer, 1995). According to Escribá-Aguir (1992), we can differentiate three types, the system of shift work without night work, shift work system with night work and shift work system with night work including weekends.

However, to better understand the problematic and the variables involved, it is necessary to consider some characteristics about them, which allows differentiating the different types that exist. Thus, the shift work can be organized as showed in the Table 1.

Table 1. Types of shifts (Adapted from: Scott & LaDou (1994) and Silva (2007)).

Types	**Fixed / Permanent**	The individual works every day at the same time, whether during the day, afternoon or evening;			
	Rotating	The individual works on multiple shifts.	**Speed of Rotation**	**Slow**	Greater than a week and usually takes 21 days working on the same shift;
				Weekly	Five to seven days in shift;
				Fast	The individual works more than one to three successive days on the same shift;
			Direction of rotation	**Forward rotation** (morning-evening-night)	Clockwise, also called "phase delay" rotation;
				Rotation backward (evening-late-morning)	Counter-clockwise, also called "phase advance" rotation;
				Hybrid rotation	Combination of the two previous rotation (e.g.: morning-afternoon-evening-afternoon);
				Oscillating	The individual alternates between night and day shifts, or between afternoon and evening on a weekly basis;
				Split Shift	A break of a few hours separates the work hours made on the same day (e.g.: restoration and transportation, where there are higher movement peaks at certain times);
				Relief shifts	The individual can enter any of the above patterns, but the working schedule will depend on the time of the missing worker.
	Alternative Types	**Four-day work week or 12-hour work periods**			They can be used in one to three shifts continuously or discontinuously (on weekends);
		Eight-day week			With four 10-hour days, followed by four days off, used mostly in firms that work 10 hours a day, seven days a week or work 20 hours a day in two shifts;
		Flextime			The worker has a considerable choice to schedule his daily working hours in meeting the weekly obligations;
		Staggered Hours			Workers are assigned or allowed to choose the hours to start work, and as a result, that time determines when they are going to leave work.

4. CHRONOBIOLOGY AND BIOLOGICAL RHYTHMS

Chronobiology is the science that studies recurrent biological phenomena that occur at a given periodicity, also known as biological rhythms, and may or may not have a temporal correspondence with environmental cycles, such as day and night cycle (Halberg, 1969). In all species, there are phenomena that are repeated with the regularity of a clock a calendar or a rhythm. Mammals, in general, and humans, in particular, have a natural rhythmicity for many body functions, which follow a well-defined periodic pattern (Filho, 2002). These are called biological rhythms, and can be of three types according to their frequency (Arechiga, 1988; Ferreira, 1987; Fraisse, 1980; Scott & LaDou, 1994; Suarez, 1990):

- **Circadian:** about one day, with a frequency close to 24 hours;
- **Ultradian:** frequency higher than the circadian rhythm, cycles lasting from one-millionth of a second to a few hours, always less than 24 hours;
- **Infradian:** lower frequency than circadian rhythm, cycles lasting longer than 24 hours.

There are several physiological, psychological and behavioural functions that follow circadian rhythms, namely body temperature, corticosteroids and electrolytes of serum and urine, cardiovascular functions, gastric enzyme secretion, blood leukocyte number, muscle strength, alertness, mood and immediate and long-term memory (Scott & LaDou, 1994).

Multiple environmental variables, such as temperature, light intensity, and relative humidity, vary cyclically and predictably, resulting in environmental cycles, the most evident ones being those with a 24-hour period, due to the rotation of the earth. That said, and for the organism to survive and ensure reproductive success in these highly cyclic environments, it is important that physiological and behavioural processes occur in specific phases of each cycle, that is, they are rhythmically expressed and synchronized with the environmental cycles. Thus, we observed the daily rhythms of several biological variables, such as the daily activity-rest rhythm that exists in many animals (Tachinardi, 2012).

The circadian rhythms are observed in all groups of living beings, for Suarez (1990) and Reinberc, Chaumont, & Laport (1973), each nerve cell, glandular, digestive, hepatic, among others, has its own circadian rhythm, since they are more active at certain hours and are at rest in others, synchronizing with each other and coupled to a master biological clock and this master clock to the environment by environmental synchronizers. Circadian rhythms, such as heart rate, respiratory rate, sleep/wake cycle, body temperature, urine excretion, cell division and hormone production, can be modulated by "zeitgebers" (synchronizers or external influences) of exogenous nature, such as the light/darkness cycle and the activity/rest cycle, by climatic factors, socio-cultural factors, periodic food intake, among others (Harrington, 1994).

Most biological cycles occur in a period of 25.2 hours, but there are differences from person to person, since the zero hour of one person is not necessarily that of another. There are people who wake up early and fall asleep early, these individuals are classified as morning persons, others prefer to go to bed around 3 o'clock in the morning and wake up around noon, it's the evening persons (Cipolla-Neto et al., 1988). This is an aspect of extreme importance, since the cycles of all functions are dragged by the sleep cycle, so the external stimuli serve only to synchronize the internal rhythms with the environment, since the organism does not behave in the same way at night and by day, not being relevant in this case, the fact that the individual is awake or sleeping.

The most relevant synchronizer in most living beings is light, that triggers an electrical message from retinal cells through the optic nerves, which reaches the hypothalamus at the base of the brain. The hypothalamus, besides commanding the glands of the organism, has a small nucleus where the biological clock is located, considered essential to the maintenance of the rhythms. The function of the pineal gland, located in the dorsal area of the brain and controlled by the hypothalamus, is regulated by the brightness of the day, which prevents the gland from producing melatonin, however, when it arrives at night, this gland is unlocked, as artificial light is not enough to sustain the same effect, thus initiating the release of its hormone which, in addition to inducing sleep, acts as a kind of indicator for all other biological rhythms. If there is no production at an optimal level of melatonin in the proper period, the worker will not experience adequate sleep quality (Filho, 2002). According to Cipolla-Neto et al. (1988) and Suarez (1990), the organism regulates various metabolic functions from the production of melatonin, which plays a role in the pathophysiology of puberty disorders and convulsions. Melatonin also has a stimulatory role in certain immune cells that fight tumours, which develop faster during the day.

The alternation of rest and activity is also powerful synchronizer for the human being, following a cycle of twenty-four hours, which means that the stability of our temporal structure depends very much on the stability of the alternation between rest and activity, linked to our social life (Filho, 2002). A change of phase of the socio-ecological synchronizers, of about five hours, will translate into a change in the phase of the peaks of the physiological variables that serve to describe our circadian temporal structure, and consequently in desynchronization of the organism (Reinberc et al., 1973). This type of change is common in shift workers, especially in those including night work, where workers are forced to reverse their normal sleep-wake cycle, according to their working hours, while the light-dark cycle and social "zeitgebers" remain the same (Foret, 1992; Reinberg, Andlauer, & Vieux, 1981).

The alternating hormone levels constitute biological rhythms, which influence the disposition of the human being. Due to this biological rhythm, it is important to keep fixed meal times, since in these moments the digestive system produces the enzymes responsible for the digestion. If this does not occur, the food finds the stomach unprepared and, however light it may be causes poor digestion. On the other hand, if food is not eaten at the usual time, the enzymes produced to attack the digestive tract itself, giving rise to gastrointestinal disorders such as heartburn, gastritis and ulcers (Filho, 2002).

According to Ferreira (1987), there is a certain internal temporal order due to the synchronism of the various rhythms between them, which is modulated by external synchronizers. With changes in working hours the individual continues to be influenced by the time indicators (family, social and cultural life), there is a conflict of synchronizers, the organism tries to adjust the biological rhythms to a new reordering, while there is an attempt to maintain the life of social relation exactly the same. When the sleep/wake cycle is reversed, that is, if one sleeps during the day and works at night, a temporal disorder occurs, on the other hand, the inversion of sleep/wake does not induce the body to reverse all other cycles with the same speed, which potentiates the temporal disorder and the worsening of the symptoms of maladjustment to shift work and night work, resulting in the development of several pathologies.

4.1. SLEEP / WAKE CYCLE

To understand how the sleep cycle works, it is necessary to consider and evaluate three criteria: the electrical activity of the cerebral cortex, the degree of ease with which the individual can be awakened and the muscle tone. When an individual is relaxed and eyes closed, EEG activity is constituted by large and slow waves (alpha waves), on the other hand, in people who are alert and with eyes open, EEG activity is more desynchronized , that is, it presents smaller amplitude waves (beta waves) (Filho, 2002).

According to Roper, Logan, & Tierney (1995), each sleep cycle lasts approximately 90 to 100 minutes and there are usually four to six cycles in a normal sleep period of an individual. Sleep cycles can then be described as having five phases:

1st Phase: The individual has just fallen asleep, there is general relaxation at this stage and the thoughts are heaped up and the individual can be awakened by any slight stimulus. This stage is considered by the individual, when he is awake, as drowsiness, it isn’t described as sleep. With drowsiness, there is a global decrease in the wave amplitude (theta waves), characterizing the first phase of sleep.

2nd Phase: It is characterized by a greater relaxation the thoughts acquire a quality of dream. The individual is now sleeping but can be awakened easily. Episodes of high-frequency activity, sleep spindles, large and slow waves of occasional occurrence (beta waves) are frequent.

3rd Phase: It usually begins after 30 minutes of sleep, is characterized by complete relaxation and the frequency of the pulse decreases, as well as most other body functions. Outside noises, like familiar noises, do not wake the individual and if not disturbed, the individual goes into the next phase. This phase is also characterized by the frequency of delta waves and maintenance of muscle tone.

4th Phase: The individual is more relaxed, rarely moves and is difficult to wake him, he is deep sleep, dominated by the slow waves (delta waves). At this stage there is a decrease in muscle tone and decrease in heart rate, respiratory and blood pressure lowering, as well as basal metabolism. This phase is called Slow Wave Sleep (SWS). It is a restful sleep considered essential to physical recovery.

5th Phase: Sleep period during which dreams happen and the eyes move rapidly back and forth, this movement is called "Rapid Eye Movement (REM), where the EEG is similar to of an awake and relaxed person, however the heart and respiratory rate, as well as the blood pressure are increased, and the muscle tone reduced. This phase is known as Paradoxical Sleep, since it is a paradox that the person is sleeping and maintains an accentuated brain activity, without being aware of what is involved.

We are diurnal creatures, therefore after a normal day of being awake and active for some time, we feel tired in the evening and ready for sleep. However, shift works sometimes make it impossible to sleep in the evening, and although it's possible to sleep during the day, as evident from the lifestyle of night workers, even in a quiet environment, daytime sleep tends to be more fragmented and shorter than nocturnal sleep (Waterhouse, Fukuda, & Morita, 2012).

According to Filho & Turnes (1995), there is a strong dependence between the quality of sleep and the quality of the wake, not sleeping or sleeping poorly translates into difficulties in fulfilling activities that require intense and resistant vigilance. Individuals subject to circadian sleep rhythm disorders have a pattern of persistent and recurrent sleep disruption that leads to excessive drowsiness or insomnia and is due to a divergence between the sleep-wake schedule required by the environment in which the subject is and its circadian sleep-wake pattern (Fauman, 2002).

Working schedules that prevent individuals from sleeping at their usual times have a negative impact on the psychophysiological balance of workers. Usually, the first shift reduces a few hours of night-time sleep, which is not compensated by the anticipation of bedtime, resulting in a loss that accumulates over the morning shift period. The worker also has sleep that follows the first day of night shift of work deteriorated, whether by the total duration, amount of Slow Wave Sleep, or by the amount of Paradoxical Sleep or regularity in the stages of sleep. During the period that the individual sleeps during the day, the body begins to adapt to the time inversion, however after the return to nocturnal sleep, it is necessary to exist a contrary adaptation. If this reinvestment is consecutively postponed, it becomes increasingly difficult to readapt (Foret, 1984).

The rhythm of ease of getting to sleep (sleep propensity) is notable in individuals that miss a night's sleep as they feel tired during the night but, despite not having sleep properly, they then feel less tired as the new day arrives and, during the afternoon, will feel surprisingly alert. However, by the evening, the sensation of fatigue increases exponentially and becomes progressively more difficult to resist. This indicates that there is an increasing drive to sleep as the amount of time awake continues to increase but it's mixed with a rhythmic component that varies during the course of 24 hours (Waterhouse et al., 2012).

According to Ferreira (1987) and Harrington (1994), the amount of sleep for night shift workers may be reduced up to two hours a day, and the quality of sleep is also affected, particularly in the second and fifth stages of sleep, therefore the internal structure of sleep is altered, this damage accumulates over the course of the day, leading to a constant sleep debt. The authors also mention that the workers in the first shift, when it starts around 5 o'clock in the morning, have the Paradoxical Sleep phase affected because they lose the final part of it due to having to wake up very early to get to work at hours.

Shift work, especially the ones including night work, disrupts sleep chronology and may reduce its quantity and quality. The magnitude of the problems of sleep that come from it varies according to the type of work that is done, the shift system adopted and environmental factors such as noise at work or noise at home during the hours used for sleep (Silva, Chaffin, Neto, & Júnior, 2010). Therefore, it is crucial to ensure a good sleep, since it is recuperative, removes the feeling of fatigue, protects the worker general health and produces an improvement in cognitive ability, this is crucial so that individuals feel ready to face the rigors of a new day (Waterhouse et al., 2012).

5. RESULTS

Table 2 summarizes the articles used to perform this review.

Table 2. Articles used to perform this review

Theme	#	Authors
SHIFT WORK SLEEP DISORDER	7	Czeisler et al. (2005); Sehgal & Mignot (2011); Allebrandt et al. (2011); Flo et al. (2012); Vogel, Braungardt, Meyer, & Schneider (2012); Markwald et al. (2013); Depner, Stothard, & Wright (2014).
CIRCADIAN RHYTHM SLEEP DISORDER	9	Sack et al. (2007); Scheer, Hilton, Mantzoros, & Shea (2009); Marcheva et al. (2010); Drake & Wright (2011); Buxton et al. (2012); Markwald & Wright (2012); Wright, Bogan, & Wyatt, (2013); Depner et al. (2014); Ruggiero & Redeker (2014).
SLEEP-WAKE PHASE DISORDERS	3	Takahashi, Hong, Ko, & McDearmon (2008); Murray & Thimgan (2016); Murray & Thimgan (2016).
SLEEP APNEA	5	Laudencka, Klawe, Tafil-Klawe, & Złomańczuk (2007); Paciorek et al. (2011); Martin et al. (2014); Murray & Thimgan (2016); Snyder & Cunningham (2018).
NARCOLEPSY	3	Rajaratnam et al. (2011); Murray & Thimgan (2016); Ohayon et al. (2018).
RESTLESS LEG SYNDROME (RLS)	4	Murray & Thimgan (2016); Trenkwalder et al. (2018); Sharifian et al. (2009); Uekata, Kato, Nagaura, Eto, & Kondo (2019).
PARASOMNIAS	3	Sateia (2014); Bjorvatn, Magerøy, Moen, Pallesen, & Waage, (2015); Murray & Thimgan (2016).
HYPERSOMNIAS	2	Gabarino et al. (2002); Murray & Thimgan (2016).
METABOLIC SYNDROME	7	Al-Naimi, Hampton, Richard, Tzung, & Morgan (2004); Chen, Lin, & Hsiao (2010); Burgueño, Gemma, Gianotti, Sookoian, & Pirola (2010); Kawabe et al. (2014); Guo et al. (2015); Oike, Mutsumi, Ippoushi, & Masuko (2015); Espitia-Bautista et al. (2017).
DIABETES MELLITUS	8	Kawachi et al. (1995); Perez-Tilve, Stern, & Tschöp (2006); Cappuccio, D'Elia, Strazzullo, & Miller (2010); Katsuhiko, Suzuki, Toshiharu, Soshi, & Hiroyuki (2013); Forouhi & Wareham (2014); Kalsbeek, La Fleur, & Fliers (2014); Gan et al. (2015); Hansen, Stayner, Hansen, & Andersen (2016).
OBESITY	7	Di Lorenzo et al. (2003); Hannerz, Albertsen, Nielsen, Tuchsen, & Burr (2004); Van Amelsvoort, Schouten, & Kok (2004); Osamu, Kaneita, Murata, Yokoyama, & Ohida (2011); Van Drongelen, Boot, Merkus, Smid, & Van der Beek (2011); Osamu et al., (2011); Canuto, Pattussi, Macagnan, Henn, & Olinto (2013).
DYSLIPIDMIA	3	Esquirol et al., (2011); Alefishat & Abu Farha (2015); Charles et al. (2016).
GASTROINTESTINAL DISTURBANCES	13	Koller (1983); Gordon et al. (1986); Simmons, Heitkemper, & Shaver, (1988); Coelho (1988); Verhaegen et al. (1987); Knauth & Härmä (1992); Costa (1997); Levenstein (1998); Caruso, Lusk, & Gillespie (2004); Sveinsdóttir (2006); Pietroiusti et al. (2006); Burch et al. (2009); Knutsson & Bøggild (2010).
CARDIOVASCULAR DISEASE	14	Gordon et al. (1986); Akerstedt & Knutsson (1997); Bøggild & Knutsson (1999); Karlsson, Knutsson, & Lindahl (2001); Van Amelsvoort et al. (2004); Ha & Park (2005); Puttonen et al. (2009); Frost et al. (2009); Puttonen, Härmä, & Hublin (2010); Hublin et al. (2010); Thomas & Power (2010); Nabe-Nielsen, Quist, Garde, & Aust (2011); Canuto, Garcez, & Olinto (2013); Landsbergis, Travis, & Schanall (2013).
HYPERTENSION	3	Thomas & Power (2010); Guo et al. (2013); Ohlander, Keskin, Stork, & Radon, (2015).
UROLOGIC CONDITIONS	15	Touitou et al. (1990); Irgens, Kruger, & Ulstein (1999); Sheiner, Sheiner, Carel, Potashnik, & Shoham-Vardi (2002) ; Smith et al. (2006); Bonzini, Coggon, & Palmer (2007); Andersen & Tufik (2008); El-Helaly, Awadalla, Mansour, & El-Biomy (2010); Ortiz et al. (2010); Quansah & Jaakkola (2010); Stocker, MacKlon, Cheong, & Bewley (2014); Van Melick, Van Beukering, Mol, Frings-Dresen, & Hulshof (2014); Eisenberg, Chen, Ye, & Louis (2015); Kim (2016); Pastuszak et al. (2017); Scovell et al. (2017).
PHYCOLOGICAL HEALTH	21	Kieseppä, Partonen, Haukka, Kaprio, & Lönnqvist (2004); Levinson (2006); Kessler, Chiu, Demler, Merikangas, & Walters (2005); Burmeister, McInnis, & Zöllner (2008); Craddock & Sklar (2009); Koido et al. (2012); Milham (2012); Smith & Eastman (2012); Sklar et al. (2012); Moylan, Maes, Wray, & Berk (2013); Jeste & Geschwind (2014); Mühleisen et al. (2014); Hawi et al. (2015); Gatt, Burton, Williams, & Schofield (2015); Zhao & Castellanos (2016); Amstadter, Maes, Sherrin, Myers, & Kendler (2016); Zhao & Castellanos (2016); Park, Han, Park, & Ryu (2016); Lee, Kim, Kim, Lee, & Kim (2016); Sousa et al. (2017); Lindgren, Deng, Pastuszak, & Lipshultz (2017).
CANCER	21	Davis, Mirick, & Stevens (2001); Schernhammer et al. (2001); Spiegel & Sephton (2002); Schernhammer et al. (2003); Davis & Mirick, (2006); Schwartzbaum, Ahlbom, & Feychting (2007); Lewy, Haus, & Ashkenazi (2007); International Agency for Research on Cancer (2007); Wood et al. (2008); Yang et al. (2009); Arendt, (2010); Viswanathan & Schernhammer (2010); Fritschi et al. (2011); Grundy, Tranmer, Richardson, Graham, & Aronson (2011); Hansen & Stevens (2012); Haus & Smolensky (2013); Herichova (2013); Sigurdardottir et al. (2013); Flynn-Evans, Mucci, Stevens, & Lockley (2013); Bhatti, Mirick, & Davis (2013); Khan et al. (2016).
CONSEQUENCES IN SOCIAL AND FAMILY LIFE	6	Gadbois (1990); Koller, Kundi, Haider, Cervinka, & Friza (1990); Fischer, Teixeira, Borges, Gonçalves, & Ferreira (2002); Baker, Ferguson, & Dawson, (2003) ; Gadbois (2004); Santos et al. (2008).
CONSEQUENCES ON THE ORGANIZATIONAL CONTEXT	10	Wojtczak-Jaroszowa & Banaszkiewicz (1974); Winget, DeRoshia, & Holley (1985); Fischer (1985).; Dorel (1996); Tucker, Folkard, & Macdonald (2003); Philip & Åkerstedt (2006); Santos, Franco, Batista, Santos, & Duarte (2008); Wagstaff & Lie (2011); Wright et al. (2013); Boivin & Boudreau (2014).

5.1. SHIFT WORK HEALTH CONSEQUENCES

There are multiple consequences in the workers' health as a result of shift working. The consequences can be the following: shift work sleep disorder, sleep-wake phase disorders, sleep apnea, narcolepsy, restless leg syndrome, parasomnias, hypersomnia, circadian rhythm sleep disorder, metabolic syndrome, diabetes mellitus, obesity, dyslipidemia, gastrointestinal disturbances, cardiovascular diseases, hypertension, urologic conditions, phycological health and cancer.

5.2. SHIFT WORK SLEEP DISORDER

The rotation of existing shift schedules affects sleep, causing health problems like insomnia, sleep apnea, periodic movement of the legs, restless leg syndrome, and disorders associated with the sleep/wake cycle, namely rapid eye movement and narcolepsy, sleep disturbances and somnambulism (Sehgal & Mignot, 2011). In addition, the deregulation of the state of homeostasis and circadian rhythms can lead to psychiatric disorders, metabolic and cardiomyopathies (Allebrandt et al., 2011). The shift work can also disrupt the human physiological patterns controlled by the circadian rhythms and sleep, like the regulation of the energy expenditure and the glucose metabolism (Depner, Stothard, & Wright, 2014; Markwald et al., 2013).

The sleep disturbances associated to shift work are a condition characterized by sleepiness or insomnia, accompanied by a total reduction in sleep time, being prevalent in about 10% to 38% of the workers subject to this type of work. This type of disturbance occurs due to the deregulation of the sleep-wake cycle by factors of extrinsic origin, being more associated with nocturnal and morning schedules (Flo et al., 2012; Markwald et al., 2013).

The reduced alertness and the performance of the worker, as well as the association to higher rates of comorbidity with gastrointestinal disturbances, make sleep disorders associated with shift work a serious condition that should be the focus of attention (Vogel, Braungardt, Meyer, & Schneider, 2012). Daytime drowsiness and nighttime insomnia become more prominent in individuals who work in shifts for extended periods of time. The major risks associated with this type of disorder are depressions, ulcers, and accidents related to drowsiness (Czeisler et al., 2005).

5.3. CIRCADIAN RHYTHM SLEEP DISORDER

This disorder is associated with irregularities caused by circadian deregulation due to variations in sleep/wake cycles. Changes in sleep/wake patterns are triggered by shift work, jet lag, light exposure and insufficient sleep time. Circadian deregulation alters neuroendocrine physiology, impairs glucose tolerance, and reduces insulin sensitivity (Buxton et al., 2012; Depner et al., 2014; Markwald & Wright, 2012; Scheer, Hilton, Mantzoros, & Shea, 2009).

The problem of sleep deprivation is that there is an incompatibility between circadian rhythms and working schedules, leading to circadian changes and sleep deprivation, which in turn lead to increased fatigue, decreased in the capacity for alertness, drowsiness, sleep deficiency, as well as physiological and behavioural problems (Drake & Wright, 2011; Marcheva et al., 2010; Markwald & Wright, 2012; Ruggiero & Redeker, 2014; Sack et al., 2007; Wright, Bogan, & Wyatt, 2013). There is also evidence of the association of 24 hours of sleep/wake syndrome with sleep disorder associated with circadian rhythm (Sack et al., 2007).

Exposure to high light levels in shift workers as well as consecutive shift work, if maintained for long periods, can potentiate changes at the genetic level. These changes will disrupt the normal functions of genes related to behaviour, sleep and the circadian system at a higher level, and consequently, lead to serious health conditions.

5.4. SLEEP-WAKE PHASE DISORDERS

There are two types of sleep-wake phase disorders, the advanced sleep-wake phase disorder, and the delayed sleep-wake phase disorder. The two sleep disorders occur when there is a mismatch between the typical day–night schedule and an individual's internal circadian rhythm, and consequently, these individuals may have difficulties falling asleep or staying asleep during sleep opportunities and unable to maintain wakefulness when necessary for work or life activities.

The advanced sleep-wake phase disorder (ASWPD) is characterized by an early awakening, about 3 to 4 hours earlier than normal times. It is inherited in an autosomal dominant way, and has its origin in disorders caused on the circadian rhythm, since the genes responsible for circadian rhythms are key factors in its development (Takahashi, Hong, Ko, & McDearmon, 2008).

People with ASWPD present symptoms that suggest their circadian clock may be running faster than the standard circadian clock so that internally timed events occur earlier. In more severe cases, of this illness, an affected person will naturally go to sleep around 6 or 7 p.m. and then awaken around 2 a.m. to start their day. Thus, basing these cases and comparing to the rest of the population, they have these events at much early times. The consequences of this disease are centred on night-time activities. Evening social activities may be difficult for these individuals, as even a typical dinner party would start about their typical bedtime. Thus, any type of job that goes into the evening hours would not be ideal. Therefore, the person may begin to become sleep deprived or the task may be very difficult because of building sleepiness. On the other hand, when the job timing is synchronized with their schedule, these patients tend not to lose too much sleep. On the other hand, when the job timing is synchronized with their schedule, these patients tend not to lose too much sleep (Murray & Thimgan, 2016).

The delayed sleep-wake phase disorder (DSWPD) is characterized by the chronic inability to fall asleep and wake up at normal times. The genes of the circadian system are strongly related to the development of this deregulated sleep behaviour, highlighting once again the negative impacts of circadian rhythms deregulation caused by shift work (Takahashi et al., 2008). This condition, results in a delayed bedtime and rise time, the opposite effect of ASWPD. In severe cases, the person will not fall asleep until between 2 and 6 am. The person will then rise about 10 am to 2 pm for 8 h of sleep. The main medical consequences of this condition are depression and the use of antacids, hypnotics, tobacco, alcohol, and caffeine. People with DSWPD may have a hard time adapting to a normal work schedule, since this condition is like having perpetual jet lag from traveling west to east, which is a more difficult adaptation. The consequences then lead to sleepiness, irritability, a lack of concentration, and increased job loss (Murray & Thimgan, 2016).

Considering that the shift work has a significant impact on the quantity and the quality of sleep, this can affect the normal functioning of the genes and consequently origin the development of one of these disorders. Thus, people that suffer from either an advance or delay of the circadian promotion of sleep and wakefulness possibly can become sleep deprived because they have to work against their circadian biology to comply with a normal work schedule and exhibit sleepiness during periods when wakefulness is required (Murray & Thimgan, 2016).

5.5. SLEEP APNEA

One of the most common sleep disorders is sleep apnea and occurs when a person has interruptions or exceptionally shallow breathing during sleep (hypopneas). These interruptions can last from a few seconds to minutes, leading to both fragmented sleep and potentially a decrease in blood oxygen saturation (Snyder & Cunningham, 2018). Therefore, with more severe apnea–hypopnea index (AHI) there is a longer duration of a disease state. One of the most prominent consequences of sleep apnea is the excessive daytime sleepiness (EDS). This condition impairs cognitive performance as patients report having difficulties staying on task, falling asleep inappropriately at their work space, poor work performance, and memory problems. These outcomes can have adverse effects on career trajectory. Increased AHI leads to increased sleep fragmentation and sleepiness in which there is an increased likelihood that one might fall asleep at inappropriate times and places. Thus, untreated sleep apnea leads to a two to sevenfold increase in car accidents and workplace accidents that can put the employees and others in dangerous situations (Murray & Thimgan, 2016).

Also, the obstructive sleep apnea (OSAS) has been identified as one of the health consequences of shift work, however, the link between the two has not yet been as studied as other problems associated with shift work (Martin et al., 2014).

A study conducted by Paciorek et al. (2011), found that individuals with sleep apnea who performed shift work had higher apnea-hypopnea index (AHI) and oxyhemoglobin desaturation index rates during daytime sleep, compared with sleep-deprived sleepers who did not perform shift work. In shift workers, the apnea-hypopnea index was higher during daytime sleep after night shifts compared to nigh time sleep, suggesting that sleep deprivation in shift workers may be one of the major contributing factors for the aggravation of sleep apnea. In other study involving eight individuals with sleep apnea, four of the individuals had higher levels of the apnea-hypopnea index during sleep after the night shift, compared to sleep at night. This suggests that only part of the individuals with sleep apnea experience the aggravation when working in shifts (Laudencka, Klawe, Tafil-Klawe, & Złomańczuk, 2007).

In this context, it is possible to conclude that more studies are necessary in order to better understand the relationship between shift work and sleep apnea since the studies carried out so far do not allow to fully understand the existing link.

5.6. NARCOLEPSY

Narcolepsy is defined as sleep attacks that people have during daytime activities. This can make it dangerous to drive a car and challenging to sit through meetings during the day. This condition is often accompanied by another condition known as cataplexy, that emotional triggers will cause muscle relaxation to the point that the person will collapse or feel as though they can no longer hold themselves up (Ohayon et al., 2018). The consequences of this disorder are the increased likelihood of having a sleep attack during an inopportune or even dangerous moment, such as while driving. The sleep attacks can also occur in social, work, or school situations, in which the person can be put in an awkward, uncomfortable, or disadvantaged position that affects their performance, and add to the discomfort in dealing with others. Without treatment, the unpredictability of behavioural state can be debilitating and result in a lack of confidence, dependence, and social isolation. In addition, people with narcolepsy may see increased weight gain (Murray & Thimgan, 2016).

A study conducted by Rajaratnam et al. (2011) involving nearly 5000 North American police officers, frequently working extended shifts and long work week, in order to quantify associations between sleep disorder risk and self-reported health, safety, and performance outcomes in police officers, concluded that 40% screened positive for at least one sleep disorder and less than 1% for narcolepsy with cataplexy. However, it is necessary to perform other studies with shift workers in order to prove the connection between shift work and narcolepsy.

5.7. RESTLESS LEG SYNDROME (RLS)

The RLS is a condition which is described as an uncomfortable or unpleasant sensation in the legs that causes them to voluntarily move their legs or less frequently other muscles, to temporarily alleviate the uncomfortable feelings. These feelings are more prevalent in the evening or night time with increased immobility and thus tend to peak near bedtime (Trenkwalder et al., 2018). This disease can severely disrupt sleep and substantially reduce the quality of life and the symptoms can vary from mildly annoying to very disruptive. Individuals with moderate to severe RLS sleep on average 5.5 h, have longer sleep latencies, and a higher arousal index, suggesting their sleep is more fragmented and they have more difficulty sleeping. Patients also report increased daytime sleepiness, fatigue, anxiety, major depression, hypertension, heart disease, and importantly, impaired daytime functioning (Murray & Thimgan, 2016).

A cross sectional study was conducted in and automobile manufacturing factory in Tehran, Ian, involving a total of 780 male assembly workers were recruited in three groups (permanent morning shift (A) and two different rotating shift schedules (B and C), with morning, afternoon and night shifts. Using the international RLS study group criteria for diagnosis of RLS, and the severity scale for severity assessment in subjects with RLS, the results indicated a significantly higher prevalence of RLS among shift workers (15%) than in workers with permanent morning work schedule (8.5%). They also found greater mean values of age and work experience, higher percentages of drug consumption, smoking and co-morbid illnesses in workers suffering from RLS, compared with subjects who did not have RLS, although these differences were statistically significant only for age, work experience and drug consumption (Sharifian et al., 2009).

Other study conducted by Uekata, Kato, Nagaura, Eto, & Kondo (2019), with the aim to examine the relationship between differences in work schedules and subjective sleep quality among female nursing staff, concluded that the prevalence of restless legs syndrome/Willis-Ekbom disease was 2.5%. Leg motor restlessness was observed in. 15.5% of participants. So, regardless of the working schedules, rates of poor sleep were high among female hospital nurses and midwives. Our findings suggest that poor sleep quality is influenced by three-shift rotation, the evening chronotype, and leg motor restlessness.

5.8. PARASOMNIAS

Parasomnias are described as recurrent episodes of incomplete awakening, absent or inappropriate responsiveness, limited or no cognition or dream report and partial or complete amnesia for the episode (Sateia, 2014). The main consequences are sleep-walking, sleep terrors, sleep-related eating, sleep violence can occur during and around the deepest form of sleep, slow wave sleep (SWS) (Murray & Thimgan, 2016).

A longitudinal cohort study involving 2198 nurses with different work schedules was performed in order to investigate whether different shift work schedules were associated with nonrapid eye movement (NREM) and/or REM-related parasomnias. The results from this study indicated that nurses working two shift (day and evening) and nurses working three shift (day, evening and night) rotational schedules had increased risk of confusional arousal, a NREM-related parasomnia, compared to nurses working daytime only (OR=2.10 and 1.71, respectively). Similarly, nurses working two and three shift rotational schedules had increased risk of nightmares, a REM-related parasomnia (OR=1.64 and 1.57, respectively). This is likely related to the circadian rhythm misalignment and sleep deprivation caused by such shift schedules. Is this study, the other parasomnias evaluated (sleepwalking, sleep terror, sleep-related eating, sleep-related violence and sexsomnia) were not significantly associated with work schedule. It is also worth notice that, in this study, working night shifts only, was not associated with any of the parasomnias (Bjorvatn, Magerøy, Moen, Pallesen, & Waage, 2015).

5.9. HYPERSOMNIAS

This disease results in a set of conditions that results in excessive sleep or drive to go to sleep during the primary wake period. The person in these conditions may not be able to sustain wakefulness or alertness when it is required. Often the person will have involuntary sleep episodes while watching TV, reading, during social events, having conversations, or while driving (Murray & Thimgan, 2016).

Gabarino et al. (2002), conducted a study that aimed to perform an evaluation of shift-work effect on sleepiness, sleep disorders, and sleep-related accidents in a population of police officers, and observed a higher prevalence of hypersomnia on shift workers compared to non-shift workers (4.9% versus 2.2%). It was also concluded that stressful conditions could cause sleepiness to be underestimated, or else they might overcome sleepiness. However, our data should alert occupational health physicians for the diagnosis and prevention of possible undetected intrinsic sleep disorders, which could possibly worsen shift workers' health and increase the risk of accidents.

5.10. METABOLIC SYNDROME

Metabolic syndrome can be defined as a set of various risk factors, namely high blood pressure, obesity, lowered high-density lipoprotein cholesterol, high fasting glucose and high triglycerides. All of which are frequently present simultaneously in an individual. A pioneering study revealed that unlike workers who perform their activity at the normal daytime schedule, shift workers are gravely vulnerable to three metabolic problems, namely high levels of triglycerides, obesity, and hypertension (Chen, Lin, & Hsiao, 2010). Other study conducted by Burgueño, Gemma, Gianotti, Sookoian, & Pirola (2010), also found a heightened susceptibility to the metabolic syndrome among night shift health care professionals is a result of poor sleeping and resting habits, associated with their professional activity and the time at which they execute it.

Some studies have established a link between shift workers and increased food intake, with a preference for carbohydrate-rich foods, and changes in lipid parameters, especially in triglyceride levels (Al-Naimi, Hampton, Richard, Tzung, & Morgan, 2004). A study conducted in China with 26.382 workers (11.783 men and 14.599 women), with a total of 9.088 shift workers, also established a strong link between shift work and the metabolic syndrome, without adjusting for any confounder's factors. In female shift workers, every 10 years spent in shift work was associated with an increase of about 10% (95% IC:1%-20%) higher odds of developing metabolic syndrome. They also found that shift workers were significantly associated with higher blood pressure levels, higher waist circumference, and increase in glucose levels, all components of metabolic syndrome (Guo et al., 2015). Similarly, a study conducted in Japan involving 3.094 individuals in the daytime work group, 73 in the fixed night time work group, 1.017 in the shift work group and 243 in the day-to-night work group, showed that fixed shift work and night time work, contributed strongly to the number of workers with metabolic syndrome, compared to daytime work (Kawabe et al., 2014).

Social jet lag is a key factor in developing metabolic syndrome since it induces changes in cholesterol levels and implies changes in food processes. It was observed in an experiment that social jet lag potentiated body weight gain by increasing overconsumption of food. As a result, it promoted high levels of insulin and dyslipidemia indicating the risk of metabolic syndrome (Espitia-Bautista et al., 2017). It is also important to mention, in combination with shift work, that a chronic shift in light/dark cycles induces obesity, increases body weight and glucose intolerance, leading to the accumulation of fat in white adipose tissues, and also changes in the expression profiles of metabolic genes in liver (Oike, Mutsumi, Ippoushi, & Masuko, 2015). Trough the studies mentioned above, the connection between shift work and the development of metabolic problems is undenied.

5.10.1 DIABETES MELLITUS

Few studies have investigated the relationship between shift work and diabetes mellitus despite a high prevalence of the disease its negative impact that this disease has on multiple organ systems (Forouhi & Wareham, 2014). However, some studies point to the existence of this relationship, namely a cohort study involving 121.700 nurses, aged between 30 and 55 years, concluded that nurses who worked longer shifts were more likely to have diabetes (Kawachi et al., 1995). A meta-analysis involving 226.652 individuals showed a odds ratio (OR) of 1.09 (95% CI 1.05-1.12; P= .014) for the association being stronger in men (OR=1.37, 95% CI 1.20-1.56) than woman (OR=1.09, 95% CI 1.04-1.14) (Gan et al., 2015).

Another study, involving 475 Japanese male manufacturing workers, concluded that the development of this disease was more likely to be associated with more intense shift work (OR=2.10, 95% CI 0.77-5.71 for continuous shift workers; OR= 0.98, 95% CI 0.28-4.81 for seasonal shift workers) compared to non-shift workers with this association being more pronounced in workers who were older than 45 years (Katsuhiko, Suzuki, Toshiharu, Soshi, & Hiroyuki, 2013).

In a longitudinal cohort study, involving 19.873 female nurses, who initially had no diabetes at initial enrolment, after 15 years, 837 nurses developed the disease. In this study, they concluded that nurses working in the night and evening shifts had a higher risk of developing diabetes (Hazard ratio= 1.58, 95% CI 1.25-1.99 for night shifts; Hazard ratio=1.29, 95% CI 1.04-1.59 for evening shifts) compared to nurses who worked day shifts (Hansen, Stayner, Hansen, & Andersen, 2016).

It is also important to mention that some studies that related sleep deregulation or its deprivation with the risk of developing diabetes have suggested that insufficient sleep time or poor quality of sleep are risk factors for the development and exacerbation of insulin resistance and can increase both appetite and adiposity (Kalsbeek, La Fleur, & Fliers, 2014; Perez-Tilve, Stern, & Tschöp, 2006). A meta-analysis of 10 studies and 107.756 participants, which assessed the relationship between habitual sleep disturbances and type 2 diabetes, established a relationship between the quantity and quality of sleep in the development of diabetes. For short duration of sleep (≤ 5-6 h/night), the risk was 1.28, and a long duration of sleep (> 8-9 h/night), the risk was 1.48 for the incidence of type 2 diabetes. For those with difficulty to initiating sleep, the risk was 1.57 and for those who have difficulty maintaining sleep, the risk was 1.84 (Cappuccio, D'Elia, Strazzullo, & Miller, 2010). These studies point to a strong link between shift work and the development of diabetes Mellitus, demonstrating once again the impact that this type of work can have on worker's health.

5.10.2. OBESITY

The association between weight gain and shift work and night work has also been investigated. A study conducted in Brazil reported extremely high rates of obesity in female night workers aged 40 years or older with low education levels and a family history of overweight. In this study, daily sleep duration was also divided into the three following categories: > 5 hours of continuous sleep, ≤ 5 hours of continuous sleep with some additional rest, or ≤ 5 hours of continuous sleep with no additional rest. After adjusting for confounding factors, obesity rates were significantly higher in the latter two groups than in the first one (composed mostly by day workers, supporting the association between sleep deprivation and obesity (Canuto, Pattussi, Macagnan, Henn, & Olinto, 2013).

Another study, conducted in Japan, which followed 21.693 men and 2.109 women between 1999 and 2006 found that the relative risk of obesity was higher in men who slept for less than 5h/day than in those who had at least 5 to 7 hours of sleep per day. In woman, these variables were not significantly associated. This study concluded that a short sleep period (<5h) accelerated the onset of obesity in shift workers (Osamu, Kaneita, Murata, Yokoyama, & Ohida, 2011).

A systematic review performed by Van Drongelen, Boot, Merkus, Smid, & Van der Beek (2011), provided strong evidence on the relationship between shift work and increased body weight. In addition, behavioural changes associated with shift work, such as reduced physical activity, may also contribute to weight gain and the development of associated conditions, such as metabolic syndrome and type 2 diabetes. However, the generalization of these findings is limited by the heterogeneity of the studies included in the meta-analysis, which varied greatly in follow-up methods and periods, in the control of confounding factors, and in their definitions of shift work.

A Japanese study, which followed 21.693 men and 2.109 women between 1999 and 2006 found that the relative risk of obesity was higher in men who slept for less than 5h/day than in those who had at least 5 to 7 hours of sleep per day. In women, this study failed to establish a significant association. The study concluded that short sleep duration (<5 h) accelerated the onset of obesity in shift workers (Osamu et al., 2011).

In another study, obesity was more prevalent in shift workers (20.0%) than in day workers (9.7%). It was considered that shift work was associated with BMI regardless of age or duration of shift work exposure (Di Lorenzo et al., 2003).

Despite the above-mentioned evidence, which establishes a strong link between shift work and obesity, the mechanisms responsible for its association have not yet been fully explained, as further studies are needed to better understand the pathogenicity of those association (Hannerz, Albertsen, Nielsen, Tuchsen, & Burr, 2004; Van Amelsvoort, Schouten, & Kok, 2004).

5.11. DYSLIPIDEMIA

The disruptions in sleep-wake cycles due to shift work may interfere with healthy eating and exercise habits, an increased risk of developing dyslipidemia in shift workers is expected. A study of 140 Jordanian employees showed that shift workers had higher serum triglyceride level (P= .012), higher triglyceride/high-density lipoprotein cholesterol ratio (P= .013), and lower high-density lipoprotein cholesterol level (P= .016) compared to daytime workers (Alefishat & Abu Farha, 2015).

However, a study which involved 360 police officers from the Buffalo department of New York showed that lipid levels were not significantly associated only with shift work alone but also with sleep quality as assessed by the Pittsburgh Sleep Quality Index questionnaire. Especially among female officers and officers older than 40 years, serum triglycerides and total cholesterol increased as sleep quality declined ($P < .05$) (Charles et al., 2016). This suggests that serum lipid levels may be indirectly related to shift work and more directly related to sleep disorders resulting from shift work. However, as other studies have concluded, a clear relationship between shift work and lipid disturbances has yet to be established (Esquirol et al., 2011).

5.12. GASTROINTESTINAL DISTURBANCES

Gastrointestinal disturbances associated with shift work have also been reported in the literature for more than two decades (Burch et al., 2009; Knutsson & Bøggild, 2010; Sveinsdóttir, 2006). Symptoms range from dyspepsia, gastritis, colitis and peptic ulcer to indigestion, nausea, appetite disturbance, irregularity of bowel movements, constipation, heartburn, abdominal pains, stomach grumbling, flatulence and gastroduodenitis (Costa, 1997; Knauth & Härmä, 1992; Knutsson & Bøggild, 2010; Verhaegen et al., 1987). Several factors that may predispose the appearance of this type of disorder, namely disturbances of circadian rhythms linked to gastric functions (gastric secretion, enzymatic activity and intestinal motility), number of meals consumed, types of food consumed and hours in which is consumed, medication, consumption of alcohol, tobacco and coffee, stress and for female workers, the menstrual cycle (Burch et al., 2009; Costa, 1997; Gordon et al., 1986; Levenstein, 1998; Simmons, Heitkemper, & Shaver, 1988).

Shift work acts as a psychosomatic factor and may be associated with the number of peptic ulcers, this number appears to be related with the previous tendency of the individual to develop the disease, time of exposure, and workers who work more frequently at night shifts. For the same author, although shift workers and night workers change their working schedules, their circadian rhythms may be only partially changed or not changed at all, but it is clear that there is a substantial increase in gastroduodenal changes, such as dyspepsia, diarrhoea, intestinal constipation, among others (Coelho, 1988).

In a study involving 340 workers from oil refineries, where 230 were shift workers, it was possible to verify that gastrointestinal diseases were more prevalent in shift workers compared to workers at regular times (30.1% vs 13.2%, respectively) (Koller, 1983).

A cross-sectional study involving 343 automobile workers, revealed that those who worked the night shift reported more gastrointestinal symptoms than workers at regular daytime hours (OR=3.30, 95% CI 1.35-8.07) (Caruso, Lusk, & Gillespie, 2004). In patients with underlying risk factors for the development of a peptic ulcer, such as Helicobacter pylori infections, shift workers continue to have a higher risk of developing duodenal ulcer compared to day-workers of the same age, sex and family history of peptic ulcer disease (OR=3.92, 95% CI 2.13-7.21). In addition, it was found that shift workers who worked at least seven nights per month were more likely to develop peptic ulcers compared to workers who worked fewer nights a month (OR=3.13, 95% CI 1.14-8.54) (Pietroiusti et al., 2006).

These studies point to the role of shift work as a potentiator of the development of this type of problem in susceptible individuals, with greater risks for those who work more in unconventional shifts. These problems should be targeted, as they may progress to more serious diseases such as chronic gastritis or peptic ulcers.

5.13. CARDIOVASCULAR DISEASE

Cardiovascular disease associated with shift work is one of the problems that have been studied for more than two decades since it has long been assumed that shift work has a detrimental effect on the vascular system. This assumption was strengthened by several studies conducted in this same area (Karlsson, Knutsson, & Lindahl, 2001; Puttonen et al., 2009; Van Amelsvoort et al., 2004). However, more recent studies have been questioning the absolute causal relationship, since they consider that the evidence is limited, and there are still some studies that conclude that there is no relation between shift work and cardiovascular diseases (Frost et al., 2009; Hublin et al., 2010).

Studies have shown that the relative risk of developing cardiovascular disease in men who work in shifts is 1.5 times higher than that in men working at regular schedules (Akerstedt & Knutsson, 1997). However, risk factors of 0.64-2.25 were reported in other studies and a higher relative risk was still reported in a woman who works in shifts (Bøggild & Knutsson, 1999; Frost et al., 2009; Ha & Park, 2005; Puttonen et al., 2009).

Although these relative risks appear to be low, the hours at which these workers perform may become a much more significant risk when combined with factors that potentiate cardiovascular disease, such as poor eating habits, obesity, high caffeine and tobacco consumption and, in woman, when the protective effects of estrogen cease after menopause or metabolic problems (Canuto, Garcez, & Olinto, 2013).

One theory of the causal link between shift work and cardiovascular disease points to the sleep loss incurred by shift workers is a significant factor, since disturbance of the circadian rhythms, by either sleep loss or change in time of sleep, constitute a major metabolic challenge for the body (Akerstedt & Knutsson, 1997; Frost et al., 2009; Puttonen, Härmä, & Hublin, 2010). This theory encompasses the research that investigates inflammation, blood coagulation, cardiac autonomic function and the interaction between cortisol and catecholamine (stress related) and cardiovascular disease (Puttonen et al., 2010).

Another possibility is that loss of the sleep or disturbed sleep affects the immune system, although the exact causal factor here is unknown (Akerstedt & Knutsson, 1997). Another premise confers the origin of cardiovascular disease to the effects of a stressful work environment on the cardiovascular system (Akerstedt & Knutsson, 1997; Landsbergis, Travis, & Schanall, 2013; Puttonen et al., 2010).

There is a final theory that canvasses the idea that the elevated morbidity/mortality statistics for cardiovascular disease may be directly related to lifestyle factors, such as the type of food consumed, and when it is eaten throughout the day, and use of other drugs, such as caffeine, alcohol, sleeping aids and other non-prescription drugs (Frost et al., 2009; Gordon et al., 1986; Nabe-Nielsen, Quist, Garde, & Aust, 2011; Thomas & Power, 2010).

5.14. HYPERTENSION

Like other comorbidities, the link between shift work and hypertension is not completely understood. Considering that shift work schedules may predispose workers to inappropriate behaviours such as smoking, poor eating habits and poor balance between work and personal life, and potentiate the activation of the autonomic nervous system, inflammation, and other metabolic syndromes, it is likely that this type of workers have a higher risk of hypertension (Puttonen et al., 2010).

A study involving more than 25.000 workers in a German automobile industry found that hypertension was more prevalent in workers who had rotating shifts or worked night shifts (11.5% and 11.0%, respectively) when compared to day workers (7.8%, $P < .001$). After adjusting for confounding factors such as smoking, BMI, alcohol consumption, lipid profiles, the authors found that the association between rotating shift workers and the development of hypertension had an OR of 1.15 (95%, IC 1.02-1.30) compared to day workers (Ohlander, Keskin, Stork, & Radon, 2015).

Another study conducted by Guo et al. (2013), suggested that shift work could have a long-term impact on blood pressure levels, since shift work was associated with hypertension in more than 26.000 Chinese workers in a refurbished automobile factory (OR=1.05, 95% IC 1.01-1.09).

Although many studies have resulted in significant but weak associations between shift work and hypertension, further studies in this area need to be conducted in order to establish a true relationship, considering several confounding variables that also affect hypertension.

5.15. UROLOGIC CONDITIONS

Hypogonadism is a disorder characterized by low levels of testosterone with clinical symptoms of decreased libido, erectile dysfunction, lethargy, difficulty concentrating, sleep disturbances, and loss of muscle mass (Pastuszak et al., 2017). Endogenous production of testosterone is linked to sleep, with increasing levels during rapid-eye-movement sleep onset and declining levels upon awakening. Thus, men who experience a reduction in rapid-eyes movement or poor sleep quality, as shift workers often experience, may have lower circulating testosterone levels (Andersen & Tufik, 2008).

However, in a cohort study conducted by Pastuszak et al. (2017), which included 182 shift workers, no association was found between sleep quality and serum testosterone levels. A study involving four oil refinery operators whose serum hormone levels were sampled every two hours in real-time during a night shift, the peak and trough times for serum testosterone concentrations were erratic as overall serum testosterone concentrations in these shift workers were significantly reduced (Touitou et al., 1990).

A study of 26 European junior doctors showed no changes in free and total testosterone levels while subjects were on vacation (baseline), working a week of night shifts, and working a normal week (Smith et al., 2006). Although there has been no definitive evidence suggesting a change in serum testosterone levels after doing shift work, studies have found that shift workers who experience shift work sleep disorder (SWSD) endorsed more hypogonadal symptoms, as determined using the quantitative Androgen Deficiency in the Aging Male questionnaire (Pastuszak et al., 2017). When assessing the relationship between sleep quality and symptoms of hypogonadism, Pastuszak et al. (2017) found a significant linear association between sleep quality and Androgen Deficiencies in Aging Male scores (ρ= .008), where individuals who indicated that they were “very satisfied” with their sleep quality had higher scores, compared with those who indicated that they were “somewhat dissatisfied” with the quality of their sleep (ρ= .02). Although there is no consensus on the effects of shift work on testosterone levels, there is evidence to support the existence of more severe symptoms of hypogonadism in shift workers who have poor sleep quality and associated sleep syndrome to shift work sleep syndrome.

Working on shift schedules poses a challenge for couples who wish to achieve fertility. In couples where one or both partners work non-standard shifts, spending time together may be difficult, and limit opportunities for intimacy (Bancroft, 1993). A study of the relationship between infertility and occupation revealed that male infertility was associated with working in industry and construction, fields in which workers were more likely to work shifts (OR=3.13, 95% CI 1.19-8.13) and endure physical exertion (OR=3.35, 95% CI 1.44-7.80) (Sheiner, Sheiner, Carel, Potashnik, & Shoham-Vardi, 2002). More recently, (Eisenberg, Chen, Ye, & Louis, 2015), found that shift work was not directly associated with semen quality but rather a physical effort in the workplace was.

In a study involving 255 infertile men and 267 fertile men, male infertility was more likely to be observed in shift workers (OR= 3.60, 95% CI 1.12-11.57) (El-Helaly, Awadalla, Mansour, & El-Biomy, 2010). Similarly, Irgens, Kruger, & Ulstein (1999) showed that reduction in semen quality was more likely in shift workers, although statistically this difference was insignificant (OR= 1.46, 95% CI 0.89-2.40).

Few have theorized the mechanism of decreased fertility in shift workers, previous studies have linked subfertility or infertility to toxic exposures in the workplace, including to electromagnetic fields, heavy metals, and chemical solvents (El-Helaly et al., 2010; Irgens et al., 1999). On the other hand, more recent studies have suggested the role of circadian rhythm disturbances as a function of shift work schedules is related to disruption of the brain-gonadal axis, which can ultimately lead to infertility. Ortiz et al. (2010) suggested the detrimental role of serotonin on male reproductive health when the authors found higher levels of urinary 5-hydroxyindoleacetic acid (HIIA), a metabolite of serotonin, in infertile male shift workers compared to shift workers who recently had kids. Higher 5-HIIA levels were associated with decreased sperm concentration and progressive motility. Serum markers such as serotonin, as indirectly measured by urinary 5-HIIA, may reflect the neuroendocrine imbalances associated with male infertility in shift workers.

A systematic review conducted by Bonzini, Coggon, & Palmer (2007), evaluated the association between shift work and reproduction more specifically the relationship between shift work and the risk of premature birth, low birth weight, and preeclampsia. The studies concluded that the risk of preterm delivery with shift work (RR 1.31, 95 % CI 1.16–1.47) and the RR for being small for gestational age at delivery was 1.07 (95 % CI 0.96–1.19).

According to Quansah & Jaakkola (2010), the risk of spontaneous abortion in shift workers was higher (OR 1.28, 95% CI 1.17-1.39). Also, Bonde, Jørgensen, Bonzini, & Keith (2014), found a significant association between fixed night work and miscarriage (OR 1.51, 95% CI 1.27-1.75). Stocker, MacKlon, Cheong, & Bewley (2014) performed a systematic review on the association between shift work and early reproductive outcomes (menstrual disruption, infertility, and early spontaneous pregnancy loss). The results indicated that there was a significant increase in the risk of menstrual disruption (OR 1.22, 95 % CI 1.15–1.29) and infertility (OR 1.80, 95 % CI 1.01–3.20) with shift work. The OR for early spontaneous pregnancy loss was 0.96 (95 % CI 0.88–1.05).

In 2014, Van Melick, Van Beukering, Mol, Frings-Dresen, & Hulshof conducted a systematic review of the association between shift work and preterm birth. Thirteen studies were selected, and a meta-analysis was performed. The results indicated no significant associations (OR 1.04, 95 % CI 0.90–1.20).

In addition to sexual dysfunction and infertility, shift workers also experience lower urinary tract syndrome (LUTS) , which include urinary frequency, urgency, weak stream, and nocturia (Abrams, 1994, 1995). A study of 1.741 patients found that shift workers reported nocturia more frequently than non-shift workers (2.38 ± 1.44 vs 2.18 ± 1.04 times, P < .01) (Kim, 2016). In other study involving 228 non-standard shift workers, worse LUTS, as assessed by the validated International Prostate Symptom Score questionnaire, was observed in men with difficulty falling asleep, difficulty staying asleep or difficulty falling back asleep after awakening (P < .001, P= .004, P < .001, respectively) compared to non-standard shift workers who did not report these sleep difficulties (Scovell et al., 2017). Given the link established with these studies between low sleep quality and LUTS, further studies are needed to better understand the role that shift work sleep disorder plays in LUTS severity.

5.16 PHYCOLOGICAL HEALTH

Continuous rotational work adversely affects the nervous system and may accelerate the development of psychiatric disorders, including bipolar disorder, schizophrenia, and major depressive disorder, which impose enormous medical burdens (Hawi et al., 2015; Jeste & Geschwind, 2014; Milham, 2012; Zhao & Castellanos, 2016). The genetic alteration and uncontrolled expression of genes primarily causing the aforementioned disorders are associated with irregular continuous changing of shifts during work (Amstadter, Maes, Sherrin, Myers, & Kendler, 2016; Burmeister, McInnis, & Zöllner, 2008; Sousa et al., 2017; Zhao & Castellanos, 2016). Night shift work contributed toward several psychiatric disorders through circadian misalignment, sleep deprivation, and light-induced melatonin suppression (Smith & Eastman, 2012).

The bipolar disorder is considered one of the severely disabling disorders, where distinctive distortions of emotion regulation are common, and make bipolar disorder a severe psychiatric condition. This condition mainly affects emotional and social behaviour and can also have a light effect on perception and thought. Being a multifactorial disorder, its risk is influenced by genetic and environmental factors (Kieseppä, Partonen, Haukka, Kaprio, & Lönnqvist, 2004). However, the genetic and pathophysiological factors involved in the development of this disease are largely unknown (Mühleisen et al., 2014). Bipolar Disorder increases the risk of schizophrenia and major depressive disorder which is an indication of a shared genetic basis between these disorders. Heritability has also been proven, although more studies are needed to investigate the genetic mechanisms involved (Craddock & Sklar, 2009; Sklar et al., 2012).

Shift work can directly or indirectly affect important genetic variants in the development of the condition. Also, certain mutations that have previously been associated with the development of bipolar disorder may be potentiated in people subject to shift work or exposed to irregular light (jet lag) (Gatt, Burton, Williams, & Schofield, 2015).

Major depression disorder is considered a leading cause of loss in work productivity and is considered a fatal disorder. This disorder is one of the most prevalent disorders that affect females more than males (Kessler, Chiu, Demler, Merikangas, & Walters, 2005; Koido et al., 2012). Similarly, to the previously mentioned disorder, genetic and environmental risk factors mainly contribute to causing the major depression disorder. This is a neuroprogressive disorder in which each persisting episode increases impairment in function and sensitivity for upcoming episodes. Susceptibility to further episodes is increased by a repeated illness which causes the permanent alteration in the normal functions of neurons and genes (Levinson, 2006; Moylan, Maes, Wray, & Berk, 2013).

In this context, some genetic variants important for the development of this condition can be affected by the shift work, potentiating its development. Several studies carried out in this area verified the above, a study that examined over 50.000 Korean employees, found that shift workers presented depressive symptoms on a significantly higher scale compared with non-shift workers (Park, Han, Park, & Ryu, 2016). Another study, involving nearly 10.000 Korean nurses, reported an increased odds of experiencing depressive symptoms among nurses who worked shifts (OR= 1.519, CI 1.380-1.674, P < .001) (Lee, Kim, Kim, Lee, & Kim, 2016).

Using the Patient Health Questionnaire (PHQ-9) as a validated measure of depressive symptoms, it was possible to show that shift workers had significantly more severe depressive symptoms as evidenced by higher PHQ-9 scores (P= .001). This study also showed that, among shift workers, the number of shifts performed per week positively correlated with higher PHQ-9 scores and thus more severe depressive symptoms (p= 0.125, P= .002) (Lindgren, Deng, Pastuszak, & Lipshultz, 2017).

The data from the studies mentioned above suggest that depressive symptoms are not merely associated with shift work exposure but also the quantity of shift work performed, however, only a limited number of studies investigating the impact of shift work on depressive symptoms exist in current literature.

5.17. CANCER

Malignancies are mostly developed by mitigation in pineal hormone melatonin by a bright light at night. Reduced production of melatonin, phase shift, and sleep disruption, caused by exposure to light at night, might be the possible mechanism that causes cancer and related disorders (Fritschi et al., 2011).

Shift work potentiates the development of cancer via altering the clock-controlled gene expression that regulates tumour suppression (Haus & Smolensky, 2013; Khan et al., 2016). The link between shift work affected the immune system with sleep deprivation increases inflammatory markers thereby causing malignancies and metabolic and cardiovascular disorders (Haus & Smolensky, 2013). Circadian rhythm disruption by shift work or bright light exposure at night increase the rate of cancer and decreases the nocturnal rise in melatonin (Davis & Mirick, 2006).

The International Agency for Research on Cancer stated that shift work that involved disturbances in circadian rhythms was probably carcinogenic to humans (International Agency for Research on Cancer, 2007). The postulated causal mechanism is melatonin suppression by exposure to light at night, increased estrogen levels and growth of hormonal-dependent tumours (Arendt, 2010; Schernhammer et al., 2003; Schwartzbaum, Ahlbom, & Feychting, 2007).

The risk of breast cancer increases in women where the circadian rhythms of cortisol and prolactin do not adjust when the woman works in shift work, this type of study have increased importance for women working in shifts due to circadian dysfunctions that this type of work imposes (Lewy, Haus, & Ashkenazi, 2007). Studies that relate the mechanisms of breast cancer and shift work have focused on the role of melatonin and the impact of the night shift on preventing the increase of this hormone at work (Bhatti, Mirick, & Davis, 2013). The study suggested that the disruption caused by night shift in the normal rise of melatonin which occurs at night, results in higher levels of other reproductive hormones, and this may increase the risk of breast cancer. The authors also theorised that male shift workers may also be at a higher risk of prostate cancer due to the same mechanism of increased reproductive hormones (Bhatti et al., 2013). A number of large-scale studies examining shift work and cancer reported an increased risk of breast cancer among shift workers (Davis, Mirick, & Stevens, 2001; Hansen & Stevens, 2012; Schernhammer et al., 2001; Spiegel & Sephton, 2002; Viswanathan & Schernhammer, 2010).Other authors have also reported the greater risk of breast cancer for those working rotating shifts including night shifts, particularly when they are worked over an extended period of time (Grundy, Tranmer, Richardson, Graham, & Aronson, 2011; Hansen & Stevens, 2012; Herichova, 2013).

In 2013, Sigurdardottir et al., carried out a systematic review of the association between circadian rhythm disruption and the risk of prostate cancer. In this review, four shift work studies were selected, three of which reported that shift work significantly increased the risk of developing prostate cancer. Another study has established a strong link between shift work and elevated levels of a specific prostatic antigen (Flynn-Evans, Mucci, Stevens, & Lockley, 2013). Shift work and the associated sleep disorders are linked to high amounts of a specific prostate antigen (PSA), indicating an increased risk of developing prostate cancer (Flynn-Evans et al., 2013). The disruption of circadian rhythms by jet lag inhibits the p53 protein, increase Myc gene expression and induce tumour genesis in the prostatic tissue (Haus & Smolensky, 2013; Yang et al., 2009).

Other studies in the same field of shift work and their connection to the development of cancer have shown that this type of hourly organization was linked to the development of several cancers, namely endometrial cancers and colorectal cancers (Schernhammer et al., 2003; Viswanathan & Schernhammer, 2010). In regard to colonic cancer, it seems to be associated with altered light schedules, being common in shift work, the exposure of light in periods where the worker would be sleeping. These changes may potentiate genetic mutation (in PER1, PER2, PER3), which can lead to colonic adenoma and colonic cancer (Davis & Mirick, 2006; Haus & Smolensky, 2013; Wood et al., 2008).

The development of ovarian cancer appears to be associated with variations in circadian genes (BMAL1, CRY2, CSNK1E, NPAS2, PER3, REV1) and downstream transcription factors (KLF10 and SENP3) caused by disruption of hormonal pathways or changes in light/dark schedules (Gery et al., 2006; Reeder & Sirlin, 2017; Yang et al., 2009). It is also important to note that the systemic or somatic disturbance of circadian rhythms due to jet lag in shift work affects the c-Myc gene and potentiates cell proliferation. In this way the PER2 and BMAL1 genes lose their ability to inhibit tumour progression, potentiating the development of lung cancer (Papagiannakopoulos et al., 2017).

6. CONSEQUENCES IN SOCIAL AND FAMILY LIFE

The structuring of family and social life in the industrialized countries is strongly synchronized with the working hours of the majority of the population, with a daytime schedule, from monday to friday, with the periods of late afternoon and weekends being the most value from the family and social point of view. However, there is a clear divergence from the point of view of shift workers, especially those working late night/weekend shifts (Baker, Ferguson, & Dawson, 2003; Gadbois, 2004).

There are several implications of shift work in social and family life. In a social context, the difficulties in socializing, the access to services offered by society stands out, which can lead to social isolation. On the other hand, the family aspect shows the impediment to follow the life of their relatives (appearance of problems related to children or with the spouse), the time with the children, especially in their supervision and education, which on one hand can be improved in these cases, given the time available for follow up, but on the other hand, may compromise the rest time as a result of the attempt to spend as much time with their children as possible (Santos et al., 2008). Still in the family context, the difficulties in marital life are also highlighted, due to the mismatch between the couple, which can lead to difficulties in communication, sexual life, and the general difficulty in organizing the household tasks, due to the diversity of time standards which have to be managed among themselves, which can lead to a feeling of work overload on the pair of the spouse (Fischer, Teixeira, Borges, Gonçalves, & Ferreira, 2002) .

As previously mentioned, shift work can also lead to behavioural changes, such as annoyance, emotional reactions, and irritability. These psychological changes and instability in the individual's mood, affects interpersonal relationships, from the personal to the family sphere (Santos et al., 2008). Thus, it is obvious that there is a clear link between the scheduling systems associated with shift work and the difficulties experienced in the family and social life plan. These problems are even more evident in the long term since it is not only the number of years of work under these conditions that increase, but also the whole social situation continues to suffer changes. The single individual marries, the children are born and grow up, the family life conditions undergo changes, changes that imply adjustments by the individual (Gadbois, 1990).

A study performed by Koller, Kundi, Haider, Cervinka, & Friza (1990), concluded that the motivations for choosing shift work were totally different in shift workers and non-shift workers.

The shift workers had chosen this type of work schedule because of the associated wage increases or because they had no other professional choice. According to the study previously mentioned, more than half would opt for a day job if they had the opportunity. Day workers, on the other hand, stated that their preference for a more conventional working schedule was essentially because of family and health reasons. The study also found that workers who left the shift work and nightshifts did so because of health.

7. CONSEQUENCES ON THE ORGANIZATIONAL CONTEXT

Shift work may lead to increased levels of stress and dissatisfaction in workers. These factors, coupled with excessive sleepiness during the work shift, resulting from the disturbance of the sleep-wake cycle caused by this type of work-time organization, may have repercussions at various levels, compromising not only the health and safety of the worker, but also the performance and alertness, originating problems not only for the worker, but for the company itself (Boivin & Boudreau, 2014; Wright et al., 2013).

According to Santos, Franco, Batista, Santos, & Duarte (2008), some studies have revealed that in the night work there is a significant decrease of the waking state, particularly between 02:00 a.m. and 04:00 a.m. This factor, allied with mental fatigue, will result in a decrease in mental capacity, which will negatively influence work performance, especially in services that require greater concentration.

Studies that related the performance of the workers with shift work, allowed to verify that the physical, psychomotor or cognitive demands lead to a reduction of the performance from 22:00 p.m., with an abrupt drop between 00:00 a.m. and 4:00 a.m., also showing a drop in performance between 14:00 p.m. and 15:00 p.m. (Winget, DeRoshia, & Holley, 1985; Wojtczak-Jaroszowa & Banaszkiewicz, 1974).

In shift work, one of the occupational safety problems that imposes special attention is the occurrence of work-related accidents caused by sleepiness and disturbances of circadian rhythms, more common in night shifts (Folkard & Lombardi, 2006).

Sleep restriction is one of the major causes of accidents in industry and transport (Philip & Åkerstedt, 2006). According to Tucker, Folkard, & Macdonald (2003), efficiency and safety in shift systems is a matter of great concern for two reasons, one of which concerns the series of accidents such as Chernobyl, Bhopal, Three Mile Island and others that occurred during the night , and drew attention to the risks and costs of poor security in terms of shift systems. The second reason is that shift work exists merely for economic reasons in order to maximize the use of expensive equipment. However, this practice should be discouraged by considering the costs to worker's health and well-being, as a decrease in worker's performance efficiency may compromise expected economic benefits. Boivin & Boudreau (2014) went even further, saying that irregular shift work has important socio-economic impacts, as it imposes an increase in accidents, worker liability and danger to public safety, especially at night.

Dorel (1996) analysed 110 human failures in nuclear power plants and found that night and morning work concentrated each, about twice as many failures as work during the afternoon. Wagstaff & Lie (2011) concluded with the review that long hours of work, shift work, and night shifts affect the risk of accidents. Working for periods longer than 8 hours leads to an increased risk of accidents, which accumulates so that the increase in accidents after 12 hours of work is twice as high as the risk in 8 hours.

Accidents origin is complex and dependent on several factors, however, it seems logical to say that stress, caused by tensions, conflicts, emotions, and routine originated in a work context, contributes to a state of organic imbalance and fatigue, and it is possible that shift work leads to a state of increased stress and, consequently, to an impaired performance, and may be one of the causes of work accidents (Fischer, 1985).

8. STUDY LIMITATIONS

While performing this study the main limitations encountered were that theme was very broad, there was also a lack of specific information in some areas since there were not so many studies carried out in those areas, in comparison to others. These limitations led to the impossibility of applying a specific methodology in this study.

9. DISCUSSION

There are numerous consequences linked to shift work, as previously mentioned, these affect primarily the worker's health, but also their social and family life and companies on the organizational context. Considering this, it is extremely important to find ways to prevent these problems, find tools to help monitor these consequences, ensure that workers are properly set to this type of organization of work time, protecting the worker health, ensure his safety, preventing the occurrence of accidents at the workplace and the development of occupational diseases.

There are international regulations, such as OSHAS, that help protect the worker's health and safety, thus it is important that shift workers are continuously monitored by the working physician and submitted to medical examinations before initiating shift work and after initiating this type of work, whenever he thinks it is necessary to ensure the worker health and prevent possible health complications. Also, the organizations must seek to protect their worker by ensuring that the duration of each shift must not exceed the maximum limits of normal working hours and the worker can only change shifts after the weekly rest day. Also, shifts in the continuous working regime and workers providing uninterrupted services shall be organized in such a way that shift workers shall enjoy at least one rest day in each seven-day period, without prejudice to the period surplus to which they are entitled. The employer must ensure free and confidential health examinations for the night worker to evaluate their health status prior to their placement and thereafter at regular intervals and at least annually. The employer must also evaluate the risks inherent in the worker's activity, considering, particularly, his/her physical and psychic conditions, before starting the activity and thereafter every six months, as well as before changing working conditions.

On the other hand, the occupational health & safety officer has at their disposal a diversity of tools that can be used to monitor health consequences and assess the impact on areas like sleep quality, mental health, and cognition. It is up to this professional to select the most appropriate tool for his/her work context, which is a complex process, since each tool has its characteristics, advantages, and disadvantages, furthermore, the technician should make a prior recognition of the situation that he/she wants to study in order to ensure that the most appropriate tool is selected. However, it may be important/advisable to use more than one tool simultaneously, since in shift work, workers are subject to multiple impacts simultaneously and these impacts are most of the times related. We highlight one of the most complete tools in this area, the "Standard Shift Work Index (SSI)", since it includes a very complex and validated set of questionnaires directed to shift work that allow to evaluate several impacts of shift work, namely impacts on sleep, fatigue, anxiety, minor depressive disorders, cardiovascular and gastrointestinal disorders, cardiovascular and gastrointestinal disorders, among others, also allowing to identify the type of chronotype of the individual, a factor that may be extremely important in the distribution process of the individuals on the different shifts, since there are individuals more fit to work at irregular hours than others. SSI also allows the different questionnaires it has to be applied and punctuated separately, allowing this tool to be applied to different contexts (Barton, Folkard, Smith, Spelten, & Totterdell, 2007). Regarding sleep-related problems, it is also important to mention the existence of "pulse actigraphs", these are compact and lightweight devices that provide objective data on the individual's activity during sleep and during waking state for several weeks, namely sleep patterns and duration of sleep. These equipment are used as a normal clock, allowing the individual to perform their daily routine without great inconvenience and the data obtained are more reliable than other questionnaire-based tools, since they are not self-reported, thus it doesn't depend on the individual's perception of the impacts that he suffers in his work (Ancoli-Isreael et al., 2015).

Cognitive function can also be evaluated through the use of tools, such as the "Montreal Cognitive Assessment (MoCA)", this tool allows the evaluation of several cognitive domains such as short-term memory, executive functions, visuospatial abilities, language, attention, concentration, working memory and temporal and special orientation. This tool is applied in an interview context, making it possible to obtain more reliable results then self-reported tools. Although it may be applied by anyone who follows the instructions provided in the document, it is important to mention that the results obtained by this tool should be evaluated by health professionals with due training and experience in the cognitive area (Freitas, Simões, Marôco, Alves, & Santana, 2012).

The above-mentioned tools make it possible not only to monitor worker's health, but also help prevent possible organizational consequences, as previously mentioned, sleep restriction may lead to excessive sleepiness during the work shift, resulting in a decrease in the worker's safety at work and also in his performance and alertness, which may lead to work accidents. If the use of these tools makes it possible to identify workers with poor sleep quality, high levels of fatigue, reduced mental health state, reduced cognitive function and low job satisfaction, and this information is used to get these workers the conditions and medical support they need to get better, it may also help reducing work accidents related to shift work factors.

According to Tucker et al. (2003), in order to minimize the risk of a shift system, it is necessary to consider the number of consecutive night shifts, the duration of the night shifts and the pauses during shifts. The employer should make it, so the number of consecutive night shifts are as fewer as possible, short time intervals between two shifts should be avoided, workers should have a few weekends free and periods of continuous work of 8 or more days should be also avoided. The shortening of the night shift should be considered, and the shift duration should be established based on the physical and mental load of the task, being shorter for activities that have strong loads. As far as the direction of rotation is concerned, the forward rotation is the most appropriate. It is also important that the morning shift does not start very early, as this may result in increased sleepiness on the shift and compromise safety at work (Wedderburn, 1991).

Other solution to alleviate the problems generated by shift work would be to induce small breaks in the middle of working hours, allowing the workers to recover some of the fatigue generated by shift work. Also, small naps, with a minimum duration of 30 minutes, can increase the sense of alertness in shift workers. Therefore, breaks during the working period play a crucial role, as they contribute not only to prevent work-related accidents, but also promote better employee performance. A study involving 1.954 workers of a mechanical industry working in shifts (2 shifts from 8 a.m. to 2 p.m., rotating every 2 weeks) which analysed the hourly standards practiced by the company, showed that the pauses (e.g. 10 min) can significantly increase the level of employee performance. It is also important to mention that the occurrence of accidents also decreases due to the pauses to levels similar to the beginning of the workday (Tucker et al., 2003).

It would also be beneficial if workers were trained in sleep hygiene, for example on aspects related to the importance of sleep, ways to reduce sleep disruptions caused by noise, light, temperature, food and other factors. Shift workers should also be made aware of health-related factors such as the gradual development of problems that may result from shift work (digestive or gastric problems, weight loss or gain, excessive fatigue or nervous system disorders) and change in habits (smoking, drinking caffeine or alcohol). It should also be taken into consideration that each person is different, thus each person should try to find the best solution for themselves. Therefore, there is always ways to minimize the damage caused by this type of temporal organization of work, but for this, it is crucial the active participation of companies in this matter, as well as family support (Filho & Turnes, 1995; Wedderburn, 1991).

Regarding the worker, he must adopt some behaviours to minimize the negative impacts of shift work and improve the adaptation to this type of work time organization. The worker can start with maintaining a regular and balanced diet and avoid drinking alcohol and caffeine, sleep for 7/8 hours whenever possible, switch off the phone during bedtime to prevent sleep interrupted, and take a nap before starting the shift to avoid sleepiness during work (Afonso, 2012).

In order to prevent problems related to social and family life, it is known that the family can be a great support, reducing the clash between work and other activities. Such a reduction can be made by simply adapting meal times and family activities. Also, the contact and interaction between families, which also have shift members, increase family understanding and support (Chen, Fernandes, Wilson, & Polzer-Debruyne, 2007). Also, companies can offer activities to workers' children, such as sponsoring sports teams, creating a calendar of activities between children and workers and providing transport and infrastructure for them (Miuccio, 2018).

In addition, it is extremely important that the workers are involved in the preparation of the timetable and the bosses should request the feedback of the workers in the process of elaboration of the schedule, which would be much more beneficial than a tax schedule (Brogmus & Maynard, 2006). In a study done in England and Wales, it was observed that workers who voluntarily chose night shifts had low cardiovascular disease symptoms compared with colleagues who did not have the choice of shifts. Also, this flexibility in the choice of schedules not only reduces the problems generated by shift work but in some cases even reverses them, turning a problem into a solution (Fenwick & Tausig, 2001).

10. CONCLUSION

The shift work has a lot of advantages such as monetary compensation, since these types of workers are often paid a night-time differential. They also have more autonomy, as their tasks are performed with less supervision, a flexible schedule that sometimes eliminates the need for childcare or other services. Also, there is a reduced workload because night shifts are often not as busy as their daytime counterparts (Kalispell Regional Medical Center, n.d.).

On the other hand, the disadvantages are superior and more problematic than the advantages, since the shift work deregulates the natural sleep/wake cycle and eating patterns, reducing work efficiency and enhancing certain physical and/or psychological health problems/disturbances (Arber, 2009; Barclay et al., 2012; Czeisler et al., 2005; Davidson et al., 2006; Flo et al., 2012; Haus & Smolensky, 2013; Kubo et al., 2006; Saksvik, Bjorvatn, Hetland, Sandal, & Pallesen, 2011; Sallinen & Kecklund, 2010; Stevens, Hansen, Costa, & Rüdiger, 2011).The problems mentioned above are also associated with certain practices, such as poor eating habits, smoking, alcohol, coffee and self-medication.

In order to minimize or eliminate these consequences that the shift worker may be exposed, the organization must protect the worker in order to increase the health and safety of the workplace. As mentioned above, the employer must provide health consultation with the working physician, that allied with the use of monitoring tools, will help improve worker's health, and help prevent possible organizational consequences. Thus, it is important to consider all these variables in order to prevent a diversity of consequences that can affect the well-being of the worker and eliminate or minimize the occurrence of accidents at work or occupational diseases.

Regarding future perspectives, it is important to perform studies in areas that lack knowledge compared to others and also in those that do not have a clear consensus on whether or not shift work is associated with the development of the disease, in order to strengthen this premise.

REFERENCES

Abrams, P. (1994). New words for old: lower urinary tract symptoms for "prostatism." BMJ, 308, 929–930.

Abrams, P. (1995). Fortnightly Review: Managing lower urinary tract symptoms in older men. BMJ, 310, 1113–1117.

Afonso, E. (2012). Trabalho Noturno e Trabalho por Turnos: Constrangimentos e Recomendações. Retrieved November 21, 2018, from http://www.4work.pt/cms/index.php?id=98&no_cache=1&tx_ttnews%5Btt_news%5D=153&tx_ttnews%5BbackPid%5D=1&cHash=cf6b81ec9a

Akerstedt, T., & Knutsson, A. (1997). Shift work and cardiovascular disease. Scandinavian Journal of Work, Environment and Health, 23(4), 241–242. https://doi.org/10.5271/sjweh.216

Al-Naimi, S., Hampton, S., Richard, P., Tzung, C., & Morgan, L. (2004). Postprandial metabolic profiles following meals and snacks eaten during simulated night and day shift work. Chronobiology International, 21(6), 937–947. https://doi.org/10.1081/CBI-200037171

Alefishat, E., & Abu Farha, R. (2015). Is Shift Work Associated with Lipid Disturbances and Increased Insulin Resistance? Metabolism Syndrome Related Disorders, 13(9), 400–405. https://doi.org/10.1089/met.2015.0052

Allebrandt, K. , Amin, N., Müller-Myhsok, B., Esko, T., Teder-Laving, M., Azevedo, R., … Roenneberg, T. (2011). A KATPchannel gene effect on sleep duration: From genome-wide association studies to function in Drosophila. Molecular Psychiatry, 18(1), 122–132. https://doi.org/10.1038/mp.2011.142

Amstadter, A., Maes, H., Sherrin, C., Myers, J., & Kendler, K. (2016). The relationship between genetic and environmental influences on resilience and common internalizing and externalizing psychiatric disorders. Social Psychiatry and Psychiatric Epidemiology, 51(5), 669–678. https://doi.org/10.1007/s00127-015-1163-6

Ancoli-Isreael, S., Martin, J., Blackwell, T., Buenaver, L., Liu, L., Meltzer, L., … Taylor, D. (2015). The SBSM Guide to Actigraphy Monitoring: Clinical and Research Applications. Behavioral Sleep Medicine, 13(1), 4–38. https://doi.org/10.1080/15402002.2015.1046356

Andersen, M., & Tufik, S. (2008). The effects of testosterone on sleep and sleep-disordered breathing in men: Its bidirectional interaction with erectile function. Sleep Medicine Reviews, 12(5), 365–379. https://doi.org/10.1016/j.smrv.2007.12.003

Arber, S. (2009). Working shifts and mental heath - findings from the British Household Panel Survey (1995-2005). Scandinavian Journal of Work, Environment and Health, 35, 361–367.

Arechiga, H. (1988). Ritmos Circadianos y ultradianos. Gaceta Medica de Mexico, 124(3–4), 58–62.

Arendt, J. (2010). Shift work: Coping with the biological clock. Occupational Medicine, 60(1), 10–20. https://doi.org/10.1093/occmed/kqp162

Baker, A., Ferguson, S., & Dawson, D. (2003). The Perceived Value of Time: Controls Versus Shiftworkers. Time & Society, 12(1), 27–39. https://doi.org/10.1177/0961463X03012001444

Bancroft, J. (1993). Impact of environment, stress, occupational, and other hazards on sexuality and sexual behavior. Environmental Health Perspectives, 101(SUPPL. 2), 101–107. https://doi.org/10.1289/ehp.93101s2101

Barclay, J., Husse, J., Bode, B., Naujokat, N., Meyer-Kovac, J., Schmid, S., … Oster, H. (2012). Circadian desynchrony promotes metabolic disruption in a mouse model of shiftwork. PLoS ONE, 7(5). https://doi.org/10.1371/journal.pone.0037150

Barton, J., Folkard, S., Smith, L., Spelten, E., & Totterdell, P. (2007). Standard Shift work index manual. Journal of Applied Psychology (Vol. 60).

Bhatti, P., Mirick, D., & Davis, S. (2013). Racial differences in the association between night shift work and melatonin levels among women. American Journal of Epidemiology, 177(5), 388–393. https://doi.org/10.1093/aje/kws278

Bjorvatn, B., Magerøy, N., Moen, B., Pallesen, S., & Waage, S. (2015). Parasomnias are more frequent in shift workers than in day workers. Chronobiology International, 32(10), 1352–1358. https://doi.org/10.3109/07420528.2015.1091354

Bøggild, H., & Knutsson, A. (1999). Shift work, risk factors and cardiovascular disease. Scandinavian Journal of Work, Environment and Health, 25(2), 85–99. https://doi.org/10.5271/sjweh.410

Boivin, D., & Boudreau, P. (2014). Impacts of shift work on sleep and circadian rhythms. Pathologie Biologie, 62(5), 292–301. https://doi.org/10.1016/j.patbio.2014.08.001

Bonde, J., Jørgensen, K., Bonzini, M., & Keith, T. (2014). Risk of miscarriage and occupational activity : a systematic review and meta-analysis regarding shift work , working hours , lifting , standing and physical workload. Scandinavian Journal of Work, Environment & Health, 39(4), 325–334. https://doi.org/10.5271/sjweh.3337

Bonzini, M., Coggon, D., & Palmer, K. (2007). Risk of prematurity, low birthweight and pre-eclampsia in relation to working hours and physical activities: A systematic review. Occupational and Environmental Medicine, 64(4), 228–243. https://doi.org/10.1136/oem.2006.026872

Brogmus, G., & Maynard, W. (2006). Safer shift work through more effective scheduling. Occupational Health Safety, 75(12), 16.

Burch, J., Tom, J., Yusheng, Z., Criswell, L., Leo, E., & Ogoussan, K. (2009). Shiftwork impacts and adaptation among health care workers. Occupational Medicine, 59(3), 159–166. https://doi.org/10.1093/occmed/kqp015

Burgueño, A., Gemma, C., Gianotti, T., Sookoian, S., & Pirola, C. (2010). Increased levels of resistin in rotating shift workers: A potential mediator of cardiovascular risk associated with circadian misalignment. Atherosclerosis, 210(2), 625–629. https://doi.org/10.1016/j.atherosclerosis.2009.12.032

Burmeister, M., McInnis, M., & Zöllner, S. (2008). Psychiatric genetics: progress amid controversy. Nature Reviews Genetics, 9, 527.

Buxton, O., Cain, S., O'Connor, S., Porter, J., Duffy, J., Wang, W., … Shea, S. (2012). Metabolic Consequences in Humans of Prolonged Sleep Restriction Combined with Circadian Disruption. Science Translational Medicine, 4(129), 1–19. https://doi.org/10.1126/scitranslmed.3003200

Canuto, R., Garcez, A., & Olinto, M. (2013). Metabolic syndrome and shift work: A systematic review. Sleep Medicine Reviews, 17(6), 425–431. https://doi.org/10.1016/j.smrv.2012.10.004

Canuto, R., Pattussi, M., Macagnan, J., Henn, R., & Olinto, M. (2013). Sleep deprivation and obesity in shift workers in southern Brazil. Public Health Nutrition, 17(11), 2619–2623. https://doi.org/10.1017/S1368980013002838

Cappuccio, F., D'Elia, L., Strazzullo, P., & Miller, M. (2010). Quantity and Quality of Sleep and Incidence of Type 2 Diabetes. Diabetes Care, 33(2), 414–420. https://doi.org/10.2337/dc09-1124.

Caruso, C., Lusk, S., & Gillespie, B.. (2004). Relationship of work schedules to gastrointestinal diagnoses, symptoms, and medication use in auto factory workers. American Journal of Industrial Medicine, 46(6), 586–598. https://doi.org/10.1002/ajim.20099

Charles, L., Gu, J., Tinney-Zara, C., Fekedulegn, D., Ma, C., Baughman, P., … Burchfiel, C.(2016). Separate and Joint Associations of Shift Work and Sleep Quality with Lipids. Safety and Health at Work, 7(2), 111–119. https://doi.org/10.1016/j.shaw.2015.11.007

Chen, J., Lin, Y., & Hsiao, S. (2010). Obesity and high blood pressure of 12-hour night shift Female Clean-ROOM workers. Chronobiology International, 27(2), 334–344.

https://doi.org/10.3109/07420520903502242

Chen, S., Fernandes, S., Gee Wilson, M., & Polzer-Debruyne, A. (2007). Shift work interventions for reduced work-family conflict. Employee Relations, 29(2), 162–177. https://doi.org/10.1108/01425450710719996

Cipolla-Neto, J., Negrão, N., Afeche, S., Paludetti, L., Benedito-Silva, A., Marques, N., & Menna-Barreta, L. (1988). Remarkable similarities between the temporal organization of neocortical electrographic sleep patterns of rats and humans. Brazilian Journal of Medical and Biological Research, 21(3), 599–601.

Coelho, P. (1988). Estudo da doença gastroduodenal nos trabalhadores de turno em indústria de papel. São Paulo.

Costa, G. (1997). The problem: Shiftwork. Chronobiology International, 14(2), 89–98. https://doi.org/10.3109/07420529709001147

Craddock, N., & Sklar, P. (2009). Genetics of bipolar disorder: successful start to a long journey. Trends in Genetics, 25(2), 99–105. https://doi.org/10.1016/j.tig.2008.12.002

Czeisler, C., Walsh, J., Roth, T., Hughes, R., Wright, K.., Kingsbury, L., … Dinges, D. (2005). Modafinil for Excessive Sleepiness Associated with Shift-Work Sleep Disorder. New England Journal of Medicine, 353(5), 476–486. https://doi.org/10.1056/NEJMoa041292

Davidson, A., Sellix, M., Daniel, J., Yamazaki, S., Menaker, M., & Block, G.(2006). Chronic jet-lag increases mortality in aged mice. Current Biology, 16(21), 7–10. https://doi.org/10.1016/j.cub.2006.09.058

Davis, S., & Mirick, D.(2006). Circadian disruption, shift work and the risk of cancer: A summary of the evidence and studies in Seattle. Cancer Causes and Control, 17(4), 539–545. https://doi.org/10.1007/s10552-005-9010-9

Davis, S., Mirick, D., & Stevens, R. (2001). Shift work, light at night, and the risk of breast cancer. Journal of the National Cancer Institute, 93(20), 1557–1562. https://doi.org/10.1093/jnci/93.20.1557

De Sousa, R., Loch, A., Carvalho, A., Brunoni, A., Haddad, M., Henter, I., … Machado-Vieira, R. (2017). Genetic Studies on the Tripartite Glutamate Synapse in the Pathophysiology and Therapeutics of Mood Disorders. Neuropsychopharmacology, 42(4), 787–800. https://doi.org/10.1038/npp.2016.149

Depner, C., Stothard, E., & Wright, K. (2014). Metabolic consequences of sleep and circadian disorders. Current Diabetes Reports, 14(7), 1–15. https://doi.org/10.1007/s11892-014-0507-z

Di Lorenzo, L., De Pergola, G., Zocchetti, C., L'Abbate, N., Basso, A., Pannacciulli, N., … Soleo, L. (2003). Effect of shift work on body mass index: Results of a study performed in 319 glucose-tolerant men working in a Southern Italian industry. International Journal of Obesity, 27(11), 1353–1358. https://doi.org/10.1038/sj.ijo.0802419

Dorel, M. (1996). Human failure in the control of nuclear power stations: temporal logic of occurrence and alternating work times. In Nevile Stanton (Ed.), Human Factors in Nuclear Safety. Taylor & Francis.

Drake, C., & Wright, K. (2011). Shift Work, Shift-Work Disorder, and Jet Lag. Principles and Practice of Sleep Medicine: Fifth Edition (Fifth Edit). Elsevier Inc. https://doi.org/10.1016/B978-1-4160-6645-3.00071-2

Eisenberg, M., Chen, Z., Ye, A., & Louis, G. (2015). Relationship between physical occupational exposures and health on semen quality: Data from the Longitudinal Investigation of Fertility and the Environment (LIFE) study. Fertility and Sterility, 103(5), 1271–1277. https://doi.org/10.1016/j.fertnstert.2015.02.010

El-Helaly, M., Awadalla, N., Mansour, M., & El-Biomy, Y. (2010). Workplace exposures and male infertility - A case-control study. International Journal of Occupational Medicine and Environmental Health, 23(4), 331–338. https://doi.org/10.2478/v10001-010-0039-y

Escribá-Aguir. (1992). Horarios de trabajo: repercussiones sobre la salud. Revista ROL de Enfermería, 169, 61–68.

Espitia-Bautista, E., Velasco-Ramos, M., Osnaya-Ramírez, I., Ángeles-Castellanos, M., Buijs, R., & Escobar, C. (2017). Social jet-lag potentiates obesity and metabolic syndrome when combined with cafeteria diet in rats. Metabolism: Clinical and Experimental, 72, 83–93. https://doi.org/10.1016/j.metabol.2017.04.006

Esquirol, Y., Perret, B., Ruidavets, J., Marquie, J., Dienne, E., Niezborala, M., & Ferrieres, J. (2011). Shift work and cardiovascular risk factors: New knowledge from the past decade. Archives of Cardiovascular Diseases, 104(12), 636–668. https://doi.org/10.1016/j.acvd.2011.09.004

Fauman, M. (2002). Guia de Estudo para o DSM-IV-TR. (C. Editores, Ed.) (1st ed.).

Fenwick, R., & Tausig, M. (2001). Scheduling Stress: Family and Health Outcomes of Shift Work and Schedule Control. American Behavioral Scientist, 44(7), 1179–1198. https://doi.org/10.1177/00027640121956719

Ferreira, L. (1987). Trabalho em turnos: temas para discussão. Revista Brasileira de Saúde Ocupacional, 15(58), 27–32.

Filho, G. (2002). Síndrome da Má-adaptação ao trabalho em turnos: uma abordagem ergonômica. Production, 11(2), 69–87. https://doi.org/10.1590/S0103-65132001000200005

Fischer, E. (1985). Acidentes de trabalho entre trabalhadores em turnos de indústrias automobilísticas. Revista Brasileira de Saúde Ocupacional, 13(53), 34–59.

Fischer, F. (1981). Trabalho em turnos: alguns aspectos económicos, médicos e sociais. Revista Brasileira de Saúde Ocupacional, 9(36), 5–40.

Fischer, F., Teixeira, L., Borges, S., Gonçalves, M., & Ferreira, R. (2002). Percepção de sono: duração, qualidade e alerta em profissionais da área de enfermagem. Cadernos de Saúde Pública (Vol. 18). https://doi.org/10.1590/S0102-311X2002000500018

Flo, E., Pallesen, S., Magerøy, N., Moen, B., Grønli, J., Nordhus, I., & Bjorvatn, B. (2012). Shift work disorder in nurses - assessment, prevalence and related health problems. PLoS ONE, 7(4), 1–9. https://doi.org/10.1371/journal.pone.0033981

Flynn-Evans, E., Mucci, L., Stevens, R., & Lockley, S. (2013). Shiftwork and prostate-specific antigen in the national health and nutrition examination survey. Journal of the National Cancer Institute, 105(17), 1292–1297. https://doi.org/10.1093/jnci/djt169

Folkard, S., & Lombardi, D. (2006). Modeling the impact of the components of long work hours on injuries and “accidents.” American Journal of Industrial Medicine, 49(11), 953–963. https://doi.org/10.1002/ajim.20307

Foret, J. (1984). To what extent can sleep be influenced by diurnal activity. Experientia, 40(5), 422–425.

Foret, J. (1992). Les apports de la chronobiologie aux problèmes posés par le travail posté. Trav. Hum., 55(3), 237–257.

Forouhi, N., & Wareham, N. (2014). Epidemiology of diabetes. Medicine (Abingdon, England : UK Ed.), 42(12), 698–702. https://doi.org/10.1016/j.mpmed.2014.09.007

Fraisse, P. (1980). Eléments de chronopsychologie. Trav. Hum., 43(2), 353–372.

Freitas, S., Simões, M., Marôco, J., Alves, L., & Santana, I. (2012). Construct Validity of the Montreal Cognitive Assessment (MoCA). Journal of International Neuropsychological Society, 18, 242–250. https://doi.org/10.1017/S1355617711001573

Fritschi, L., Glass, D., Heyworth, J., Aronson, K., Girschik, J., Boyle, T., … Erren, T. (2011). Hypotheses for mechanisms linking shiftwork and cancer. Medical Hypotheses, 77(3), 430–436. https://doi.org/10.1016/j.mehy.2011.06.002

Frost, P., Kolstad, H., & Bonde, J. (2009). Shift work and the risk of ischemic heart disease - A systematic review of the epidemiologic evidence. Scandinavian Journal of Work, Environment and Health, Supplement, 35(3), 163–179. https://doi.org/10.5271/sjweh.1319

Gabarino, S., Carli, F., Nobili, L., Mascialino, B., Squarcia, S., Penco, M., … Ferrillo, F. (2002). Sleepiness and sleep disorders in shift workers: a study on a group of italian police officers. Sleep Disorders, 25(6), 642–658. Retrieved from https://watermark.silverchair.com/sleep-25-6-642.pdf?token=AQECAHi208BE49Ooan9kkhW_Ercy7Dm3ZL_9Cf3qfKAc485ysgAAAl0wggJZBgkqhkiG9w0BBwagggJKMIICRgIBADCCAj8GCSqGSIb3DQEHATAeBglghkgBZQMEAS4wEQQMs_iYja2o1VqMgrzKAgEQgIICEIvCqWKXsX96deePzR45JVHq1CQyO3rYdSVW3JwVWSLmCuohuIcDcSNVgzyAMQnxQKDk3VyffiufrPIJ8AdQoPk00vr0MomLBfnTlpOWW7rF_1pwDrnk-8glF6VsZ1V_mnAa91DVbDdly9ILc4VQHpDO69Mviq0Nv6YmxWx1TK6ekbiZa6k-iGRM9KKN0gUqMUa9N_XsthcDPo9de4FVye3SdXdWEEA7d-54AKPmOF7SjdPN17JjKz787ON72u8RyW42EuFMRTKuV4oeIKL9ZQhy-7yy0vB7IB3L9nTJZ759eJIy2i0b-eZibqS97EXx9dYRXeUY2QRjdZc0UwcsVCPwFhn5Uc-8g4HDC4o-wGBLLq8g9gyB07e5HsxUsDxKr7Butuo6rVNHzCQggtVeTEBWJwcsVvKrE2BfHf5M8yvQAPevg5_39FzWY6MPLuKtx6d8TSpo3iEQVxnFq9JWjOxfiV8bthBtBRPnhwM6SkBYQv5QKwHNfDzrrj7Ga1qqVVOMGtzd3ekU2a1iFKOAOKQtNX_pCNipxE114GOEkprMj5RdodYbKfXkPBivOmkUKiph62VFSigmBXanKsyZ7LjiBHhvBaDBSuyQzVFviF18KV8OLei4P1eXOH3uaOJ8EWIH6hW6gnduRtWsVsrRqnflnybG2ZGZsh86rDfv_gc_MyOttaBErqo1uyxlQ2eo8g

Gadbois, C. (1990). Travail posté et vie sociale recherches acluelles et perspectives. Le Travail Humain, 53(2), 97–101.

Gadbois, C. (2004). Les discordances psychosociales des horaires postés : questions en suspens. Le travail humain, 67(1), 63–85. https://doi.org/10.3917/th.671.0063

Gan, Y., Chen, Y., Xinyue, T., Huilian, S., Yingjie, C., Xiaoxu, Y., … Zuxun, L. (2015). Shift work and diabetes mellitus: A meta-analysis of observational studies. Occupational and Environmental Medicine, 72(1), 72–78. https://doi.org/10.1136/oemed-2014-102150

Gatt, J.., Burton, K., Williams, L., & Schofield, P. (2015). Specific and common genes implicated across major mental disorders: A review of meta-analysis studies. Journal of Psychiatric Research, 60, 1–13. https://doi.org/10.1016/j.jpsychires.2014.09.014

Gery, S., Komatsu, N., Baldjyan, L., Yu, A., Koo, D., & Koeffler, H. (2006). The Circadian Gene Per1 Plays an Important Role in Cell Growth and DNA Damage Control in Human Cancer Cells. Molecular Cell, 22(3), 375–382. https://doi.org/10.1016/j.molcel.2006.03.038

Gordon, N., Cleary, P., Parker, C., & Czeisler, C. (1986). The prevalence and health impact of shiftwork. American Journal of Public Health, 76(10), 1225–1228. https://doi.org/10.2105/AJPH.76.10.1225

Grossman, V. (1997). Defying circadian rhythm : The emergency nurse and the night shift. Journal of Emergency Nursing, 23(6), 602–607.

Grundy, A., Tranmer, J., Richardson, H., Graham, C., & Aronson, K. (2011). The influence of light at night exposure on melatonin levels among Canadian rotating shift nurses. Cancer Epidemiology Biomarkers and Prevention, 20(11), 2404–2412. https://doi.org/10.1158/1055-9965.EPI-11-0427

Guo, Y., Liu, Y., Huang, X., Rong, Y., He, M., Wang, Y., … Chen, W. (2013). The Effects of Shift Work on Sleeping Quality, Hypertension and Diabetes in Retired Workers. PLoS ONE, 8(8), 1–6. https://doi.org/10.1371/journal.pone.0071107

Guo, Y., Rong, Y., Huang, X., Hanpeng, L., Luo, X., Zhihong, Z., … Weihong, C. (2015). Shift work and the relationship with metabolic syndrome in chinese aged workers. PLoS ONE, 10(3), 1–12. https://doi.org/10.1371/journal.pone.0120632

Ha, M., & Park, J. (2005). Shiftwork and metabolic risk factors of cardiovascular disease. Journal of Occupational Health, 47(2), 89–95. https://doi.org/10.1539/joh.47.89

Halberg, F. (1969). Chronobiology. Annual Review of Physiology, 31(1), 675–726. https://doi.org/10.1146/annurev.ph.31.030169.003331

Hannerz, H., Albertsen, K., Nielsen, M. ., Tuchsen, F., & Burr, H. (2004). Occupational factors and 5-year weight change among men in a danish national cohort. Health Psychology, 23(3), 283–288. https://doi.org/10.1037/0278-6133.23.3.283

Hansen, A., Stayner, L., Hansen, J., & Andersen, Z. (2016). Night shift work and incidence of diabetes in the Danish Nurse Cohort. Occupational and Environmental Medicine, 73(4), 262 LP – 268.

Hansen, J., & Stevens, R. (2012). Case-control study of shift-work and breast cancer risk in Danish nurses: Impact of shift systems. European Journal of Cancer, 48(11), 1722–1729. https://doi.org/10.1016/j.ejca.2011.07.005

Harrington, J. (1994). Shift work and health - a critical review of the literature on working hours. Academy of Medicine of Singapore, 23(5), 699–705.

Haus, E., & Smolensky, M. (2013). Shift work and cancer risk: Potential mechanistic roles of circadian disruption, light at night, and sleep deprivation. Sleep Medicine Reviews, 17(4), 273–284. https://doi.org/10.1016/j.smrv.2012.08.003

Hawi, Z., Cummins, T., Tong, J., Johnson, B., Lau, R., Samarrai, W., & Bellgrove, M. . (2015). The molecular genetic architecture of attetion deficit hyperactivity disorder. Molecular Psychiatry, 20(3), 289–297. https://doi.org/10.1111/jcpp.12503

Herichova, I. (2013). Changes of physiological functions induced by shift work. Endocrine Regulations, 47, 159–170. https://doi.org/10.4149/endo_2013_03_159

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, 25(5), 315–323. https://doi.org/10.1007/s10654-010-9439-3

International Agency for Research on Cancer. (2007). IARC Monographs Programme finds cancer hazards associated with shiftwork, painting and firefighting.

International Labour Organization. (2004). Shift Work. Retrieved November 26, 2018, from https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---travail/documents/publication/wcms_170713.pdf

Irgens, A., Kruger, K., & Ulstein, M. (1999). The effect of male occupational exposure in infertile couples in Norway. Journal of Occupational and Environmental Medicine, 41(12), 1116–1120.

Jeste, S., & Geschwind, D. (2014). Disentangling the heterogeneity of autism spectrum disorder through genetic findings. Nature Reviews Neurology, 10(2), 74–81. https://doi.org/10.1038/nrneurol.2013.278.Disentangling

Kalispell Regional Medical Center. (n.d.). Shift Work. Retrieved October 24, 2018, from http://www.krh.org/data/content/Shift Work.pdf

Kalsbeek, A., La Fleur, S., & Fliers, E. (2014). Circadian control of glucose metabolism. Molecular Metabolism, 3(4), 372–383. https://doi.org/10.1016/j.molmet.2014.03.002

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, 58(11), 747–752. https://doi.org/10.1136/oem.58.11.747

Katsuhiko, I., Suzuki, E., Toshiharu, M., Soshi, T., & Hiroyuki, D. (2013). Shift work and diabetes Mellitus among male workers in Japan: Does the intensity of shift work matter? Acta Medica Okayama, 67(1), 25–33. https://dx.doi.org/10.18926/AMO/49254

Kawabe, Y., Nakamura, Y., Kikuchi, S., Yoshitaka, M., Tanaka, T., Takebayashi, T., … Hirotsugu, U. (2014). Relationship between shift work and clustering of the metabolic syndrome diagnostic components. Journal of Atherosclerosis and Thrombosis, 21(7), 703–711. https://doi.org/10.5551/jat.19380

Kawachi, I., Colditz, G., Stampfer, M., Willett, W., Manson, J., Speizer, F., & Hennekens, C. (1995). Prospective study of shift work and risk of coronary heart disease in women. Circulation, 92(11), 3178–3182.

Kessler, R., Chiu, W., Demler, O., Merikangas, K., & Walters, E. (2005). Prevalence, Severity, and Comorbidity of Twelve-month DSM-IV Disorders in the National Comorbidity Survey Replication (NCSR). Archives of General Psychiatry, 62(6), 617–627. https://doi.org/10.1001/archpsyc.62.6.617

Khan, S., Ullah, M., Siddique, R., Nabi, G., Manan, S., Muhammad, Y., & Hou, H. (2016). Role of recombinant DNA technology to improve life. International Journal of Genomics, 2016. https://doi.org/10.1155/2016/2405954

Kieseppä, T., Partonen, T., Haukka, J., Kaprio, J., & Lönnqvist, J. (2004). High concordance of bipolar I disorder in a nationwide sample of twins. American Journal of Psychiatry, 161(10), 1814–1821. https://doi.org/10.1176/ajp.161.10.1814

Kim, J. (2016). Effect of Shift Work on Nocturia. Journal of Volcanology and Geothermal Research, 87, 153–160. https://doi.org/10.1016/j.urology.2015.07.047

Knauth, P., & Härmä, M. (1992). The Relation of Shift Work Tolerance to the Circadian Adjustment. Chronobiology International, 9(1), 46–54. https://doi.org/10.3109/07420529209064515

Knutsson, A., & Bøggild, H. (2010). Gastrointestinal disorders among shift workers. Scandinavian Journal of Work, Environment and Health, 36(2), 85–95. https://doi.org/10.5271/sjweh.2897

Koido, K., Traks, T., Balõtšev, R., Eller, T., Must, A., Koks, S., … Vasar, E. (2012). Associations between LSAMP gene polymorphisms and major depressive disorder and panic disorder. Translational Psychiatry, 2. https://doi.org/10.1038/tp.2012.74

Koller, M., Kundi, M., Haider, M., Cervinka, R., & Friza, H. (1990). Changements survenus en cinq ans dans la vie familiale, la satisfaction et la santé de travailleurs postés. Le Travail Humain, 53(2), 153–174.

Koller, M. (1983). Health risks related to shift work: An example of time-contingent effects of long-term stress. International Archives of Occupational and Environmental Health, 53(1), 59–75. https://doi.org/10.1007/BF00406178

Kubo, T., Ozasa, K., Mikami, K., Wakai, K., Fujino, Y., Watanabe, Y., … Tamakoshi, A. (2006). Prospective cohort study of the risk of prostate cancer among rotating-shift workers: Findings from the Japan Collaborative Cohort Study. American Journal of Epidemiology, 164(6), 549–555. https://doi.org/10.1093/aje/kwj232

Landsbergis, P., Travis, A., & Schanall, P. (2013). Working conditions and masked hypertension. High Blood Pressure & Cardiovascular Prevention, 20(2), 69–76. https://doi.org/10.1007/s40292-013-0015-2

Laudencka, A., Klawe, J., Tafil-Klawe, M., & Złomańczuk, P. (2007). Does night-shift work induce apnea events in obstructive sleep apnea patients? Journal of Physiology and Pharmacology, 58(SUPPL. 5), 345–347.

Lee, H. , Kim, M. , Kim, O., Lee, I. , & Kim, H. (2016). Association between shift work and severity of depressive symptoms among female nurses: The Korea Nurses' Health Study. Journal of Nursing Management, 24(2), 192–200. https://doi.org/10.1111/jonm.12298

Levenstein, S. (1998). Stress and peptic ulcer : life beyond helicobacter. British Medical Journal, 316, 538–541.

Levinson, D. (2006). The Genetics of Depression: A Review. Biological Psychiatry, 60(2), 84–92. https://doi.org/10.1016/j.biopsych.2005.08.024

Lewy, H., Haus, E., & Ashkenazi, I. (2007). Possible linkage between the ability to change the period (τ) of the prolactin and cortisol rhythms in women and breast cancer risk. Chronobiology International, 24(2), 365–381. https://doi.org/10.1080/07420520701282349

Lindgren, M., Deng, N., Pastuszak, A., & Lipshultz, L. (2017). 015 Male Non-Standard Shift Workers Are Predisposed to Depression and Hypogonadal Symptoms. The Journal of Sexual Medicine, 14(2), e7. https://doi.org/10.1016/j.jsxm.2016.12.028

Linton, S., Kecklund, G., Franklin, K., Leissner, L., Sivertsen, B., Lindberg, E., … Hall, C. (2015). The effect of the work environment on future sleep disturbances: a systematic review. Sleep Medicine Reviews, 23, 10–19. https://doi.org/https://doi.org/10.1016/j.smrv.2014.10.010

Marcheva, B., Ramsey, K., Buhr, E., Kobayashi, Y., Su, H., Ko, C., … Bass, J. (2010). Disruption of the Clock Components CLOCK and BMAL1 Leads to Hypoinsulinemia and Diabetes. Nature, 466(7306), 627–631. https://doi.org/10.1038/nature09253

Markwald, R., Melanson, E., Smith, M., Higgins, J., Perreault, L., Eckel, R., & Wright, K. (2013). Impact of insufficient sleep on total daily energy expenditure, food intake, and weight gain. Proceedings of the National Academy of Sciences of the United States of America, 110(14), 5695–5700. https://doi.org/10.1073/pnas.1216951110

Markwald, R., & Wright, K. (2012). Circadian Misalignment and Sleep Disruption in Shift Work: Implications for Fatigue and Risk of Weight Gain and Obesity. In Sleep Loss and Obesity. New York, NY, USA: Springer. https://doi.org/10.1007/978-1-4614-3492-4_8

Martin, S., Atlantis, E., Lange, K., Taylor, A., O'Loughlin, P., & Wittert, G. (2014). Predictors of Sexual Dysfunction Incidence and Remission in Men. The Journal of Sexual Medicine, 11(5), 1136–1147. https://doi.org/10.1111/jsm.12483

Milham, M. (2012). Open Neuroscience Solutions for the Connectome-wide Association Era. Neuron, 73(2), 214–218. https://doi.org/10.1016/j.neuron.2011.11.004

Miuccio, J. (2018). Shiftwork – Health Effects and Solutions. Retrieved November 27, 2018, from https://www.ohcow.on.ca/edit/files/rsi_day/rsi_handouts_2018/shiftwork2018.pdf

Moylan, S., Maes, M., Wray, N., & Berk, M. (2013). The neuroprogressive nature of major depressive disorder: Pathways to disease evolution and resistance, and therapeutic implications. Molecular Psychiatry, 18(5), 595–606. https://doi.org/10.1038/mp.2012.33

Mühleisen, T., Leber, M., Schulze, T., Strohmaier, J., Degenhardt, F., Treutlein, J., … Cichon, S. (2014). Genome-wide association study reveals two new risk loci for bipolar disorder. Nature Communications, 25(2), 99–105. https://doi.org/10.1016/j.tig.2008.12.002

Murray, S., & Thimgan, M. (2016). Chapter 5 - Sleep disorders. In S. L. Murray & M. S. B. T.-H. F. R. M. Thimgan (Eds.) (pp. 81–113). Oxford: Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-802412-6.00005-4

Nabe-Nielsen, K., Quist, H., Garde, A., & Aust, B. (2011). Shiftwork and changes in health behaviors. Journal of Occupational and Environmental Medicine, 53(12), 1413–1417. https://doi.org/10.1097/JOM.0b013e31823401f0

Ohayon, M., Black, J., Krystal, A., Shapiro, C., Swick, T., Bogan, R., & Wells, C. (2018). Longitudinal Study of Narcolepsy Symptoms in First, Second, and Third-Degree Relatives of Simplex and Multiplex Narcolepsy Families. Sleep Medicine. https://doi.org/10.1016/j.sleep.2018.06.015

Ohlander, J., Keskin, M., Stork, J., & Radon, K. (2015). Shift work and hypertension: Prevalence and analysis of disease pathways in a German car manufacturing company. American Journal of Industrial Medicine, 58(5), 549–560. https://doi.org/10.1002/ajim.22437

Oike, H., Mutsumi, S., Ippoushi, K., & Masuko, K. (2015). Time-fixed feeding prevents obesity induced by chronic advances of light/dark cycles in mouse models of jet-lag/shift work. Biochemical and Biophysical Research Communications, 465(3), 556–561. https://doi.org/10.1016/j.bbrc.2015.08.059

Ortiz, Á., Espino, J., Bejarano, I., Lozano, G., Monllor, F., García, J., … Rodríguez, A. (2010). The correlation between urinary 5-hydroxyindoleacetic acid and sperm quality in infertile men and rotating shift workers. Reproductive Biology and Endocrinology, 8(1), 138. https://doi.org/10.1186/1477-7827-8-138

Osamu, I., Kaneita, Y., Murata, A., Yokoyama, E., & Ohida, T. (2011). Association of onset of obesity with sleep duration and shift work among Japanese adults. Sleep Medicine, 12(4), 341–345. https://doi.org/10.1016/j.sleep.2010.09.007

Paciorek, M., Korczyński, P., Bielicki, P., Byśkiniewicz, K., Zieliński, J., & Chazan, R. (2011). Obstructive sleep apnea in shift workers. Sleep Medicine, 12(3), 274–277. https://doi.org/10.1016/j.sleep.2010.06.013

Papagiannakopoulos, T., Bauer, M., Davidson, S., Heimann, M., Subbaraj, L., Bhutkar, A., … Jacks, T. (2017). Circadian Rhythm Disruption Promotes Lung Tumorigenesis. Cell Metabolism, 24(2), 324–331. https://doi.org/10.1016/j.cmet.2016.07.001.Circadian

Park, J., Han, M., Park, J., & Ryu, S. (2016). Prevalence of depressive symptoms and related factors in Korean employees: The third Korean working conditions survey (2011). International Journal of Environmental Research and Public Health, 13(4). https://doi.org/10.3390/ijerph13040424

Pastuszak, A., Moon, Y., Scovell, J., Badal, J., Lamb, D., Link, R., & Lipshultz, L. (2017). Poor Sleep Quality Predicts Hypogonadal Symptoms and Sexual Dysfunction in Male Nonstandard Shift Workers. Urology, 102, 121–125. https://doi.org/10.1016/j.urology.2016.11.033

Perez-Tilve, D., Stern, J., & Tschöp, M. (2006). The Brain and the Metabolic Syndrome: Not a Wireless Connection. Endocrinology, 147(3), 1136–1139.

Philip, P., & Åkerstedt, T. (2006). Transport and industrial safety, how are they affected by sleepiness and sleep restriction? Sleep Medicine Reviews, 10(5), 347–356. https://doi.org/10.1016/j.smrv.2006.04.002

Pietroiusti, A., Forlini, A., Magrini, A., Galante, A., Coppeta, L., Gemma, G., … Bergamaschi, A. (2006). Shift work increases the frequency of duodenal ulcer in H pylori infected workers. Occupational and Environmental Medicine, 63(11), 773–775. https://doi.org/10.1136/oem.2006.027367

Puttonen, S., Härmä, M., & Hublin, C. (2010). Shift work and cardiovascular disease - Pathways from circadian stress to morbidity. Scandinavian Journal of Work, Environment and Health, 36(2), 96–108. https://doi.org/10.5271/sjweh.2894

Puttonen, S., Kivimäki, M., Elovainio, M., Pulkki-Råback, L., Hintsanen, M., Vahtera, J., … Keltikangas-Järvinen, L. (2009). Shift work in young adults and carotid artery intima–media thickness: The Cardiovascular Risk in Young Finns study. Atherosclerosis, 205(2), 608–613. https://doi.org/10.1016/j.atherosclerosis.2009.01.016

Quansah, R., & Jaakkola, J. (2010). Occupational exposures and adverse pregnancy outcomes among nurses: a systematic review and meta-analysis. Journal of Women's Helath, 19(10), 1851–1862. https://doi.org/10.1089/jwh.2009.1876

Rajaratnam, S., Barger, L., Lockley, S., Shea, S., Wang, W., Landrigan, C. (2011). Sleep Disorders, Health, and Safety in Police Officers. JAMA, 306(23), 2567–2578. https://doi.org/10.1001/jama.2011.1851

Reeder, S., & Sirlin, C. (2017). Proton Density Fat-Fraction: A Standardized MR-Based Biomarker of Tissue Fat Concentration. Clinical and Experimental Rheumatology, 35(5), 857–859. https://doi.org/10.1002/jmri.23741.Proton

Reinberc, A., Chaumont, A., & Laport, A. (1973). Mémories. Étude chronobiologique des effets des changements d'horaires de travail (autométrie de 20 sujets postés; systeme des 3x8 à rotation hebdomadaire. Arc. Mal. Prof. Méd. Trav. Sêc. Soc., 35(3), 373–392.

Reinberg, A., Andlauer, P., & Vieux, N. (1981). Tolérance du travail posté: une approche chronobiologique. Trav. Hum., 44(1), 55–69.

Roper, N., Logan, W., & Tierney, A. (1995). Modelo de Enfermagem. (Mc Graw-Hill, Ed.) (3rd ed.).

Ruggiero, J., & Redeker, N. (2014). Effects of Napping on Sleepiness and Sleep-Related Performance Deficits in Night-Shift Workers: A Systematic Review. Biollogical Research for Nursing, 16(2), 134–142. https://doi.org/10.1177/1099800413476571

Rutenfranz, J., Knauth, P., & Fischer, F. (1995). Trabalho em turnos e noturno. In Hucitec (Ed.), Sistemas de saúde: continuidades e mudanças (p. 135). São Paulo.

Sack, R., Auckley, D., Auger, R., Carskadon, M., Wright., K., Vitiello, M., & Zhdanova, I. (2007). Circadian Rhythm Sleep Disorders: Part I, Basic Principles, Shift Work and Jet Lag Disorders. Sleep Medicine Reviews, 30(11), 1460–1480. https://doi.org/10.1093/sleep/30.11.1460

Saksvik, I., Bjorvatn, B., Hetland, H., Sandal, G., & Pallesen, S. (2011). Individual differences in tolerance to shift work – A systematic review. Sleep Medicine Reviews, 15(4), 221–235. https://doi.org/10.1016/j.smrv.2010.07.002

Sallinen, M., & Kecklund, G. (2010). Shift work, sleep, and sleepiness - Differences between shift schedules and systems. Scandinavian Journal of Work, Environment and Health, 36(2), 121–133. https://doi.org/10.5271/sjweh.2900

Santos, R., Franco, M.., Batista, V.., Santos, P., & Duarte, J. (2008). Consequências do trabalho por turnos na qualidade de vida dos enfermeiros : um estudo empírico sobre o Hospital Pêro da Covilhã. Referência, Série II(8), 17–31.

Sateia, M. (2014). International Classification of Sleep Disorders-Third Edition. Chest, 146(5), 1387–1394. https://doi.org/10.1378/chest.14-0970

Scheer, F., Hilton, M., Mantzoros, C., & Shea, S. (2009). Adverse metabolic and cardiovascular consequences of circadian misalignment. Proceedings of the National Academy of Sciences, 106(11), 4453–4458. https://doi.org/10.1073/pnas.0808180106

Schernhammer, E., Laden, F., Speizer, F., Willett, W., Hunter, D., Kawachi, I., & Colditz, G. (2001). Rotating night shifts and risk of breast cancer in women participating in the nurses' health study. Journal of the National Cancer Institute, 93(20), 1563–1568.

Schernhammer, E., Laden, F., Speizer, F., Willett, W., Hunter, D., Kawachi, I., … Colditz, G. (2003). Night-shift work and risk of colorectal cancer in the nurses' health study. Journal of the National Cancer Institute, 95(11), 825–828.

Schwartzbaum, J., Ahlbom, A., & Feychting, M. (2007). Cohort study of cancer risk among male and female shift workers. Scandinavian Journal of Work, Environment and Health, 33(5), 336–343. https://doi.org/10.5271/sjweh.1150

Scott, A., & LaDou, L. (1994). Health and safety in shift workers. Occupational Medicine: Principles and Practical Applications, 960–986.

Scovell, J., Pastuszak, A., Slawin, J., Badal, J., Link, R., & Lipshultz, L. (2017). Impaired Sleep Quality is

Associated With More Significant Lower Urinary Tract Symptoms in Male Shift Workers. Urology, 99, 197–202. https://doi.org/10.1016/j.urology.2016.05.076

Sehgal, A., & Mignot, E. (2011). Genetics of Sleep and Sleep Disorders. Cell, 146(2), 194–207. https://doi.org/10.1016/B978-1-4160-6645-3.00016-5

Sharifian, A., Firoozeh, M., Pouryaghoub, G., Shahryari, M., Rahimi, M., Hesamian, M., & Fardi, A. (2009). Restless Legs Syndrome in shift workers: A cross sectional study on male assembly workers. Journal of Circadian Rhythms, 7, 12. https://doi.org/10.1186/1740-3391-7-12

Sheiner, E., Sheiner, E., Carel, R., Potashnik, G., & Shoham-Vardi, I. (2002). Potential association between male infertility and occupational psychological stress. Journal of Occupational and Environmental Medicine, 44(23), 1093–1099.

Sigurdardottir, L., Valdimarsdottir, U., Fall, K., Rider, J., Lockley, S., Schernhammer, E., & Mucci, L. (2013). Circadian Disruption, Sleep Loss and Prostate Cancer Risk: A Systematic Review of Epidemiological Studies. Cancer Epidemiology Biomarkers and Prevention, 21(7), 1002–1011. https://doi.org/10.1158/1055-9965.EPI-12-0116

Silva, E., Chaffin, R., Neto, V., & Júnior, C. (2010). Impactos gerados pelo trabalho em turnos. Perspectivas Online, 4(13), 65–86. https://doi.org/10.7594/revbio.12.02.01

Silva, J.., & Turnes, U. (1995). Trabalho em turnos. In S. I. Vieira (Ed.), Medicina Basica do Trabalho (2nd ed., pp. 119–127). Curitiba: Genesis.

Silva, I. (2007). Adaptação ao Trabalho por Turnos. Universidade do Minho. Retrieved from http://hdl.handle.net/1822/7723

Simmons, L., Heitkemper, M., & Shaver, J. (1988). Gastrointestinal function during the mestrual cycle. Health Care for Woman International, 9, 201–209.

Sklar, P., Ripke, S., Scott, L., Andreassen, O., Cichon, S., Craddock, N., … Purcell, S. (2012). Large-scale genome-wide association analysis of bipolar disorder identifies a new susceptibility locus near ODZ4. Nature Genetics, 43, 977–983. https://doi.org/10.1038/ng.943

Smith, A., Morris, P., Rowell, K., Clarke, S., Jones, T., & Channer, K. (2006). Junior doctors and the full shift rota--psychological and hormonal changes: a comparative cross-sectional study. Clinical Medicine, 6(2), 174–177.

Smith, M., & Eastman, C. (2012). Shift work: health, performance and safety problems, traditional countermeasures, and innovative management strategies to reduce circadian misalignment. Nature and Science of Sleep, 4, 111–132. https://doi.org/10.2147/NSS.S10372

Snyder, B., & Cunningham, R.(2018). Sex differences in sleep apnea and comorbid neurodegenerative diseases. Steroids, 133, 28–33. https://doi.org/10.1016/j.steroids.2017.12.006

Spiegel, D., & Sephton, S. (2002). Night shift work, light at night, and risk of breast cancer. Journal of the National Cancer Institute, 94(7), 530–533.

Stevens, R., Hansen, J., Costa, G., & Rüdiger, H. (2011). Considerations of circadian impact for defining “shift work” in cancer studies: IARC Working Group Report. Occupational and Environmental Medicine, 68, 154–162.

Stocker, L., MacKlon, N., Cheong, Y., & Bewley, S. (2014). Influence of shift work on early reproductive outcomes: A systematic review and meta-analysis. Obstetrics and Gynecology, 124(1), 99–110. https://doi.org/10.1097/AOG.0000000000000321

Suarez, E. (1990). Ritmos circadianos: implicações clinicas. In R. Reimão (Ed.), Sono: aspectos atuais (pp. 237–248). Atheneu.

Sveinsdóttir, H. (2006). Self-assessed quality of sleep, occupational health, working environment, illness experience and job satisfaction of female nurses working different combination of shifts. Scandinavian Journal of Caring Sciences, 20(2), 229–237. https://doi.org/10.1111/j.1471-6712.2006.00402

Tachinardi, P. (2012). Efeitos das variações de temperatura ambiental em ritmos circadianos. Revista Da Biologia, 9(3), 13–18. https://doi.org/10.7594/revbio.09.03.03

Takahashi, J., Hong, H., Ko, C., & McDearmon, E. (2008). The Genetics of Mammalian Circadian Order and Disorder: Implications for Physiology and Disease. Nature Reviews Genetics, 9(10), 764–775. https://doi.org/10.1038/nrg2430

Thomas, C., & Power, C. (2010). Shift work and risk factors for cardiovascular disease: A study at age 45 years in the 1958 British birth cohort. European Journal of Epidemiology, 25(5), 305–314. https://doi.org/10.1007/s10654-010-9438-4

Touitou, Y., Motohashi, Y., Reinberg, A., Touitou, C., Bourdeleau, P., Bogdan, A., & Auzéby, A. (1990). Effect of shift work on the night-time secretory patterns of melatonin, prolactin, cortisol and testosterone. European Journal of Applied Physiology and Occupational Physiology, 60(4), 288–292.

https://doi.org/10.1007/BF00379398

Trenkwalder, C., Allen, R., Högl, B., Clemens, S., Patton, S., Schormair, B., & Winkelmann, J. (2018). Comorbidities, treatment, and pathophysiology in restless legs syndrome. The Lancet Neurology, 17(11), 994–1005. https://doi.org/https://doi.org/10.1016/S1474-4422(18)30311-9

Tricco, A., Lillie, E., Zarin, W., O'Brien, K., Colquhoun, H., Hempel, S., … Straus, S. (2018). PRISMA extension for Scoping Reviews (PRISMA-SCR): Checklist and explanation. Annals of Internal Medicine, 19. Retrieved from https://guides.temple.edu/ld.php?content_id=44376438&fbclid=IwAR0vOLKA7Aa0DPthbM4gRCXR0dj69THama4XtkYz2pael0OKu5gtyBJxG-8

Tucker, P., Folkard, S., & Macdonald, I. (2003). Rest breaks and accident risk For personal use . Only reproduce with permission from The Lancet Publishing Group ., 361, 2003.

Uekata, S., Kato, C., Nagaura, Y., Eto, H., & Kondo, H. (2019). The impact of rotating work schedules, chronotype, and restless legs syndrome/Willis-Ekbom disease on sleep quality among female hospital nurses and midwives: A cross-sectional survey. International Journal of Nursing Studies, 95, 103–112. https://doi.org/10.1016/j.ijnurstu.2019.04.013

Van Amelsvoort, L., Schouten, E., & Kok, F. (2004). Impact of one year of shift work on cardiovascular disease risk factors. Journal of Occupational and Environmental Medicine, 46(7), 699–706. https://doi.org/10.1097/01.jom.0000131794.83723.45

Van Drongelen, B., Boot, C., Merkus, S., Smid, T., & Van der Beek, A. (2011). The effects of shift work on body weight change - A systematic review of longitudinal studies. Scandinavian Journal of Work, Environment and Health, 37(4), 263–275. https://doi.org/10.5271/sjweh.3143

Van Melick, M., Van Beukering, M., Mol, B., Frings-Dresen, M., & Hulshof, C. (2014). Shift work, long working hours and preterm birth: a systematic review and meta-analysis. International Archives of Occupational and Environmental Health, 87(8), 835–849. https://doi.org/10.1007/s00420-014-0934-9

Verhaegen, P., Cober, R., De Smedt, M., Dirkx, J., Kerstens, J., Ryvers, D., & Van Daele, P. (1987). The adaptation of night nurses to different work schedules. Ergonomics, 30(9), 1301–1309. https://doi.org/10.1080/00140138708966024

Viswanathan, A., & Schernhammer, E. (2010). Circulating Melatonin And The Risk Of Breast And Endometrial Cancer In Women. Cancer Letters, 281(1), 1–7. https://doi.org/10.1016/j.canlet.2008.11.002

Vogel, M., Braungardt, T., Meyer, W., & Schneider, W. (2012). The effects of shift work on physical and mental health. Journal of Neural Transmission, 119(10), 1121–1132. https://doi.org/10.1007/s00702-012-0800-4

Wagstaff, A., & Lie, J. (2011). Shift and night work and long working hours - a systematic review of safety implications. Scandinavian Journal of Work, Environment and Health, 37(3), 173–185. https://doi.org/10.5271/sjweh.3146

Waterhouse, J., Fukuda, Y., & Morita, T. (2012). Daily rhythms of the sleep-wake cycle. Journal of Physiological Anthropology, 31(1), 1. https://doi.org/10.1186/1880-6805-31-5

Wedderburn, A. (1991). Guidelines for Shiftworkers. (E. F. for the I. of L. and W. Conditions., Ed.), -bulletin of European Shiftwork Topics. Retrieved from https://publications.europa.eu/en/publication-detail/-/publication/4b001fb7-5eae-4ab2-90f6-edb0502e044d/language-en

White, L., & Keith, B. (1990). The Effect of Shift Work on the Quality and Stability of Marital Relations. Journal of Marriage and Family, 52(2), 453–462. https://doi.org/10.2307/353039

Winget, C., DeRoshia, C., & Holley, D. (1985). Circadian rhythms and athletic performance. Medicine and Science in Sports and Exercise, 17(5), 498–516.

Wojtczak-Jaroszowa, J., & Banaszkiewicz, A. (1974). Physical Work Capacity During the Day and at Night. Ergonomics, 17(2), 193–198. https://doi.org/10.1080/00140137408931338

Wood, P., Yang, X., Taber, A., Oh, E., Ansell, C., Ayers, S., … Hrushesky, W. (2008). Period 2 Mutation Accelerates ApcMin/+ Tumorigenesis. Molecular Cancer Research, 6(11), 1786–1793. https://doi.org/10.1158/1541-7786.MCR-08-0196

Wright, K., Bogan, R., & Wyatt, J. (2013). Shift work and the assessment and management of shift work disorder (SWD). Sleep Medicine Reviews, 17(1), 41–54. https://doi.org/10.1016/j.smrv.2012.02.002

Yang, X., Wood, P., Oh, E., Du-Quiton, J., Ansell, C., & Hrushesky, W. (2009). Down regulation of circadian clock gene Period 2 accelerates breast cancer growth by altering its daily growth rhythm. Breast Cancer Research and Treatment, 117(2), 423–431. https://doi.org/10.1007/s10549-008-0133-z

Zhao, Y., & Castellanos, F. . (2016). Anual research review: Discovery science strategies in studies of the pathophysiology of child and adolescent psychiatric disorders: promises and limitations. The Journal of Child Psychology and Psychiatry, 57(3), 421–439. https://doi.org/10.1016/j.trsl.2014.08.005