Does work shift affect workers' sleep quality? a systematic review

O turno de trabalho afeta a qualidade do sono dos trabalhadores? uma revisão sistemática

¿El turno de trabajo afecta la calidad del sueño de los trabajadores? una revisión sistemática

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ABSTRACT

Shift work in industry negatively affects the circadian cycle, resulting in impaired sleep quality (SQ), increased fatigue, attention deficits, and consequently reduced productivity and work performance. The aim of this study was to determine whether shift work affects the SQ of industrial workers, using the Pittsburgh Scale as an assessment tool. This is a systematic review conducted according to the PRISMA guideline. It included studies that used the Pittsburgh scale to assess SQ, stratified the sample by work shift, written in English, original, and published in the last five years. A total of 276 studies were found, but three studies (Germany, India, and Australia) made up the review. Two of the studies reported worsening SQ in workers. The workers were aged between 18 and 41 years, and the daytime Pittsburgh scale scores ranged from 5.7 to 8.8 points, and the nighttime worker scores ranged from 3.6 to 7.8 points. The results were inconclusive, although two studies showed worse SQ in workers who perform their duties on different shifts.

Keywords: shift work, industry, sleep quality, circadian rhythm sleep disorders.
Pittsburg como instrumento de avaliação. Esta é uma revisão sistemática conduzida de acordo com a diretriz PRISMA. Foram incluídos estudos que utilizaram a escala de Pittsburg para avaliar a QS, estratificaram a amostra por turno de trabalho, escritos em inglês, originais e publicados nos últimos cinco anos. Foram encontrados 276 estudos, mas três estudos (Alemanha, Índia e Austrália) compuseram a revisão. Dois dos estudos relataram piora na QS nos trabalhadores. Os trabalhadores tinham idade entre 18 e 41 anos, e as pontuações da escala de Pittsburgh diurna variaram de 5,7 a 8,8 pontos, e as pontuações do trabalho noturno variaram de 3,6 a 7,8 pontos. Os resultados foram inconclusivos, embora dois estudos tenham demonstrado pior QS em trabalhadores que exercem suas funções em turnos diferentes.

Palavras-chave: trabalho por turnos, indústria, qualidade do sono, distúrbios do ritmo circadiano.

RESUMEN
El trabajo por turnos en la industria afecta negativamente el ciclo circadiano, lo que resulta en una peor calidad del sueño (QS), un aumento de la fatiga, déficits de atención y, en consecuencia, una reducción de la productividad y el rendimiento laboral. El objetivo de este estudio fue determinar si el trabajo por turnos afecta la CS de los trabajadores industriales, utilizando como herramienta de evaluación la Escala de Pittsburg. Esta es una revisión sistemática realizada según la guía PRISMA. Incluyó estudios que utilizaron la escala de Pittsburgh para evaluar la CS, estratificaron la muestra por turno de trabajo, escritos en inglés, originales y publicados en los últimos cinco años. Se encontraron un total de 276 estudios, pero la revisión se compone de tres estudios (Alemania, India y Australia). Dos de los estudios informaron un empeoramiento de la CS en los trabajadores. Los trabajadores tenían edades comprendidas entre 18 y 41 años, y las puntuaciones de la escala de Pittsburgh durante el día oscilaban entre 5,7 y 8,8 puntos, y las puntuaciones de los trabajadores nocturnos oscilaban entre 3,6 y 7,8 puntos. Los resultados no fueron concluyentes, aunque dos estudios mostraron una peor CS en trabajadores que realizan sus tareas en turnos diferentes.

Palabras clave: trabajo por turnos, industria, calidad de sueño, trastornos del ritmo circadiano del sueño.

1 INTRODUCTION

The industrial work environment requires workers to meet multiple demands within a 24-hour period. Today, industries operate 365 days a year with no weekends or holidays off, so employees must be organized into shifts to meet
the needs of the business (MAISEY et al., 2021). These organizational strategies are important to keep things running smoothly and to meet goals. In this sense, the work shifts that exist in industries with the largest number of employees are day shifts (e.g., 06:00-14:00), afternoon shifts (e.g., 14:00-23:00), and night/midnight shifts (e.g., 23:00-06:00) (MAISEY et al., 2021). However, night/midnight workers can be classified together with workers on rotating schedules (a mixture of day and night shifts) and long shifts (long working hours) and are recognized as shift workers in some studies (COSTA, 2016; STIELER, HUNGER, SEIBT, 2022; VIDYA et al., 2019; ZHOU et al., 2022).

Shift workers perform their work activities at unconventional times of the day and sleep for rest and cell regeneration (STIELER, HUNGER, SEIBT, 2022). As a result, they experience changes in their circadian rhythms, as they are forced to modify their sleep-wake patterns by sleeping during the day or not having a specific sleep schedule (MAISEY et al., 2021). As a result, the quality of sleep may be compromised and may negatively affect occupational health with the presence of fatigue, sleepiness, anxiety, depression and stress (MCNAMARA, ROBBINS, 2023; SATHVIK, KRISHNARAJ, IRFAN, 2022). It is important to note that other comorbidities are associated with sleep-wake alterations, culminating in cardiovascular disease and musculoskeletal injuries, which may contribute to occupational injuries in industry.

The American Academy of Sleep Medicine and the Sleep Research Society recommend 7-9 hours of sleep per night (WATSON et al., 2015). Sleeping less than 7 hours is associated with lower immunity, performance, increased errors and risk of accidents (YU, SIEGEL, 2023). Sleeping more than 9 hours is also associated with health risks, although it is appropriate for young adults and people with sleep disorders or illnesses (WATSON et al., 2015). From this perspective, shift workers may not get the recommended amount of sleep because of external factors (room temperature, light and noise) or because of their work routine (long working hours and worries about workload), which influences an imbalance in the circadian cycle (DAVY, 2014; MAISEY et al., 2021; SETIA et al., 2019).
Studies evaluating the sleep of industrial shift workers have found that working hours may contribute to poorer sleep quality (MCNAMARA, ROBBINS, 2023; SADEGHNIAT-HAGHIGHI et al., 2020; SETIA et al., 2019). In addition to working hours, there is evidence that physical activity is reduced in this occupational group, which has a negative impact on sleep (MCNAMARA, ROBBINS, 2023; STIELER, HUNGER, SEIBT, 2022; STIELER et al., 2019). However, working in the morning or afternoon may be better for maintaining adequate sleep and physical activity (PA) levels recommended by the World Health Organization, which are approximately 150 to 300 minutes of moderate-intensity PA per week or 75 minutes of vigorous-intensity PA per week (BULL et al., 2020; SETIA et al., 2019).

To date, shift work in industry is known to have a negative impact on occupational health, with a decrease in sleep quality among workers (MCNAMARA, ROBBINS, 2023; SADEGHNIAT-HAGHIGHI et al., 2020). As a result, it favors the emergence of mental disorders such as anxiety, depression and stress (MCNAMARA, ROBBINS, 2023; SATHVIK, KRISHNARAJ, IRFAN, 2022; SETIA et al., 2019), which contribute to a poor quality of life (VIDYA et al., 2019). There is also evidence of cardiovascular risks in this occupational group, with hypertension, sedentary lifestyle (SETIA et al., 2019; STIELER et al., 2019) and obesity (ASARE et al., 2023) being the most common. In addition, poor sleep quality can increase the risk of musculoskeletal injuries and reduce productivity in the performance of industry-defined activities.

From a different perspective, this systematic review investigated whether the Pittsburgh Sleep Quality Index (PSQI) is a useful tool for assessing sleep quality in industrial workers. Although this instrument has been validated, it has not been adapted to assess the sleep of workers with sleep-wake alterations and it is essential to use specific ferments for this analysis. However, the aim of this study was to determine whether shift work affects the sleep quality of industrial workers, using the Pittsburg Scale as an assessment tool.
2 METHODS

This is a systematic review registered in the International Prospective Register of Systematic Reviews (PROSPERO, Registration ID: CRD42023457084) and conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.

2.1 IDENTIFYING THE RESEARCH QUESTION

Several meetings were held at the Cardiorespiratory and Metabolic Health Studies Laboratory (LESaC) to define the question to be studied. This laboratory already conducts research on cardiovascular health1 (SILVA et al., 2022) and mental disorders (anxiety, depression) (BORGES et al., 2022) of workers. However, the current focus is on the sleep quality of industrial workers and shift work.

The meetings were held by two occupational health researchers (VS and PHAS) who presented different perspectives on the research topic, namely: a) which sleep assessment instrument would be considered; b) what the outcome measure would be; c) and why shift workers should be studied. Based on these meetings, the researchers formulated the following research question Is there a difference in the quality of sleep of industrial workers when comparing work shifts and using the Pittsburg Scale?

2.2 IDENTIFICATION AND SELECTION OF RELEVANT STUDIES

The Scopus, Publisher Medline (PubMed), and Web of Science databases were used, and articles on the topic were identified by title/abstract for PubMed and Web of Science, while keywords were added in Scopus. The Boolean operator AND was used for the descriptors in the search strategy and the combinations between them, as detailed in Table 1.
Table 1 - Strategies for searching for scientific articles in the main sources of information

<table>
<thead>
<tr>
<th>Database</th>
<th>Combining search terms</th>
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<tbody>
<tr>
<td>PubMed (Title/abstract)</td>
<td>(shift work) AND (sleep) AND (industry); (shift night) AND (sleep) AND (industry); (shift work) AND (sleep duration) AND (industry); (shift work) AND (polysonnography) AND (industry); (shift work) AND (sleep deprivation) AND (industry); (shift work) AND (sleep quality) AND (industry).</td>
</tr>
<tr>
<td>Web of Science (Title and abstract)</td>
<td>shift work AND sleep AND industry; shift night AND sleep AND industry; shift work AND sleep duration AND industry; shift work and polysonnography AND industry; shift work AND sleep deprivation AND industry; shift work AND sleep quality AND industry.</td>
</tr>
<tr>
<td>Scopus (Title/abstract/keywords)</td>
<td>(shift AND work) AND (sleep) AND (industry); (shift AND night) AND (sleep) AND (industry); (shift AND work) AND (sleep AND duration) AND (industry); (shift AND work) AND (polysonnography) AND (industry); (shift AND work) AND (sleep AND deprivation) AND (industry); (shift AND work) AND (sleep AND quality) AND (industry).</td>
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</table>

Source: Authors (2024)

We included articles published in the last 5 years that used the Pittsburgh scale to assess sleep quality in industrial workers, studies that stratified the sample by work shifts, written in English, and original studies (cross-sectional, case-control, and longitudinal). Case reports, narrative reviews, letters to the editor, descriptive studies, protocol studies, and studies evaluating workers older than 59 years were excluded. After applying the criteria, the selected articles were read in full (Figure 1). Mendeley was used to store the bibliographic references and to eliminate duplicates.

The article searches were carried out between July and September 2023 by four researchers (PHAS, DAAPO, GOF, KASS and FMGSC), who independently checked the title, abstract and, if necessary, key words of the articles and, in case of doubt about their eligibility, resolved this through discussion among the authors until consensus was reached.
2.3 DATA EXTRACTION

Data were extracted into a standardized spreadsheet containing information on author, year of publication, country, sleep assessment instrument, outcome, number of participants, type of industry, work shifts, Pittsburgh scale scores, and conclusion. Some studies (ASARE *et al*., 2023; LI *et al*., 2022; LI, GAO, LIU, 2019; MCNAMARA, ROBBINS, 2023; SADEGHNIAT-HAGHIGHI *et al*., 2020; SATHVIK, KRISHNARAJ, IRFAN, 2022; SETIA *et al*., 2019; STIELER *et al*., 2019; ZHANG *et al*., 2020; ZHOU *et al*., 2022) did not provide estimates of the mean and standard deviation of the Pittsburgh questionnaire scores by work shift classification. Therefore, the authors of this study asked the corresponding
authors (e-mail) to send the data as mentioned above. However, we did not receive a response and these articles were excluded.

2.4 ASSESSMENT OF STUDY QUALITY

The quality of the studies was assessed using the Downs and Black (1998) scale. This instrument is recommended by the Cochrane Collaboration for observational and experimental studies and consists of 27 questions on external validity, selection and measurement bias, and power. The instrument was adapted to assess the quality of the observational studies included in this systematic review (items: 1-3, 6-7, 9-12, 18, 20 and 26-27). The cut-off points of the original version range from 0-1 for each question, and when added together, ≤14 points represent low quality, while ≥14 points represent high quality. The studies were analyzed by the researchers (PHAS, GOF, KASS and FMGSC) and the cut-off point considered was 7 points (frame 1).

Frame 1 Quality of studies according to the Downs and Black (1998) scale

<table>
<thead>
<tr>
<th>Questions</th>
<th>Points</th>
<th>Studies E1</th>
<th>E2</th>
<th>E3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Is the hypothesis/aim/objective of the study clearly described?</td>
<td>0-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2- Are the main outcomes to be measured clearly described in the Introduction or Methods section?</td>
<td>0-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3- Are the characteristics of the patients included in the study clearly described?</td>
<td>0-1</td>
<td>0</td>
<td>1</td>
<td>1</td>
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<tr>
<td>6- Are the main findings of the study clearly described?</td>
<td>0-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>7- Does the study provide estimates of the random variability in the data for the main outcomes?</td>
<td>0-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>9- Have the characteristics of patients lost to follow-up been described?</td>
<td>0-1</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<tr>
<td>10- Have actual probability values been reported (e.g. 0.035 rather than &lt;0.05) for the main outcomes except where the probability value is less than 0.001?</td>
<td>0-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>11- Were the subjects asked to participate in the study representative of the entire population from which they were recruited?</td>
<td>0-1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>12- Were those subjects who were prepared to participate representative of the entire population from which they were recruited?</td>
<td>0-1</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>18- Were the statistical tests used to assess the main outcomes appropriate?</td>
<td>0-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>20- Were the main outcome measures used accurate (valid and reliable)?</td>
<td>0-1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</table>
 Were losses of patients to follow-up taken into account?  

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<tr>
<td>26-</td>
<td>0-1</td>
<td>1</td>
<td>0</td>
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</table>

Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?  

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<tr>
<td>27-</td>
<td>0-1</td>
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</table>

**Total score**  

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<tbody>
<tr>
<td>13</td>
<td>10</td>
<td>9</td>
<td>13</td>
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</tbody>
</table>

Source: E1- STIELER et al., (2022); E2- VIDYA et al., (2019); E3- WILSON et al., (2020)

### 3 RESULTS

A total of 276 studies were identified, but when the inclusion and exclusion criteria were analyzed, only three studies remained for analysis. The characteristics of the selected studies are shown in Table 2. Regarding the origin of the studies, one was conducted in Germany (STIELER, HUNGER, SEIBT, 2022), one in India (VIDYA et al., 2019) and one in Australia (WILSON et al., 2020). The study from India (VIDYA et al., 2019) did not specify which industries the shift workers came from, but the studies from Germany (STIELER, HUNGER, SEIBT, 2022) and Australia (WILSON et al., 2020) evaluated workers from the hotel/restaurant industry and mining, respectively.

In the German study (STIELER, HUNGER, SEIBT, 2022) the researchers showed that there was no difference in the quality of sleep of industrial workers when compared between work shifts. On the other hand, the Indian (VIDYA et al., 2019) and Australian (WILSON et al., 2020) studies reported that industrial workers who worked shifts or for long periods (away from home) had poorer sleep quality. In addition, the Australian study (WILSON et al., 2020) reported that workers who work away from home for long periods (≥14 days) experience greater daytime sleepiness and moderate to extreme loneliness symptoms (University of California, Los Angeles Loneliness Scale).

In the study by Stieler, Hunger and Seibt (2022), 64 (40%) shift workers were evaluated, including those who alternated morning shifts (start: 6:00-9:00; end: 15:00-19:00) with afternoon shifts (start: 12:00-15:00; end: 21:00-00:00). Of these, 32 (20%) were female and 32 (20%) were male, and the average age was 32.3 (±9.0) years. And to complete the 160 employees, 96 (60%) worked during the fixed daytime period (start: 6h00-9h00 end: 14h30-17h30).
Vidya et al., (2019) evaluated 278 employees, but 147 (52.9%) were from the rotating shift (shift workers) and 131 (47.1%) were from the day shift. Of the 147 employees, 42 (28.6%) were female and 105 (71.4%) were male. The mean age was 19.67 (±0.99) years. In the study by Wilson et al., (2020) the total sample was 199 workers, 195 (98%) were female and 4 (2%) were male. In addition, 74.9% were between the ages of 18 and 44, and the mean and standard deviation were not reported. The researchers looked at fly-in, fly-out, drive-in, drive-out (FIFO/DIDO) workers who worked long hours and were away from home for up to four weeks. Of these, 49.7% worked away from home for between 8 and 14 days, and 32.7% worked away from home for more than 14 days.
Table 2 Characterization of the selected studies (n=3)

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Country</th>
<th>Outcome</th>
<th>sample n</th>
<th>Type of industry</th>
<th>Work shift</th>
<th>Score</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stieler, Hunger e Seibt (2022)</td>
<td>Germany</td>
<td>Pittsburgh score</td>
<td>160</td>
<td>Hotels and restaurants</td>
<td>SW e DS</td>
<td>5.4 ± 3.1</td>
<td>5.7 ± 2.6</td>
</tr>
<tr>
<td>Vidya et al., (2019)</td>
<td>India</td>
<td>Pittsburgh score</td>
<td>278</td>
<td>Various industries</td>
<td>SW e DS</td>
<td>3.6 ± 2.8</td>
<td>7.1 ± 3.0</td>
</tr>
<tr>
<td>Wilson et al., (2020)</td>
<td>Australia</td>
<td>Pittsburgh score</td>
<td>199</td>
<td>Mining</td>
<td>OH e IH</td>
<td>7.8 ± 3.3*</td>
<td>8.8 ± 3.1**</td>
</tr>
</tbody>
</table>

Abbreviations: SW- shift workers; DS- Day shift; *- Rest period; ** - ≥ 14 days away from home; QoL- Quality of life; OH- Out of home; IH – inside home; DD – Daytime drowsiness; ES – Effect Size
4 DISCUSSION

The main findings were that in two of the three studies analyzed, industrial workers who worked shifts or worked from home had higher sleep quality scores than those who worked the day shift, indicating less favorable sleep quality. It is known that adequate sleep contributes to physical and mental health, helps regenerate cells, bones and tissues, boosts immunity, reduces stress and muscle fatigue, and also stimulates the central nervous system to improve alertness (BARANWAL, YU, SIEGEL, 2023). All these aspects lead to better productivity of employees during their work activities.

The instrument studied (PSQI) was chosen because it has psychometric properties, an accessible number of items and is widely used in science to assess sleep quality in adults (FABBRI et al., 2021). The questionnaire is inexpensive, easy to use, has good reliability and has been validated in some countries, especially in Brazil (BERTOLAZI et al., 2011). It is the most widely used measure for self-reported (subjective) assessment of sleep. Its validity has been considered convergent and it has been suggested that the PSQI can be considered an accepted reference or even the gold standard in the subjective assessment of sleep quality (FABBRI et al., 2021). This questionnaire has been used in the reviewed articles and it has been found that shift workers or those working away from home have impaired sleep due to their working hours. On the other hand, there is evidence that this instrument is inconsistent when applied to some occupational groups exposed to sleep-wake schedules due to poor internal consistency and construct validity (ROCHE et al., 2022). Thus, the PSQI may not be appropriate for assessing the sleep of workers with irregular sleep-wake schedules.

In addition to the PSQI, there are other tools for assessing sleep in industrial workers, such as actigraphy (SADEGHNIAT-HAGHIGHI et al., 2020) and wearable sensors. The ReadibandTM watch (version 5, Fatigue Science Inc., Canada) has also been mentioned as a useful tool in a protocol study (MAISEY et al., 2021), as has polysomnography (KECKLUND, 2016). However, these
tools, although validated and of good quality, may not be specific for assessing sleep in shift workers. Evidence suggests the use of the Shift Work Disorder Questionnaire (SWDQ) (Barger et al., 2012) and the Bergen Shift Work Sleep Questionnaire (BSWSQ) (FLO et al., 2012) as they have been adapted primarily for these workers with irregular sleep-wake schedules (ROCHE et al., 2022). The SWDQ and BSWSQ have good construct validity, are easy to administer and, because they are inexpensive, can assess large numbers of workers.

The SWDQ and BSWSQ are psychometric instruments that can provide a subjective assessment of sleep. The former contains 26 items related to working hours, insomnia, and sleepiness (BARGER et al., 2012). Response categories range from four to five points (BARGER et al., 2012). The second consists of 22 items related to the last three months (FLO et al., 2012). Each item is scored on a 0–4-point scale (FLO et al., 2012). The scores are calculated using a Likert-type scale and are capable of diagnosing sleep-related symptoms in shift workers. In contrast, the PSQI has 24 items to be scored that relate to the last month, but 19 are self-reported and five require feedback from your partner (BERTOLAZI et al., 2011). The fact that it relies on a second person's perception of your sleep may lead to inconsistent results, especially in shift workers. The PSQI has been validated in adults without sleep-wake irregularities.

The circadian cycle is characterized by intrinsic biological clocks that specifically affect the homeostatic functions of the human body. These circadian clocks undergo physiological oscillations and have an approximate 24-hour cycle. The suprachiasmatic nucleus (central circadian clock), located in the hypothalamus, contributes to various physiological and behavioral functions and is influenced by external factors such as exposure to light and darkness (BARANWAL, YU, SIEGEL, 2023). In the presence of light signals, light is captured by the retina and electrical signals are sent to the brain indicating that it is daytime and cortisol is released, while the lack of light stimulates the release of melatonin, the sleep hormone (BARANWAL, YU, SIEGEL, 2023). Thus, the concentration of these glucocorticoids may be dysregulated in shift workers and negatively affect sleep quality (LI, GAO, LIU, 2019).
Of the included studies, shift workers were found to have poor sleep quality when analyzed using the PSQI. These workers sleep at unconventional times of the day between morning and afternoon, which contributes to the disruption of the circadian cycle. This physiological imbalance facilitates the development of hormonal changes and metabolic disorders that negatively affect occupational health (LUNDE et al., 2020). When these symptoms are present, the development of anxiety, depression, fatigue, drowsiness, insomnia and cardiovascular disease becomes more common in these workers (BAZAZAN et al., 2019; LUNDE et al., 2020; MCNAMARA, ROBBINS, 2023).

5 CONCLUSION

Among the studies found, the PSQI scale showed poor sleep quality in industrial shift workers. Although this questionnaire was not adapted for workers with sleep disorders, it was found that the workers assessed had poorer sleep quality. It should be noted that the literature is still in its infancy when it comes to observational studies or interventions that stratify the sample by work shifts. However, there is a need for more studies that can use scales according to the specificity of the work environment. In addition, there is a need to establish prevention and health promotion objectives for workers, with the aim of minimizing the harm caused by changes in sleep routines and even in the number of hours slept.
REFERENCES


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