# The Factors Influencing Sleep Quality and Its Related Disorders in Process, Manufacturing, and Service Industries: A Systematic Review

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## Abstract

**Background and Objective:** Numerous factors in industrial environments affect employees' sleep quality and cause poor sleep quality and its related disorders. This study was conducted to investigate factors influencing sleep quality and its related disorders in the process, manufacturing, and service industries.

**Materials and Methods:** In this study, the related articles published in the Embase, PubMed, Google Scholar, Scopus, Web of Science, Magiran, SID, IranMedex, and IranDoc databases from 2010 to 2021 were reviewed. Some of the used search terms were "sleep", "sleep quality", "sleep disorder", "process industry", "manufacturing industry", and "service industry". searched articles were reviewed to extract the required data.

**Results:** Out of the 431 studies identified, 59 articles were eligible for analysis, of which 19 studies were conducted in process industries, 35 studies in service industries, and 5 studies in manufacturing industries. In process industries, factors such as anxiety, depression, shift work, job stress, and exposure to high noise and vibration reduce workers' sleep quality. In the manufacturing industry, work stress, and shift work impair sleep quality. Inadequate sleep quality was common in the service industry, and several factors, including depression, job stress, shift work, and musculoskeletal disorders play a role in this regard.

**Conclusion:** The results indicate that working conditions are such that people's sleep can be affected by various factors, so more attention should be paid to sleep health. Shift plans should be implemented following the best method. Moreover, it is critical to focus on sleep quality in the workplace.

**Keywords:** Sleep quality; Sleep disorders; Sleepiness; Circadian rhythm disorders; Manufacturing industry

## Introduction

Maintaining a healthy workforce is the cornerstone of any prosperous society. All individuals' essential characteristics must be considered (1). Sleep is one of these fundamental human characteristics that significantly affect people's health.

Sleep is a dynamic and well-structured biological activity and one of the main aspects of the entire 24-hour life cycle, which is considered an essential part of life and is associated with restoring physical and mental strength (2). If people have a good night's sleep, their performance and alertness will increase throughout the day (3). This increase in awareness and performance impacts individuals' daily life, especially in their work environments, and increases their productivity in the workplace (4).

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Inadequate sleep quality can decrease mental function, degrade cognition and decision-making and increase error (5). Poor sleep quality increases daily absenteeism from work and increases the frequency of accidents (6). Findings of a cross-sectional study conducted on 200 drivers of heavy vehicles in Iran showed that the prevalence of poor sleep quality is higher in drivers who have a history of accidents (7). Many individual and environmental factors such as age, circadian rhythm, work schedule, and sleep pattern can affect sleep quality (8).

If poor sleep quality persists, people's sleep and its regular rhythm will be affected, this will bring about the conditions for sleep disorders (9). Sleep disorder is a perturbation in the natural cycle of sleep and arousal with adverse effects such as depression, anxiety, lethargy and distraction, and loss of consciousness (10, 11). Sleep disorders affect people in various ways and reduce their quality of life and work performance (12). According to the results of a study conducted in Iran, sleep disorders have adverse effects on the performance of people in the workplace (13). In addition, the findings of a prospective cohort study in the United States showed that sleep disorders and mood problems of the hospital personnel were independently associated with adverse outcomes and further increased risk (10).

Today, industries are divided into the 3 main categories of process, manufacturing, and service industries (14). In each of these industries, people's sleep status is of different importance depending on the nature of their job. In many jobs, long working hours, short rest times, and shift work can affect employees' sleep (15, 16). Many of these factors cause sleep deprivation in employees in various occupations. Lack of sleep causes cognitive function problems such as lower concentration, longer reaction time, lower capacity to acquire and recall new knowledge, and impaired motor skills (17). With the emergence of these problems, people's health, safety, and productivity in these industries are affected (12).

Therefore, it is necessary to study the factors affecting sleep quality and the related disorders in different industries according to their nature. In addition, according to the searches conducted by the authors of this study, no review study has been conducted in this field. For this purpose, the present study was conducted to investigate the factors influencing sleep quality and its related disorders in the process, manufacturing, and service industries.

## Materials and Methods

*Search strategy:* The two authors used the Embase, PubMed, Google Scholar, Scopus, Web of Science, Magiran, SID, IranMedex, and IranDoc databases to search for related articles. Research articles published in English and Persian from 2010 to 2021 in these valid databases were retrieved. Keywords used for the research included "sleep", "sleep quality", "sleep disorder", "sleep problem", "sleep disturbance", "sleep health", "sleep quality", "sleepiness", "drowsiness", "circadian rhythm disorder", "process industry", "manufacturing industry", and "service industry".

*Study selection and data extraction:* The two authors independently reviewed the search results and screened the qualified studies for full-text review. All studies that explicitly examined the factors affecting sleep quality and its related disorders in the process, manufacturing, and service industries between 2010 and 2021 were included in this study. However, non-research articles such as editorials, authors' notes, letters to the editor, standard texts, and studies not written in Persian and English were excluded. To extract data from the reviewed articles, the authors used a form that contained items on study design, year of publication, country, the industry studied, sleep measurement tool, sample size (number, gender, and age), and results. Figure 1 shows the general process of choosing articles.

*Evaluation criteria for the quality of articles:* The Joanna Briggs Institute (JBI) checklist was used to evaluate the quality of the articles (18). This checklist has 9 items with the responses "yes", "no", "unspecified", and "not applicable". This checklist determines the methodological quality of studies and ways to acquire and identify errors in studies, design, and data analysis. The Preferred Reporting Items for Systematic reviews and Meta-Analyses for Protocols 2015 (PRISMA-P 2015) was also applied to write the article itself. This tool includes a 17-item checklist for the preparing and describing of a robust protocol for the systematic review (19).

## Results

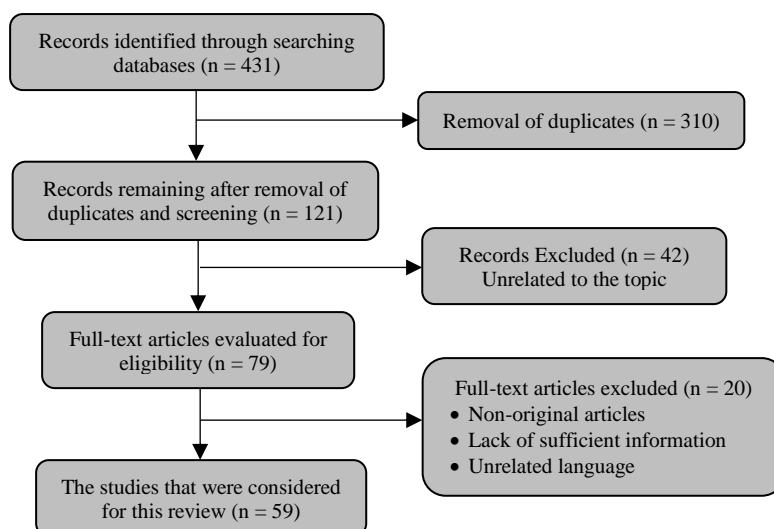The process of article selection is presented in figure 1.

**Figure 1**. The general process of selecting articles

Out of 79 selected articles, 59 studies were finally selected for use in this article. Out of the 59 studies reviewed, 19 studies (32.2%) were conducted in process industries (4, 20-37), 35 studies (59.3%) in service industries (38-72), and 5 studies (8.5%) in manufacturing industries (13, 73-76).

According to tables 1, 2, and 3, of the 59 selected studies, 45 studies (76.3%) were cross-sectional, and 14 studies (23.7%) were conducted with other study designs. In addition, among the studies, 22 studies (37.3%) were performed in Iran, 11 studies (18.7%) in the United States, and 26 studies (44%) in other countries (Figure 2). Moreover, the share of Asia was 35 studies

(59.3%), North America 12 studies (20.3%), and other continents 11 studies (18.6%).

These studies were conducted on 43271 people, 8312 women (19.3%), 34656 men (80%), and 303 unknown (0.7%) participants. Of these, 21048 (48.6%) participated in research related to sleep quality and 22223 (51.4%) in research related to sleep disorders.

Among the tools used to assess participants' sleep status, the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and Berlin Questionnaire (BQ) were the most widely used tools, respectively (Figure 3). The PSQI was used in 69.5% of articles, ESS in 23.7% of articles, and BQ in 11.9% of articles.
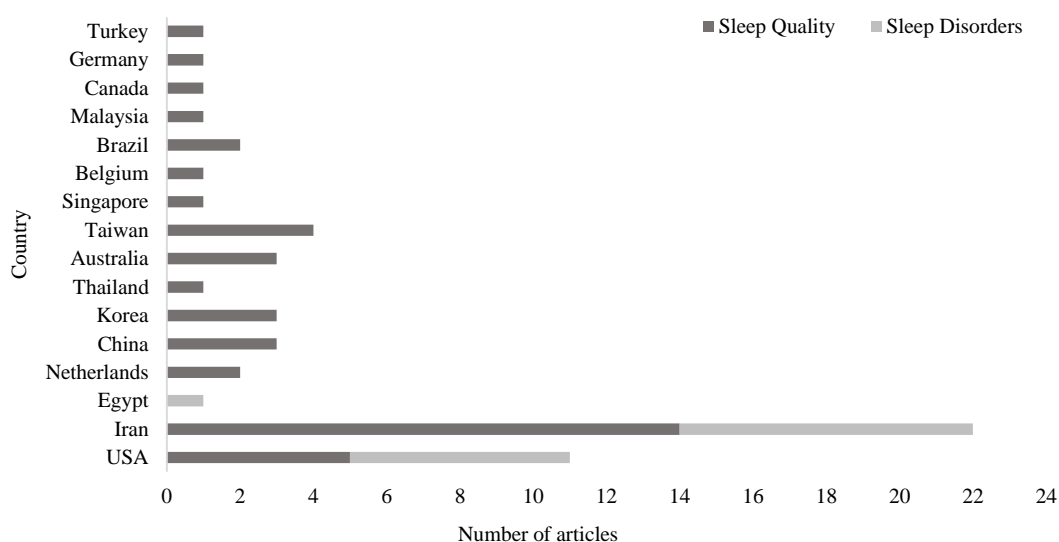


**Figure 2.** Distribution of articles by country (2010-2021)

**Table 1.** A summary of studies between 2010 and 2020 that examine factors influencing sleep quality and its related disorders in the process industry

| Study design | Country (Year) | Industry | Sleep measurement tool | Sample size | Result(s) |
|---|---|---|---|---|---|
| **Sleep disorders** | | | | | |
| Cross-sectional (23) | Iran (2021) | Petroleum industry | ESS, ISI | 188 men, mean age: 37.06 ± 9.2 years | - SWD is regarded as a substantial health issue among oil rig shift workers. <br> - SWD is related to daytime sleepiness, insomnia, and depression. |
| Cross-sectional (33) | Iran (2018) | Petrochemical industry | KSS and employees' periodic medical examination records | 501 employees: 477 men and 24 women, 22-70 years | - Participants with sleep disturbances had significantly higher scores on various fatigue dimensions when compared to those without sleep disturbances. |
| Case-Control (20) | Iran (2013) | Textile Factory | PSQI, BQ, ESS, ISI, and RLSQ | 400 male workers: 196 shift workers (mean age: 33.9 ± 5.9 years) and 204 non-shift workers (mean age: 35.1 ± 10.9 years) | Shift workers had substantially higher insomnia and poor sleep quality rates than non-shift workers. |
| Cross-sectional (21) | Iran (2017) | Steel Factory | PSQI | 282 men, mean age: 32.21 ± 6.57 years | - No link was found between sleep disturbances and workplace accidents. |
| Case Study (37) | Iran (2015) | Wind Farm | ESS | 53 men, mean age: 30.8 years | - There was a significant association between age, employees' experience, equivalent sound level, and sleep disorders. |
| **Sleep quality** | | | | | |
| Cross-sectional (24) | China (2020) | Petroleum industry | PSQI | 2116 workers: 1020 men and 1096 women, 18-60 years | - Workplace stress has a detrimental impact on workers' sleep quality. <br> - The CLOCK and Per3 genes may increase the risk of sleep problems. |
| Cross-sectional (27) | China (2019) | Petroleum industry | PSQI | 2116 workers: 1020 men & 1096 women, 18-60 years | - High job stress increases the likelihood of sleep problems. |
| Cross-sectional (34) | Iran (2019) | Power plant | PSQI | 275 male workers [exposed group (n = 132) and unexposed group (n = 143)], < 30 years (n = 88), 30-40 years (n = 127), ≥ 40 years (n = 48) | - Prolonged industrial ELF-EMF exposure may result in anxiety, depression, stress, and poor sleep quality. |
| Ex Post Facto (31) | Iran (2017) | Gas refinery | PSQI | 255 male workers, 20-60 years | - In terms of sleep disturbances, there was no significant difference between shift workers and day workers. However, the differences in sleep latency and sleep efficiency between the two groups were significant. |
| Descriptive (35) | Iran (2019) | Gas refinery | PSQI | 180 men, 23-59 years | - There was a significant relationship between occupational stress and quality of sleep. |
| Cross-sectional (22) | Turkey (2018) | Textile Factory | PSQI | 100 male workers | - The length of working in the textile industry affects sleep quality metrics. |
| Case-Control (25) | Iran (2014) | Petrochemical industry | PSQI | 62 men: case group (n = 40), control group (n = 22) | - There was no significant association between exposure level, quality of sleep, and overall health. |
| Quasi-experimental research with a pretest-posttest design (26) | Iran (2014) | Petrochemical industry | PSQI | 90 men: (45 case and 45 control), 30-58 years | - Stress management training enhanced staff members' mental health, career satisfaction, and sleep quality. |

**Table 1.** A summary of studies between 2010 and 2020 that examine factors influencing sleep quality and its related disorders in the process industry (continue)

| Study design | Country (Year) | Industry | Sleep measurement tool | Sample size | Result(s) |
|---|---|---|---|---|---|
| Cross-sectional (30) | Iran (2016) | Petrochemical industry | ESS | 180 men, 18-53 years | - Drowsiness, work overload, and work situation awareness had a significant internal relation. |
| Cross-sectional (36) | Iran (2016) | Steel Factory | PSQI | 256 men, mean age: 33.6 ± 6.9 years | - There was a positive and clear link between sleep quality and the overall health of shift workers. |
| Cross-sectional (32) | Brazil (2018) | Mining | PSQI | 89 men, mean age: 32.9 ± 6.3 years | - Positive correlations were found among self-perception of health, and duration and quality of sleep.<br>- Anxiety, and sleep length and quality were found to be related. |
| Cross-sectional (28) | Canada (2017) | Mining | ESS, KSS, and Actigraph | 19 male underground miners, 41.5 ± 5.1 years | -The miners' efficiency decreased overnight. |
| Cross-sectional (29) | Canada (2020) | Mining | Actigraph | 89 male miners: 38 night shift (mean age: 36.8 ± 13.9 years) and 51 day shift (mean age:37.1 ± 12.8 years) | Despite restricted circadian acclimation in terms of nocturnal vigilance, underground miners have fine sleep quality. |
| Cross-sectional (4) | Germany (2018) | Wind Farm | PSQI | 268 men, 20-34 years (n = 116), 35-49 years (n = 122), ≥ 50 years (n = 30) | - Higher levels of noise exposure, vibrations, and artificial ventilation are related to poor sleep quality. |

ESS: Epworth Sleepiness Scale; ISI: Insomnia Severity Index; SWD: Shift Work Disorder; KSS: Karolinska Sleepiness Scale; PSQI: Pittsburgh Sleep Quality Index; BQ: Berlin Questionnaire; RLSQ: Restless Legs Syndrome Questionnaire; ELF-EMF: Extremely Low-Frequency Electric and Magnetic Fields

**Table 2.** A summary of studies between 2010 and 2020 that examine factors influencing sleep quality in the manufacturing industry

| Study design | Country (Year) | Industry | Sleep measurement tool | Sample size | Result(s) |
|---|---|---|---|---|---|
| Cross-sectional (74) | Malaysia (2018) | Cable manufacturing | PSQI | 140 men, 21-57 years | - A greater level of all aspects of work stress and a higher level of avoidance were associated with poor sleep quality. |
| Cross-sectional (73) | Korea (2017) | Electronics Manufacturing industry | PSQI | 1472 workers: 1178 men and 294 women, 19-39 years | Serum vitamin D insufficiency was found to strongly correlate with poor sleep quality. |
| Descriptive-Analytical (75) | Iran (2012) | Automobile industry | ESS | 120 male workers: 60 fixed morning shifts (31.16 ± 5.55 years) and 60 night rotation shifts (31.83 ± 7.29 years) | - Sleepiness and shifts are harmful to the general health of workers. |
| Case Study (76) | Taiwan (2010) | Semi-conductor Manufacturing Company | PSQI | 239 worker: 198 men and 41 women, 21-50 years | - The effects of varying work shifts on sleep quality and career efficiency were substantial. |
| Cross-sectional (13) | Iran (2014) | Car accessories manufacturing plant | MUSIC-NQ | 727 male workers, 21-63 years | - There was a strong link between sleep disorders and workability. |

PSQI: Pittsburgh Sleep Quality Index; ESS: Epworth Sleepiness Scale; MUSIC-NQ: Musculoskeletal Intervention Center-Norrtalje Questionnaire

**Table 3.** A summary of studies between 2010 and 2020 examining factors influencing sleep quality and its related disorders in the service industry

| Study design | Country (Year) | Industry | Sleep measurement tool | Sample size | Result(s) |
|---|---|---|---|---|---|
| **Sleep disorders** | | | | | |
| Pilot (58) | USA (2013) | Nursing | BQ and PSG | 21 women, mean age: 40 ± 13 years | - According to the PSG, the prevalence of sleep-disordered breathing was 43%, but only 24% of these cases were regarded as high risk according to the BQ. |
| Cross-sectional (38) | Iran (2016) | Nursing | PSQI | 1456 nurses: 1296 women and 160 men, 19-60 years | - Sleep troubles have a remarkable impact on health-related quality of life. |
| Cross-sectional (70) | Iran (2019) | Nursing | PSQI, ESS, and ISI | 100 nurse: 49 women and 51 men, mean age: 30.4 ± 7.5 years | - Sleep disturbances were more common in nurses working in the surgical ward than those in other parts of the hospital. |
| Descriptive cross-sectional (45) | Egypt (2014) | Nursing | The two-week sleep diary | 52 nurse: 51 women and 1 man, 19-34 years | - The rate of errors peaked with unusual shift work patterns and night sleep patterns in nurses who had worked more than 4 nights in the previous 2 weeks. |
| Cross-sectional (71) | USA (2015) | Firefighting | BQ, AIS, RLSQ, and SWD screening tool | 6933 firefighters: 6360 men & 410 women & 163 unknown, mean age:40.4 ± 8.9 years | - Sleep disturbances are common among firefighters and are linked to an increased risk of adverse health and safety consequences. |
| Cross-sectional (39) | USA (2019) | Firefighting | BQ, AIS, RLSQ, ESS | 6037 firefighters: 5812 men, 372 women, 123 unknown, mean age: 40.4 ± 8.9 years | - Sleep and mental health troubles were linked to an elevated risk of burnout in firefighters. |
| Cross-sectional (42) | USA (2019) | Firefighting | PSQI | 652 firefighters: 611 men and 36 women, and 5 transgender people, mean age: 38.4 ± 8.6 years | - High alcohol abuse and low distress tolerance were significantly associated with high sleep disturbance. |
| Cross-sectional (41) | USA (2020) | Firefighting | PSQI, Micro Sleep Watch actigraphs | 45 firefighters: 44 men and 1 women, mean age: 37.4 ± 7.22 years | - Even minor sleep disruptions impacted cognitive performance, thus increasing the probability of poor job performance or injury. |
| Cross-sectional (44) | Iran (2020) | Driving | ESS | 281 male locomotive drivers, mean age: 43 ± 10 years | - 166 drivers had 2 or more OSA risk factors, and there was a high rate of OSA among locomotive drivers. |
| Cross-sectional and prospective cohort (48) | USA (2011) | Police officers | BQ, AIS, RLSQ, CQ, ESS, and PSG | 4957 police officers: 861 women and 4079 men, and 17 unknown. 20-77 years | - Sleep disturbances were significantly linked to a higher risk of self-reported detrimental health, performance, and safety consequences. |
| **Sleep quality** | | | | | |
| Cross-sectional (63) | Taiwan (2013) | Nursing | PSQI, A take-home Holter ECG SD-100 portable recorder | 156 women, mean age: 34.6 ± 8.1 years | - Subjective and objective findings showed that hospital nurses suffered from poor sleep quality. |
| Descriptive-comparative (57) | Iran (2011) | Nursing | PSQI | 180 nurses: 14 men and 166 women, mean age: 31.6 ± 8.5 years | - There was a statistically significant difference in the quality of sleep and the overall health of nursing staff. |
| Cross-sectional (50) | Iran (2014) | Nursing | PSQI | 200 nurses: 175 women and 25 men, mean age: 32.9 ± 5.7 years | - With increased job stress, nurses' sleep quality deteriorates, and their fatigue worsens. |
| Cross-sectional (62) | China (2020) | Nursing | PSQI | 155 women, 21-54 years | - Work-related stress harms sleep quality. |

**Table 3.** A summary of studies between 2010 and 2020 examining factors influencing sleep quality and its related disorders in the service industry (continue)

| Study design | Country (Year) | Industry | Sleep measurement tool | Sample size | Result(s) |
|---|---|---|---|---|---|
| Quantitative, cross-sectional, descriptive, and comparative (47) | Brazil (2010) | Nursing | PSQI | 203 nurses: 179 women and 24 men, < 30 years (n = 31), 30-40 years (n = 65), 40-49 years (n = 85), ≥ 50 years (n = 22) | - There was a significant relationship between sleep and stress. |
| Cross-sectional (65) | Singapore (2010) | Nursing | KSS | 163 nurses: 147 women and 16 men, mean age: 32.8 ± 6.9 years | - Over 70% of nurses said they did not get enough sleep. Older age, poor sleep situation, digestive symptoms, and higher strain and symptom levels were all risk factors for inadequate sleep. |
| Cross-sectional (43) | Taiwan (2010) | Nursing | PSQI | 435 women, 20-52 years | - There was an inverse relationship between sleep quality scores and overall quality of life scales. |
| Cross-sectional (49) | Korea (2018) | Nursing | PSQI | 188 nurses: 182 women and 6 men, mean age: 30.84 ± 7.08 years | Sleep problems and subjective sleep quality were significant predictors of nurse productivity, shift work, and age. |
| Cross-sectional (72) | Iran (2018) | Firefighting | PSQI | 118 men, mean age: 33.2 ± 4.9 years | - Poor sleep quality was associated with musculoskeletal problems, shift work, and a high BMI in firefighters. |
| Descriptive (67) | USA (2011) | Firefighting | PSQI, ESS | 112 firefighters: 107 men and 5 women, mean ages: 43.6 ± 7.7 years | - There was an association between sleep deprivation, depressed mood, physical/mental health, and drinking habits. |
| Cross-sectional (40) | Australia (2016) | Firefighting | Wrist actigraph | 40 firefighters: 31 men and 9 women, 19-65 years | - The amount of sleep achieved during shift work times was limited, and pre-and post-sleep fatigue scores were more significant than non-shift work times. |
| Cross-sectional (69) | USA (2016) | Firefighting | PSQI | 109 male career firefighters, 20-59 years | - Firefighters who work second jobs have significantly poorer sleep quality. |
| Cross-sectional (68) | Belgium (2011) | Driving | ESS, PSQI, and BQ | 476 men, mean age: 42.7 ± 10.2 years | - Lack of sleep and daytime sleepiness were common among truck drivers. |
| Cross-sectional (46) | Iran (2016) | Driving | PSQI | 1500 men, 22-72 years | - Experienced drivers had a high rate of poor sleep quality. |
| Cross-sectional (66) | Thailand (2019) | Driving | PSQI, BQ | 338 men, mean age: 45.8 ± 8.1 years | - Poor sleep quality was linked to night shift work, night or day shift patterns, consumption of alcohol, marriage, and lack of physical activity. |
| Cross-sectional (60) | Iran (2012) | Driving | PSQI | 100 men, 26-63 years | - There was a tangible link between sleep quality, age, and work satisfaction. |
| Cross-sectional (55) | Korea (2014) | Driving | PSQI | 4634 train drivers:4597 men and 37 women, mean age: 45.3 ± 9.4 years | - Human errors were significantly associated with inadequate sleep quality and posttraumatic stress disorder. |
| Cross-sectional (53) | Australia (2018) | Driving | ESS, PSQI, KSS, and EEG | 63 train drivers: 54 men and 9 women, 24-69 years | - Train drivers' subjective fatigue/sleepiness levels were predicted with different levels of success. |
| Cross-sectional (59) | USA (2016) | Policing | PSQI | 363 police officers: 260 men and 103 women, 27-66 years | - Evening and night work schedules are linked to an increased prevalence of inadequate sleep quality in police officers. |
| Cross-sectional (64) | Taiwan (2015) | Policing | PSQI | 796 male police officers, mean age: 37.36 ± 7.73 years | - Police officers who had more sleep disturbances were more likely to have metabolic syndrome and abdomen obesity. |

**Table 3.** A summary of studies between 2010 and 2020 examining factors influencing sleep quality and its related disorders in the service industry (continue)

| Study design | Country (Year) | Industry | Sleep measure-ment tool | Sample size | Result(s) |
|---|---|---|---|---|---|
| Cross-sectional (61) | Australia (2016) | Policing | ESS, PSQI | 206 police officers: 140 men and 66 women, mean age: 31.63 ± 8.51 years | - In the survey, bad sleeping quality and fatigue intensity were found to be prevalent. |
| Cross-sectional (51) | USA (2019) | Policing | PSQI | 356 police officers: 256 men and 100 women, mean age: 41.3 ± 6.7 years | - Police officers' perceptions of the severity of stress and the rate of stress factors are linked to poor sleep quality. |
| Cross-sectional (52) | USA (2011) | Policing | PSQI | 391 police officers: 284 men and 107 women, mean age: 40.70 ± 7.14 years | - Quality of sleep was found to be noticeably and separately linked to symptoms of depression. |
| Cross-sectional (54) | Netherlands (2015) | Policing | A seven-dimensional questionnaire | 740 police force: 252 women and 488 men, mean age: 35.7 ± 10.6 years | - Sleep quality was the most crucial factor in shift work tolerance, followed by the need for fatigue, recovery, and work-life balance. |
| Cross-sectional (56) | Netherlands (2021) | MRI Technicians | The 12-item Medical Outcomes Study sleep scale | 233 technicians: 186 women and 47 men, mean age: 42.56 ± 10.6 years | - Contact with MRI-related magnetic fields tends to be related to elevated sleep disruption and non-optimal sleep length. |

BQ: Berlin Questionnaire; PSQI: Pittsburgh Sleep Quality Index; ISI: Insomnia Severity Index; AIS: Athens Insomnia Scale; RLSQ: Restless Legs Syndrome Questionnaire; SWD: Shift Work Disorder; ESS: Epworth Sleepiness Scale; CQ: Cataplexy Questionnaire; PSG: Polysomnography; KSQ: Karolinska Sleep Questionnaire; KSS: Karolinska Sleepiness Scale; EEG: Electroencephalography; MRI: Magnetic resonance imaging
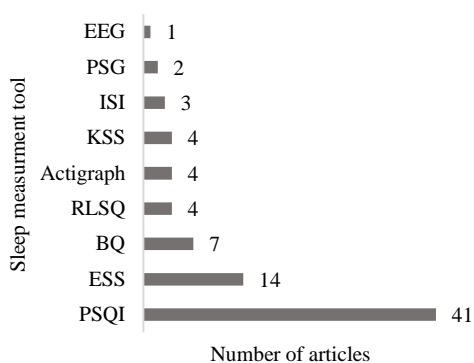
**Figure 3.** Distribution of sleep measurement tools in articles (2010-2021)

In the process industries, factors such as anxiety, depression, shift work, job stress, and exposure to high noise and vibration reduce workers' sleep quality. People with sleep disorders also suffer from more fatigue (4, 20, 23, 27, 33, 35, 37). In addition, exposure to Extremely Low-Frequency Electric and Magnetic Fields (ELF-EMF) may reduce sleep quality (34). Most of the studies conducted in these industries were in the petrochemical, petroleum, and mining industries (Figure 4).
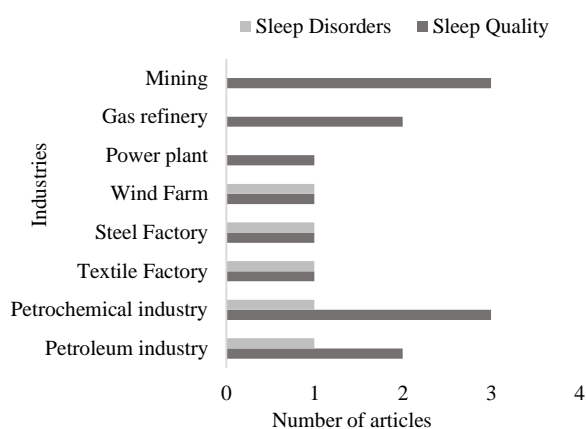


**Figure 4.** Distribution of articles in process industries (2010-2021)

Work stress and shift work impair sleep quality in the manufacturing industries and reduce job productivity and workers' general health (74-76). In addition, vitamin D deficiency has been suggested to influence sleep quality (73).

In service occupations, such as nursing, sleep quality is related to general health, and job stress affects sleep quality and fatigue (47, 50, 62, 63). In addition, in jobs such as firefighting, factors such as shift work, musculoskeletal disorders, sleep deprivation, depression and working in a second job are also associated with poor sleep quality (40, 67, 69, 72). Inadequate sleep quality is common among drivers, and factors such as night work, poor sleep patterns, alcohol consumption, and lack of physical activity are the cause (46, 66, 68). Poor sleep quality and fatigue are also common among police officers, are more evident in the evening and night work, and are affected by factors such as stress and depression (51, 52, 59, 61). Most of the studies conducted in these industries have been in the nursing and firefighting professions (Figure 5).
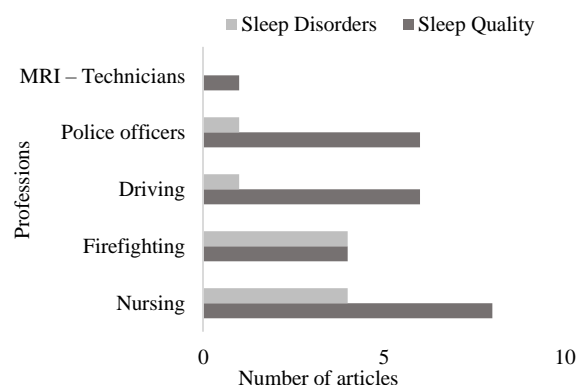


**Figure 5.** Distribution of articles in service occupations (2010-2021)

The distribution of published articles assessing sleep quality and its related disorders by year of publication is shown in figure 6.
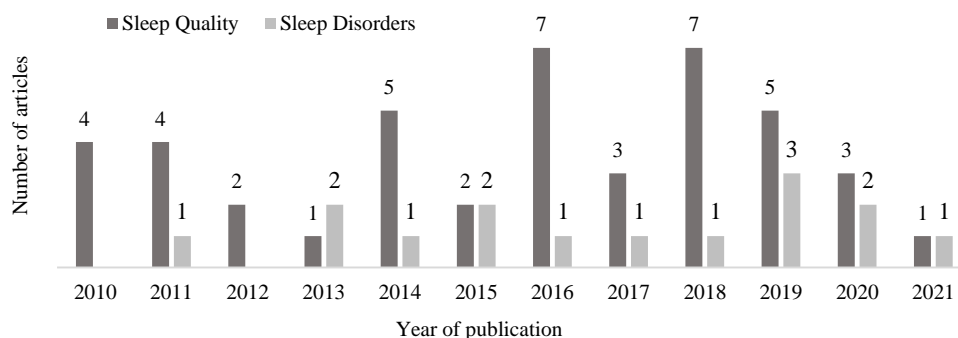


**Figure 6.** Distribution of articles by year of publication

The trend of publishing articles in these 10 years shows the importance of the issue of sleep in the industries.

**Discussion**

There are several variables in the process, manufacturing, and service industries that affect sleep quality. These variables reduce sleep quality and increase sleep disorders (35). Shift work is one of the main factors affecting sleep quality and its related disorders (77). Shift work is inevitable in many industries due to the requirements and nature of work. The concept of shift work mainly refers to scheduling daily work schedules. In shift jobs, individuals work outside the usual 8 hours a day (78). Problems such as gastrointestinal diseases, diabetes, infectious diseases, cardiovascular disorders, musculoskeletal disorders, and sleep disorders are common in shift workers (79). According to a cross-sectional study conducted on 2,453 employees of the China Petroleum and Xinjiang Petrochemical Company, shift workers had more sleep disorders than non-shift workers (80). In addition, the results of a case study on 239 workers at a semiconductor manufacturing company in Taiwan suggested that different shifts had a significant effect on sleep quality and work quality (76).

Job stress is another component that can affect sleep quality and its related disorders. Occupational stress is a type of psychological stress that occurs due to workers' psychological, physical, and social pressures (81). Problems such as cardiovascular diseases, stomach diseases, digestive issues, headaches, and sleep problems appear as a result of occupational stress (35). Occupational stress is a component that is strongly related to and affects sleep quality. A descriptive study on 180 male employees of Behbahan Bid Boland gas refinery in Iran showed a strong association between job stress and sleep quality (35). Prolonged stress can increase the number of self-regulatory reactions during the night and reduce sleep quality (27).

The impact of factors influencing sleep quality and its related sleep disorders in different industries varies according to the conditions of each industry. Industries and occupations are generally divided into process, production, and services (14). In each of these industries, there are jobs in which the sleep status of employees is of grave importance. If sleep problems occur for employees of these occupations, their productivity will be significantly reduced. Process industries are the first category to be discussed.

*Process industries:* Process industries are considered to be complex systems due to the presence of hazardous materials, the large number of workers, and the complexity of operational processes (82). These industries use chemical, biochemical, or physical materials to convert raw materials and/or energy. These industries include various industries such as chemical and petrochemical, gas processing, electricity generation, and water and wastewater industries (83). The topic of sleep is essential in many industries in this category. One of these industries is the petroleum industry. In this industry, due to the nature of the work (workers work 24 hours a day, 7 days a week), the sleep status of employees is severely affected (80). The decline in sleep quality is evident in workers in the petroleum industry. A cross-sectional study on 43 male sailors from the National Iranian Drilling Company found poor sleep quality among oil rig shift workers (84).

The gas industry is also one of the most vital industries in this category. The working conditions in the gas industry are also challenging and dangerous (85). Due to the shift work and the nature of employees' work in the gas industry, the quality of sleep of workers dramatically decreases (86). Due to poor working conditions, most gas refinery workers complain of insufficient sleep because insufficient sleep negatively affects cognitive behaviours such as logical reasoning and working memory (31).

*Manufacturing industries:* These industries are defined as operational processes that have specific products. In these industries, identifiable objects are produced (14). The steel industry, automotive industry, cable industry, and many other manufacturing industries fall into this category. Numerous studies have evaluated sleep quality and its related disorders among manufacturing workers. A cross-sectional study conducted on 256 steel plant employees in Iran showed a significant relationship between general health, shift work, and sleep disorders (36). In addition, another cross-sectional study was conducted with the participation of 2820 manufacturing workers in China. According to the findings of this study, both insomnia and sleep duration in workers independently and jointly are associated with an increased risk of poor working ability (87).

***Service industries:*** In these industries, fewer industrial resources are usually used. These industries are a large group of occupations working to serve other industries, especially manufacturing industries (14). Driving is one of these occupations. Driving is a high-precision job that requires psychomotor responses and is highly susceptible to fatigue (88). Fatigue and drowsiness are particularly common among truck drivers due to the nature of their job (89).

Inadequate sleep and drowsiness are the leading causes of accidents in these occupations (90). A cross-sectional study conducted on 150 truck drivers in Iran found that about a quarter of road accidents are caused by drowsiness, and driving accidents are less common among drivers who get enough sleep (91).

Firefighting is another occupation in this category. Firefighters are primarily responsible for public safety, and their services are full-time (92). Firefighters often experience irregular and inadequate sleep due to their shift work time (93). Because of their frequent night shift schedules and workplaces, they are at greater risk of sleep deprivation than the general population (94). Sleep disorders in firefighters are significantly more common than in the public adult community (95).

Nursing is another job that falls into this category. Nursing is a distinct occupational group with a different job nature than other occupations (11). Nursing requires focus and often involves activities that require a high level of complexity and responsibility (96). Decreased sleep quality has been shown to impair nurses' decision-making and performance, resulting in errors and accidents (97). Low-quality sleep in this profession increases absenteeism, decreases job satisfaction, and reduces the quality of tasks (98). A cross-sectional study of 315 shift nurses in Italy found that specific characteristics and employment status of shift nurses can indirectly affect sleep quality and burnout (99).

In general, inadequate sleep quality and its related disorders are interrelated with many work environment parameters. Many components of the work environment, such as shift work, job stress, working time, and rest, affect employee sleep. These harmful components of the work environment have affected the quality of sleep of peoples in various industries and created unfavorable conditions for employees' sleep (15, 16). This unhealthy sleep situation has long-term adverse effects on employees in multiple industries.

## Conclusion

Employees' sleep status in various industries is unsatisfactory and can be affected by many factors such as job stress, anxiety, stress, and shift work. Poor sleep status can negatively affect employee performance, productivity, accident rates, and many other factors. By taking the necessary measures and through appropriate planning according to employees' quality of sleep in the workplace, poor sleep quality and the resulting sleep disorders can to some extent be prevented.

Among the limitations of most studies was the use of subjective tools to assess the quality of sleep and its mental disorders such as questionnaires. In this regard, researchers are advised to conduct more clinical studies using modern equipment if possible. Moreover, due to the small number of studies in this regard, it is recommended that more researches be conducted on sleep quality and its related disorders in the manufacturing industries.

## Conflict of Interests

## Acknowledgments

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