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Association between Overtime and Sleep Quality, Occupational Fatigue, Depression, Anxiety, and Stress among Industrial Rotational Shift Workers

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Abstract

Background: This study aimed to investigate the effects of overtime on the Pittsburgh Sleep Quality Index (PSQI), Occupational Fatigue Exhaustion Recovery (OFER-15), Depression, Anxiety, and Stress Scale (DASS) among food industry rotational shift workers.

Materials and Methods: This descriptive study was conducted among 85 rotating shift workers in an Iranian food industry company. Samples were selected through a census with criteria considered among all 102 workers who were asked to work overtime. A demographic questionnaire, the DASS, the PSQI, and the OFER-15 questionnaire were used to collect information. Shift workers completed the questionnaires before and after overtime.

Results: Poor sleep quality and occupational fatigue significantly increased after overtime by 28.3% (chi-square=11.02) and 36.4% (z=-4.71), respectively. In the PSQI subscales, sleep duration increased by 37.6% (z=-4.62), sleep efficiency by 9.5% (z=-2.29), sleep disturbance by 14.1% (z=-3), and the use of sleeping medications by 3.5% (z=-1.89) after the overtime period showing statistically significant increases in the categories of relatively poor and very poor sleep. Furthermore, the subscales of OFER-15 showed that acute fatigue (t=-3.98), chronic fatigue (t=-7.79), and inter-shift recovery (z=-3.47) were statistically more undesirable after overtime. Additionally, in the DASS subscales, participants reported moderate to extremely severe stress by 23.3% (z=-4.521), anxiety by 28.2% (z=-4.47), and depression by 23.5% (z=-4.45), all showing a statistically significant increase after overtime.

Conclusion: Overtime work leads to sleep issues, increased reliance on sleeping medications, and higher occupational fatigue among industrial workers on rotational shifts. This ultimately results in greater stress, anxiety, and depression.

Keywords: Shift Work, , Industry, Food, Rotation

Introduction

Overtime has become a common practice in developed nations, but it directly affects workers' physical health and lifestyle [1-3]. Overtime refers to working hours beyond a predefined threshold that triggers the payment of an overtime premium [4]. It increases stress levels and reduces leisure, family, and work recovery time [1, 2]. European studies show that almost 17% of workers report working overtime every week, with Sweden having a percentage of nearly 30% [5]. About 22% of workers still work more than 48 hours per week. The negative impact of overtime goes beyond physical well-being and can also affect mental health, leading to sleep disorders, anxiety, stress, depression, and chronic fatigue [3, 6, 7].

Over time, affecting sleep time and reducing sleep duration can lead to stress and depression. As a result of reduced sleep time, occupational fatigue is not resolved

and increases depressive symptoms. Job fatigue, stress, anxiety, depression, and sleep quality can have mutual effects and act as a two-way cycle [8].

In Japan, the number of workers experiencing cardiovascular disease, cerebrovascular disease, and work-related mental disorders has tripled over the past decade [5]. Recent research highlights that long working hours are linked to a higher risk of depression in Asian countries, surpassing the rates observed in European countries [9]. It is important to note that the likelihood of encountering occupational health problems increased by 24.3%, with mental health issues being more common than physical health problems [3].

Working long hours and overtime can cause sleep disorders that affect a person's health and lead to reduced performance, disruptions in the body's natural rhythms, and impaired cognitive function [3, 10, 11]. The impact on mental health is influenced by several factors, including conflict between work and family life, burnout, increased cortisol levels, and alcohol abuse, all of which contribute to the development of sleep disorders [5, 6, 10, 12].

Lack of independence in determining working hours in shift work can affect employees' health and performance [5]. Sleep disorders can lead to higher rates of absenteeism, reduced job performance, and diminished quality of life [5]. Additionally, sleep disorders can increase the use of the healthcare system and make workers more prone to accidents [5, 13]. The impact of nighttime sleep on the recovery and restoration of mental and physical processes further emphasizes its importance in maintaining overall physical and psychological health [14].

Organizational constraints, job dissatisfaction, and frustration contribute to increased employee stress. Research on employee welfare has shown that overtime causes stress [15, 16]. Additionally, considering that overtime work increases exposure to harmful chemicals and other potential health risks, it also impacts the mental health of employees, making it a subject worthy of further research [10].

Insufficient sleep, long working hours, and heavy workloads increase worker fatigue [17, 18]. Previous studies have shown that overtime and long working hours can result in a high workload and increased fatigue [19]. In addition, inadequate rest for workers during shifts and poor planning of activities can lead to overload and, consequently, increased fatigue, possibly even leading to chronic fatigue [20, 21].

Many organizations and factories in China have reported health-related problems due to long working hours [22]. Overall, the findings suggest that long working hours adversely affect health [3]. Despite the importance of long working hours, apart from the research conducted by Sparks and Cooper [23], who discovered a slightly positive correlation between various health syndromes and long working hours, Kapo Wong's [3] research showed that employees who work long hours are vulnerable to various types of occupational health problems. There has been little follow-up research to investigate the effects of overtime on mental health and sleep quality in an interventional way.

It is considered that one of the negative effects of rotating shifts due to hormonal changes is the reduction of sleep quality, which can lead to fatigue, stress, anxiety, and depression among shift workers. Overtime or long working hours decrease rest time or sleep duration and subsequently reduce sleep quality [6, 24]. Therefore, it is necessary to implement strategies to address sleep problems and alleviate fatigue, stress, anxiety, and depression among industrial shift workers.

Due to limited research on overtime among rotating shift workers in the industry and the lack of comprehensive investigation into its impact on sleep quality, occupational fatigue, stress, anxiety, and depression, it is necessary to conduct this study. Therefore, this study aims to investigate the impact of overtime on sleep quality, occupational fatigue, depression, anxiety, and stress among rotational shift workers in the food industry. This study contributes to the existing body of knowledge by providing valuable insights into effectively managing overtime and work shifts to enhance industrial workers' overall health and wellness.

The hypotheses are as follows: 1. Sleep quality differs among rotating shift workers before and after overtime. 2. The levels of stress, anxiety, and depression experienced by rotating shift workers change after overtime. 3. Occupational fatigue in rotating shift workers increases after overtime.

Materials and Methods

This descriptive-analytical study was conducted on rotating shift workers in Iran’s food industry in 2022. The study was approved by the University of Medical Sciences and participants completed a consent form before the study began.

Out of the 102 workers suggested for overtime, all selected through the census, 17 were excluded due to leaving their jobs or unwillingness to participate. This left 85 workers, all of whom were shift workers operating in three forward rotating shifts that changed weekly. Workers were included based on the following entry criteria: more than two months of shift experience [10], full-time workers [6], and working more than 48 hours per week [5].

First, a demographic information questionnaire was distributed to 102 workers to collect data and meet the inclusion criteria. The Depression, Anxiety, and Stress Scale (DASS), Pittsburgh Sleep Quality Index (PSQI), and Occupational Fatigue Exhaustion Recovery (OFER-15) questionnaire were administered to 85 rotating shift

workers in a self-report format in the presence of the researcher, taking in approximately 20 minutes to complete. Before filling out the questionnaires, the workers explained the research objectives. The researcher guided the workers and answered any questions to ensure accurate and complete responses. The factory under study added four overtime hours to the daily work schedule for two months. After two months of overtime, the workers completed the questionnaires again. This allowed for a comparison of sleep quality, stress, anxiety, depression, and job fatigue of all workers who worked overtime and were willing to participate before and after the overtime period. The control group in the study consisted of the same workers before the overtime period.

PSQI Questionnaire: The PSQI evaluates sleep quality over the past month, considering subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. A score of 5 or higher indicates a sleep disorder [25]. The subscales of sleep latency, sleep duration, and sleep efficiency were calculated from questions one to four of the questionnaire, where participants reported their answers in hourly units.

In Farahi's study, the internal consistency analysis revealed a Cronbach's alpha of 0.77, indicating acceptable reliability. Furthermore, the validity of the questionnaire was assessed by comparing the PSQI global score with high and low scores on the General Health Questionnaire-12 (GHQ-12), resulting in a correlation coefficient of 0.54. This suggests a satisfactory correlation between the two instruments. These findings confirm that the Persian version of the PSQI is a reliable and valid tool [26-28].

Offer-15 Questionnaire: The OFER-15 questionnaire was used to evaluate the severity of occupational fatigue. This questionnaire consists of items that are rated on a 7-point Likert scale. Fatigue is evaluated across three dimensions: acute fatigue (5 questions), chronic fatigue due to work (6 questions), and recovery between shifts (4 questions scored in reverse). The total score is divided into three levels: low (score below 23.33), medium (score between 23.33 and 60), and high (score above 60) [29].

In a study involving 581 hospital nurses, Cronbach's alpha coefficients of the OFER-15 questionnaire dimensions ranged from 0.81 to 0.86, indicating suitable internal consistency. Furthermore, Feng et al. confirmed the construct validity of the three factors mentioned in this questionnaire, further validating its reliability and effectiveness [29].

DASS-21 Questionnaire: The DASS-21 questionnaire was used to evaluate the severity of stress, anxiety, and depression. The final score for each scale is calculated by summing the total scores of 7 questions related to that scale and then multiplying by 2. Each item is rated on a four-point (0-3) Likert scale, leading to a possible final score ranging from 0 to 21 for DASS. Higher scores indicate elevated levels of stress, depression, and anxiety.

Sahibi et al.'s study revealed internal consistency within the DASS-21 scales, with Cronbach's alpha values of 0.77 for depression, 0.79 for anxiety, and 0.78 for stress. To assess the validity of the DASS-21, the study simultaneously administered the Beck Depression, Zang Anxiety, and Perceived Stress questionnaires. The resulting correlation coefficients for the depression, anxiety, and stress scales were 0.70, 0.67, and 0.49, respectively, all of which were statistically significant at $p<0.001$[30].

A one-sample Kolmogorov-Smirnov test was used to assess the normality of the data. To compare the DASS, PSQI, and OFER-15 before and after overtime, McNemar, Paired-Sample T-Test, and Wilcoxon tests were conducted using SPSS version 23 software.

Results

The results showed that the average age of the workers was 35.40 ± 6.57 years, with an average of 7.13±6.47 years of experience. Approximately 77% of the participants were married, and over half had a diploma. Additional information can be found in Table 1.

Fig. 1 displays the levels of sleep quality (good and poor), while Figure 2 illustrates the level of occupational fatigue (low, medium, and high) among workers before and after overtime work.

Table 1. Demographic information of shift worker participants in the study (n=85)

Quantitative information		Qualitative information			
Variable	**Mean ± SD**	**Variable**	**Classification**	**Frequency**	**Percentage**
Age (year)	35.4 ± 6.5	Marital status	Single	19	22.4
Height (cm)	174.2±7.5		Married	66	77.6
Weight (kg)	78.8± 14.0	Level of education	Secondary education	27	31.8
			Diploma	45	52.9
			More than Diploma	28	15.3

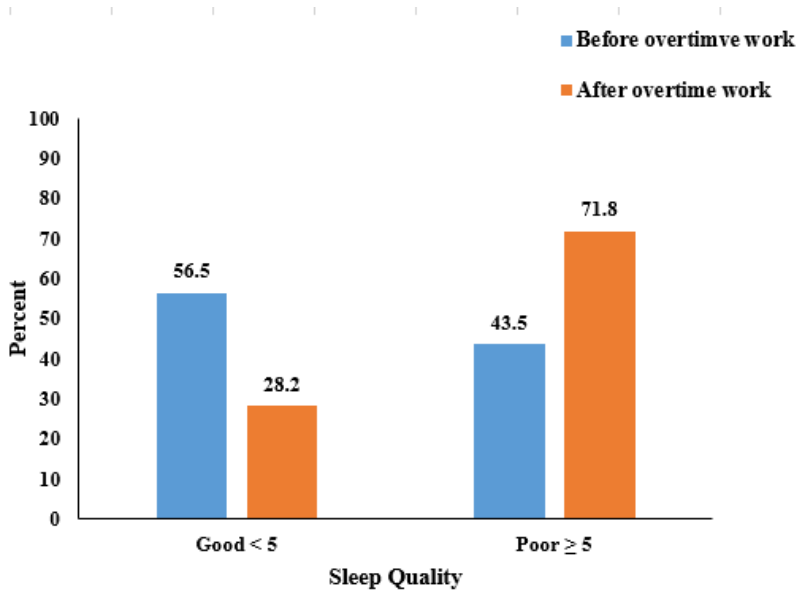

Fig. 1. The percentage of the PSQI category (qualitative) among participating workers before and after overtime work (n=85)

Data regarding the frequency and percentages of the subscales of the PSQI before and after overtime work are presented in Table 2. Table 2 shows that the subscales of subjective sleep quality (15.3%), sleep duration (37.6%), sleep efficiency (9.5%), sleep disturbances (14.1%), use of sleeping medications (3.5%), and daytime dysfunction (5.8%) all increased in categories of relatively poor and very poor after overtime work compared to before it.

Table 2 also indicates that the quality of sleep (χ^2=11.02, p<0.01), and subscales including sleep duration (z=-4.62, p<0.01), sleep efficiency (z=-2.29, p<0.05), sleep disturbances (z=-3, p<0.01), and use of sleeping medications (z=-1.89, p<0.01), have a statistically significant relationship after overtime work compared to before it, based on the McNemar test and the Wilcoxon test.

The frequency and percentage of subscales of the DASS-21 among workers who participated in the study are shown in Table 3. According to the results in Table 3, the levels of stress, anxiety, and depression following overtime in the normal category decreased by 34.6%, 23.6%, and 17.7%, respectively. Conversely, in the moderate to extremely severe categories, they increased by 23.3%, 28.2%, and 23.5%, respectively.

Stress (z=-4.52, p<0.01), anxiety (z=-4.47, p<0.01), and depression (z=-4.45, p<0.01) after overtime were found to be statistically significant. This indicates the impact of overtime on the deterioration of DASS (see Table 3).

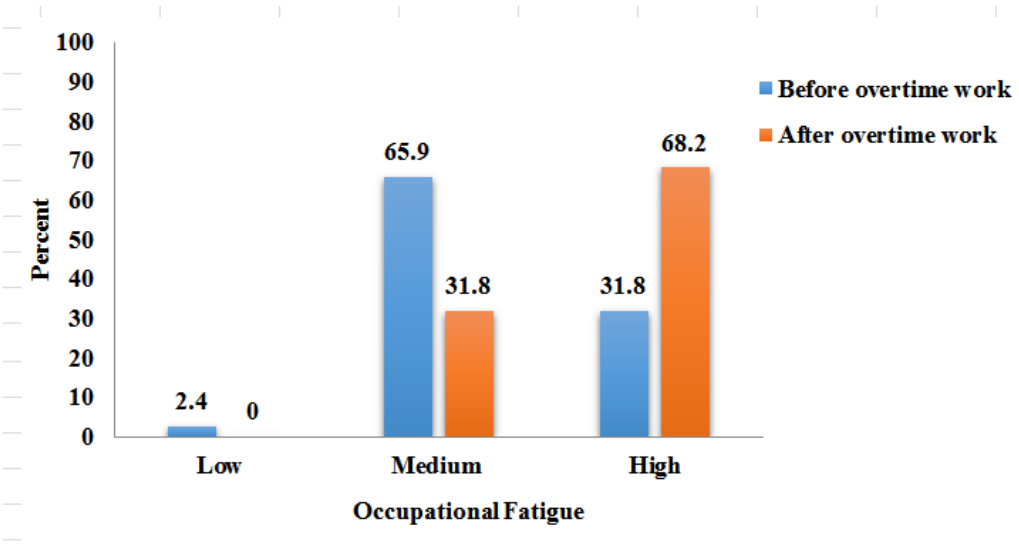

Fig. 2. The percentage of the OFER-15 category (qualitative) among participating workers before and after overtime work (n=85)

Table 2. The frequency and percentage of subscales of the PSQI (quality) and comparison of the results of its before and after overtime work among shift workers (n=85) based on Wilcoxon / McNemar tests

Subscales of the PSQI							
Variables	**Category**	**Before overtime work**		**After overtime work**		**Z**	**P**
		Frequency	**Percent**	**Frequency**	**Percent**		
Subjective sleep quality	Very good	10	11.8	8	9.4	-1.58	0.11
	Fair good	47	55.3	36	42.4		
	Relatively poor	20	23.5	28	32.9		
	Very poor	8	9.4	13	15.3		
Sleep latency	Very good	21	24.7	18	21.2	-0.05	0.95
	Fair good	41	48.2	46	54.1		
	Relatively poor	18	21.2	18	21.2		
	Very poor	5	5.9	3	3.5		
Sleep duration	Very good	37	43.5	14	16.5	-4.62	0.00**
	Fair good	34	40.0	25	29.4		
	Relatively poor	9	10.6	29	34.1		
	Very poor	5	5.9	17	20.0		
Sleep efficiency	Very good	73	85.9	65	76.5	-2.29	0.02*
	Fair good	12	14.1	12	14.1		
	Relatively poor	0	0	6	7.1		
	Very poor	0	0	2	2.4		
Sleep disturbances	Very good	3	3.5	0	0	-3.00	0.00**
	Fair good	74	87.1	65	76.5		
	Relatively poor	8	9.4	20	23.5		
	Very poor	0	0	0	0		
Use of sleeping medications	Very good	85	100	81	95.3	-1.89	0.05*
	Fair good	0	0	1	1.2		
	Relatively poor	0	0	3	3.5		
	Very poor	0	0	0	0		
Daytime dysfunction	Very good	28	32.9	16	18.8	-1.29	0.19
	Fair good	33	38.8	40	47.1		
	Relatively poor	19	22.4	28	32.9		
	Very poor	5	5.9	1	1.2		
PSQI		-	-	-	-	**Chi-square**	**P**
		-	-	-	-	11.02	0.00**

*P-value <0.05 **P-value <0.01

Table 3. The frequency and percentage of subscales of the DASS-21 (quality) and comparison of the results of its before and after overtime work among shift workers (n=85) based on Wilcoxon tests

Subscales of the DASS-21							
Variables	**Category**	**Before overtime work**		**After overtime work**		**Z**	**P**
		Frequency	**Percent**	**Frequency**	**Percent**		
Stress	Normal	68	81.7	40	47.1	-4.52	0.00**
	Mild	9	9.8	18	21.2		
	Moderate	4	4.9	19	22.4		
	Severe	4	3.7	6	7.1		
	Extremely severe	0	0	2	2.4		
Anxiety	Normal	36	42.4	16	18.8	-4.47	0.00**
	Mild	16	18.8	12	14.1		
	Moderate	28	32.9	38	44.7		
	Severe	4	4.7	16	18.8		
	Extremely severe	1	1.2	3	3.5		
Depression	Normal	35	41.2	20	23.5	-4.45	0.00**
	Mild	28	32.9	23	27.1		
	Moderate	18	21.2	35	41.2		
	Severe	3	3.5	4	4.7		
	Extremely severe	1	1.2	3	3.5		

*P-value <0.05 **P-value <0.01

The results of the mean and standard deviation of the subscales of the OFER-15 among workers who participated in the study are presented in Table 4. According to Table 4, chronic and acute fatigue as well as inter-shift recovery after overtime work, increased compared to before.

In addition, occupational fatigue (z=-4.71, p<0.01) and its subscales, such as acute fatigue (t=-3.98, p<0.01), chronic fatigue (t=-7.79, p<0.01), and inter-shift recovery (z=-3.47, p<0.01) significantly increased after overtime compared to before. This was determined through a Paired-Sample T-test and Wilcoxon test analysis (see Table 4).

Table 4. Mean and standard deviation of the subscales of the OFER-15 and comparison of the results of its before and after overtime work among shift workers (n=85) based on Paired-sample-test / Wilcoxon tests

Subscales of the OFER-15				
Variables	**Before overtime work**	**After overtime work**	**t/z**	**P**
	Mean± SD	**Mean± SD**		
Chronic fatigue	13.32±5.92	19.40±4.34	-7.79	0.00**
Acute fatigue	22.41±8.82	25.54±5.50	-3.98	0.00**
Inter-shift recovery	15.58±5.60	18.04±3.79	-3.47	0.00**
OFER-15	Mean rank=22	Mean rank=22.58	-4.71	0.00**

*P-value <0.05 **P-value <0.01

Discussion

Based on the study results, sleep quality after overtime has decreased by 28.3%. According to the McNemar test, this change is significant. These findings align with studies by Afonso et al. [5], Kapo Wong et al. [3], and Nakashima et al. [31], which showed that working long hours hurts sleep quality due to reduced time for sleeping [3]. Conversely, the current study's findings contradict those of Hirsch-Allen et al. [32], who reported that long working hours lead to long-term sleep recovery. These inconsistencies may be due to differences in the study population, type of work, and rotation and shift work of participants. Previous studies have concluded that shift work is associated with sleep disturbance, which may affect the results [5]. Considering that most participants are married, research has indicated that married individuals often have poorer sleep quality and overall quality of life due to concerns stemming from life responsibilities and financial challenges [33].

According to the findings presented in Table 2, the sleep duration subscale showed a 27% decrease in the "very good" category after overtime. This indicates that nearly one-third of the workers are experiencing a decrease in their usual sleep duration. Other reasons for lack of sleep include dedicating excessive time to leisure and social activities, factors often overlooked in research studies [5]. Lombardi et al., in their study, also point out that increased work reduces daily sleep hours [34].

Additionally, there was a 9.5% increase in the "relatively poor" and "very poor" categories in the sleep efficiency subscale. This suggests that workers are spending more time in bed than actually sleeping. Furthermore, the sleep disturbances subscale revealed a 14.1% increase in the "relatively poor" category. This indicates that one-sixth of the workers experienced sleep disturbances for various reasons such as feeling cold or hot, coughing, difficulty breathing, disturbed sleep, and pain. In their study, Sobhani and her colleagues also state that most sleep problems reported by shift workers are related to sleep disorders. In addition to overtime, shift work has also aggravated this subscale [33].

Finally, the use of sleeping medications in the "very good" category decreased by 4.7%, indicating that some workers relied on sleeping medications to fall asleep.

In all four mentioned subscales, the results of the Wilcoxon statistical tests in Table 2 indicated significant changes. These findings are consistent with those of previous studies conducted by Afonso et al. [5], Kapo Wong et al. [3], and Anna Dahlgr et al. [1].

According to studies, poor sleep quality can lead to mental health issues such as paranoia, hallucinations, anxiety, and depression [13]. The current study findings indicate that stress levels increased by 23.3% in the moderate to extremely severe categories over time. This increase can be attributed to the high workload, mental burden, and lack of workers' sleep [14]. Hsu et al. [35] found in their study that long working hours increase mental and work-related stress, which is consistent with the results of this study. However, Lee et al.'s [36] study suggested that working more than 45 hours per week reduces the risk of psychological stress. Nevertheless, the positive correlation between overtime and stress is apparent in various cultures [7].

On the anxiety scale, there was a 16.4% increase in the severe and extremely severe categories. Signs of increased anxiety among workers can be associated with dry mouth, difficulty breathing, trembling, fear, and an elevated heart rate [37]. Compared to people who do not have sleep disorders, those who experience sleep problems and insomnia are more likely to experience physical discomfort, psychological discomfort, and anxiety in life [33]. Marital status also exacerbates this issue [33].

In the depression subscale, there was a 23.5% increase in the moderate to extremely severe category after overtime, which is consistent with the study by Amagasa et al. [38]. The increase in depression after overtime among workers leads to difficulty in relaxing, not experiencing positive emotions, not making progress at work, feeling discouraged and heartbroken, lacking enthusiasm, and feeling worthless and meaningless in life.

The Wilcoxon test (Table 3) indicates a statistically significant increase in stress, anxiety, and depression following overtime work. Overtime work reduces the duration of sleep, leading to heightened levels of stress, anxiety, and depression [1]. Studies by Nagashima S et al. [39], Afonso et al. [5], and Virtanen M et al. [40] support these findings.

Kim et al. [41] and Virtanen et al. [42] reported that rates of anxiety and depression were lower among workers who worked up to 52 hours per week compared to those who worked less than 40 hours per week. This contradicts the findings of this study. Nishikitani et al. [43] stated that overtime does not directly cause mental health disorders, but other factors such as demographic variables and work psychological characteristics may have been inaccurately linked to overtime. Additionally, Hobson and Beach [44] found that perceived workload to working hours is associated with mental health, which differs from the present study's findings.

Additionally, the results indicate that occupational fatigue increased by 36.4% in the high category. According to the Wilcoxon test, this change is statistically significant after overtime work compared to before. This suggests that as working hours increase, occupational fatigue also increases, especially among workers with rotating shifts. Long working hours or overtime, by reducing the duration of sleep, leads to increased fatigue among workers, aligning with previous studies [1, 3]. Richter et al. [45] concluded that shift workers experience job fatigue due to irregular sleep patterns and overtime work. This aligns with the findings of the present study.

In the subscale of chronic fatigue, acute fatigue, and inter-shift recovery after overtime work, the mean values increased to 6.08, 3.13, and 2.46, respectively, compared to before. According to the Paired-Sample T-test and Wilcoxon test in Table 4, all three fatigue subscales above show significant changes after overtime work. These increases indicate that, due to the short time between shifts, workers still feel extremely tired from the previous shift, and their fatigue has not been resolved, with insufficient recovery.

The study's sample size of 85 workers from the food industry is relatively small, which may limit the generalizability of the findings to other populations or industries. The specific characteristics of the food industry and its workers may not fully represent workers' experiences in different sectors. Another limitation of this study is its focus on examining the effects of overtime on sleep quality, occupational fatigue, depression, anxiety, and stress. Without considering other factors that could influence these outcomes, such as individual differences, work environment, and personal circumstances. Considering these factors can contribute to a more comprehensive understanding of the relationship between overtime and the variables under study.

Conclusion

Long working hours or overtime among industrial workers with rotating shifts can lead to problems with sleep quality, occupational fatigue, stress, anxiety, and depression in approximately one-third of these workers. Therefore, managing overtime related to work shifts is crucial to eliminate fatigue, restore workers' energy for other activities, enhance their alertness, and ensure good sleep quality without relying on sleeping medications. This includes addressing psychological issues like anxiety and confusion, as well as reducing overall stress, anxiety, and depression among these workers.

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Conflict of interest

None declared.

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Ethical Considerations

Participant information was kept confidential. All participants voluntarily participated in the study.

Code of Ethics

This study received ethical approval from the Qazvin University of Medical Sciences Ethics Committee with the code IR.QUMS.REC.1401.327.

Authors' Contributions

Faeze Dehghan Banadaki: conceived the idea, collected data, and conducted the analysis. Sakineh Varmazyar: oversaw the data collection and analysis, verifying the methodology. Both Faeze Dehghan Banadaki and

Sakineh Varmazyar collaborated on drafting, writing, and editing the manuscript. Both authors have reviewed and approved the publication of this manuscript.

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