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Impact of Workplace Exercise Movements on the Seven Subscales of the Pittsburgh Sleep Quality Index (PSQI) among Rotational Shift Workers

Faeze Dehghan Banadaki [a] | **Sakineh Varmazyar** [b*] | **Ali Safari Variani** [c]

a. Department of Occupational Health Engineering, Student Research Committee, Faculty of Health, Qazvin University of Medical Sciences, Qazvin, Iran.
b. Department of Occupational Health Engineering, Social Determinants Health Research Center and Research Institute for Prevention of Non-Communicable Diseases, Faculty of Health, Qazvin University of Medical Sciences, Qazvin, Iran.
c. Department of Occupational Health Engineering, Faculty of Health, Qazvin University of Medical Sciences, Qazvin, Iran.

***Corresponding author:** Department of Occupational Health Engineering, Social Determinants Health Research Center and Research Institute for Prevention of Non-Communicable Diseases, Faculty of Health, Qazvin University of Medical Sciences, Qazvin, Iran. Postal Code: 3419759811. E-mail: svarmazyar@qums.ac.ir

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A B S T R A C T

Background: Due to the increasing demand for production, shift work has become necessary. However, shift workers often experience decreased sleep quality due to misalignment between their working hours and physiological rhythms. This study aims to investigate the impact of workplace exercise on the sleep quality of rotational shift workers.
Methods: This interventional study involved 164 production line shift workers, who were divided into two groups: an experimental group (n = 82) and a control group (n = 82). Data were collected using a demographic questionnaire and the Pittsburgh Sleep Quality Inventory (PSQI). The experimental group engaged in corrective exercises conducted within the workplace for two 10-minute sessions per day, six days a week for eight weeks. Following the intervention, PSQI questionnaires were re-administered to both groups.
Results: The results indicated that after the workplace exercise intervention, the sleep quality of rotational shift workers in the experimental group improved by 7.3%, while it decreased by 28.1% in the control group. Additionally, the exercise intervention significantly reduced sleep latency ($Z = -3.47$, $P < 0.001$) and sleep disturbance ($Z = -2.9$, $P < 0.001$), while enhancing sleep efficiency ($Z = -2.34$, $P \leq 0.01$).
Conclusion: Implementing workplace exercise interventions with supervisors and in groups can enhance sleep quality among rotational shift workers leading to reduced sleep latency and disturbances.

1. Introduction

In response to the growing need for productivity and the prevalence of continuous work schedules, there has been a significant rise in the number of employees engaged in rotating shifts worldwide (Lim et al., 2020). Shift work has been linked to negative consequences on individuals' well-being (Flahr et al., 2018; Park & Suh, 2020). Studies have shown that shift workers with prior experience in such schedules are 40% more likely to experience adverse effects compared to those with limited experience (Brown, 2019). Approximately 50% of the global labor force is involved in shift work (Flahr et al., 2018). Shift workers often face irregular sleep patterns due to the necessity of working during hours that do not align with their inherent physiological or social circadian rhythm. These circumstances result in a gradual accumulation of sleep deprivation (Park & Suh, 2020). Furthermore, the sleep

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quality of shift workers may decline as wakefulness increases, eventually leading to fatigue (Wahyu et al., 2020). Research findings have demonstrated that engaging in physical exercise can improve the quality and duration of sleep while also reducing the occurrence of sleep disorders. Furthermore, moderate exercise can enhance overall health and sleep quality. It is important to note, however, that excessively strenuous exercise can delay the onset of sleep, disrupt the entire sleep period, and negatively impact sleep patterns (Kredlow et al., 2015; Park & Suh, 2020; Talbot et al., 2014; Wang & Boros, 2021). The level of physical activity that individuals engage in during their work environment and daily routines has been shown to improve the overall well-being and psychological state of employees, as demonstrated by several studies (Badicu, 2018; Díaz-Silveira et al., 2020; Flahr et al., 2018; Wang & Boros, 2021). Given the issues caused by insufficient sleep among shift workers, it is crucial to address this concern. This study aimed to investigate how performing exercise movements in the workplace affects the sleep quality of rotational shift workers.

2. Materials and Methods

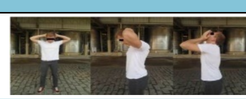
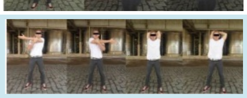
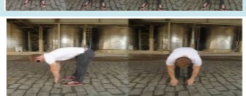
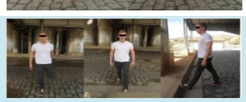
2.1 Participants

This interventional study was approved by the University Ethics Committee (code: IR.QUMS.REC.1400.443). Out of 251 male workers on production lines engaged in shift work in the food industry, 39 did not participate in the study. Nine workers were excluded based on the inclusion criteria, and 39 subjects were excluded according to the exclusion criteria. Finally, 164 workers were divided into two experimental and control groups, each consisting of 82 individuals. The inclusion criteria specified individuals over 18 years of age (Kredlow et al., 2015; Songkham et al., 2019; Yang et al., 2020), working in shift rotations (Martins et al., 2016), employed full-time (Songkham et al., 2019; Yang et al., 2020), and free from any confirmed physical or mental illness (Edimansyah et al., 2008), as assessed through a demographic questionnaire. Exclusion criteria encompassed accidents, changes in job responsibilities, contracting Omicron's disease, missing more than three exercise sessions, and participating in physical exercise daily beyond the research scope (Ezati et al., 2020; Kredlow et al., 2015).

2.2 Demographic and PSQI Questionnaires

The demographic questionnaire included age, height, weight, work experience, and inclusion criteria. The PSQI questionnaire includes seven subscales with each subscale scoring from 0 to 3. (1) Subjective sleep quality (refers to a person's overall description of their sleep), (2) Sleep latency (delay in falling asleep), (3) Sleep duration (refers to the amount of restful sleep a person receives), (4) Sleep efficiency (ability to obtain sufficient sleep), (5) Sleep disturbances (sleep disorders characterized by waking up during the night), (6) Use of sleeping medications and (refers to the quantity of sleeping pills taken), (7) Daytime dysfunction (refers to issues caused by poor sleep that affect a person during the day) (Afonso et al., 2017). The questionnaire comprises a total of 18 questions, with a final score ranging from 0 to 21. A score of 5 and higher indicates poor sleep quality, indicating severe problems in at least two sub-scales or moderate issues in more than three sub-scales (Buysse et al., 1989). Farhi *et al.'s* study found that the internal consistency analysis produced a Cronbach's alpha of 0.77, showing acceptable reliability. Furthermore, the validity assessment results support the Persian version of PSQI as a reliable tool (Farrahi Moghaddam et al., 2012).

Table 1. Examples of exercise protocol (Santos et al., 2016)

No	Exercise	Picture	EL	Week	Set repetition	Rest
1	Stretching for the posterior and anterior cervical muscles		BW	1-8	FS: 20 R SS: 20 R	20 se
2	Stretching for the upper limb muscles		BW	1-8	FS: 20 R SS: 20 R	20 se
3	Stretching for the lower limb		BW	1-8	FS: 20 R SS: 20 R	20 se
4	Stretching for lower limb		BW	1-8	FS: 20 R SS: 20 R	20 se

EL: Exercise Load BW: Body weight FS: First Set SS: Second Set R: Repetitions

2.3 Performing Corrective Exercises in the Workplace

Exercise protocols were developed by sports science experts and were based on scientific articles and books (Santos et al., 2016). Researchers instructed supervisors and line workers in each production hall on sports movements through training videos and pamphlets. Subsequently, supervisors worked with the workers in two 10-minute sessions daily, six days per week, over eight weeks (before work and during the rest period between tasks) (Arslan et al., 2019; Ezati et al., 2020; Rubio-Arias et al., 2017; Santos et al., 2020) in three production halls. The researchers supervised

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the implementation of the exercise protocol. A schedule detailing the days and times of exercise per week was given to the production line supervisors for monitoring, and the researchers checked the records twice a week. According to the planned protocol, each participant did 7 minutes of stretching movements and 13 minutes of strength movements. Workers rotated weekly across the three shifts: 7 a.m. to 3 p.m., 3 p.m. to 11 p.m., and 11 p.m. to 7 a.m. Examples of the exercises are provided in Table 1.

2.4 Statistical analysis

The normality of the data was assessed using a one-sample Kolmogorov-Smirnov test, histogram diagram, skewness, and kurtosis. Wilcoxon and McNemar tests were used to compare the PSQI and subscales of PSQI before and after the intervention in both groups using SPSS version 23.

3. Results and Discussion

3.1 Demographic Information

The mean and standard deviation of age, height, weight, and work experience in the experimental and control groups were reported as 34.91 ± 7.70 years, 175.60 ± 6.43 cm, 74.65 ± 11.04 kg, and 4.90 ± 4.90 years; and 35.13 ± 6.42 years, 174.28 ± 7.59 cm, 78.66 ± 14.23 kg, and 6.80 ± 5.98 years respectively.

3.2 PSQI in experimental and control groups

Figure 1 presents a comparison of the qualitative classification percentages (poor and good) of sleep quality in the experimental and control groups before and after intervention.

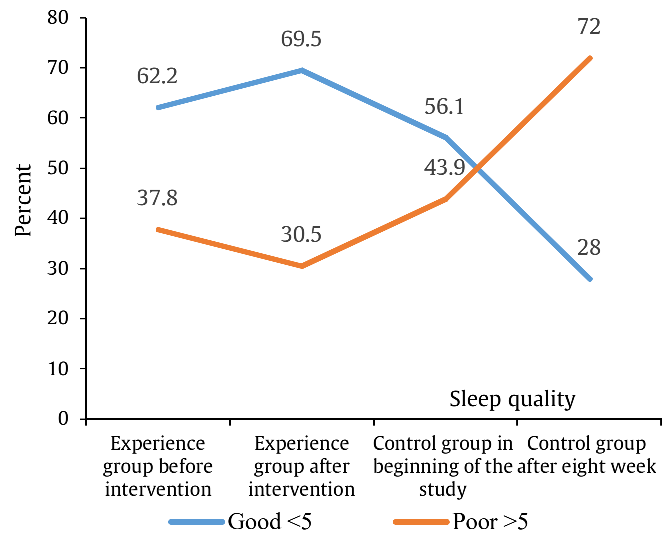

Figure 1. Category of the PSQI (qualitative) in the experimental and control groups of participants before and after the intervention (n = 82)

3.3 Inferential statistics of implementation exercise on PSQI

The investigation of the comparison between the results of the PSQI before and after is statistically significant in the control group. Additional information regarding the comparison of the results of the sub-scales of the PSQI is provided in Table 3.

Table 2. The frequency and percentage of sub-scales of the PSQI in both groups (n = 82) of shift workers

Variables	Category	Subscales of the PSQI			
		Before intervention		After intervention	
		Excremental group Frequency (Percent)	Control group Frequency (Percent)	Excremental group Frequency (Percent)	Control group Frequency (Percent)
Subjective sleep quality	Very good	19 (23.2)	10 (12.2)	19 (23.2)	8 (9.8)
	Fair good	39 (47.6)	44 (53.7)	40 (48.8)	33 (40.2)
	Relatively poor	16 (19.5)	20 (24.4)	14 (17.1)	28 (34.1)
	Very poor	8 (9.8)	8 (9.8)	9 (11.0)	13 (15.9)
Sleep latency	Very good	16 (19.5)	21 (25.6)	36 (43.9)	18 (22.0)
	Fair good	43 (52.4)	40 (48.8)	33 (40.2)	45 (54.9)
	Relatively poor	21 (25.6)	16 (19.5)	11 (13.4)	16 (19.5)
	Very poor	2 (2.4)	5 (6.1)	2 (2.4)	3 (3.7)
Sleep duration	Very good	46 (56.1)	36 (43.9)	38 (46.3)	14 (17.1)
	Fair good	22 (26.8)	32 (39.0)	26 (31.7)	25 (30.5)
	Relatively poor	13 (15.9)	9 (11.0)	18 (22.0)	27 (32.9)
	Very poor	1 (1.2)	5 (6.1)	0 (0)	16 (19.5)
Sleep efficiency	Very good	69 (84.1)	70 (85.4)	59 (72.0)	62 (75.6)
	Fair good	12 (14.6)	12 (14.6)	15 (18.3)	12 (14.6)
	Relatively poor	0 (0)	0 (0)	4 (4.9)	6 (7.3)
	Very poor	1 (1.2)	0 (0)	4 (4.9)	2 (2.4)
Sleep disturbances	Very good	5 (6.1)	3 (3.7)	16 (19.5)	0 (0)
	Fair good	57 (69.5)	72 (87.8)	53 (64.6)	62 (75.6)
	Relatively poor	19 (23.2)	7 (8.5)	13 (15.9)	20 (24.4)
	Very poor	1 (1.2)	0 (0)	0 (0)	0 (0)
Use of sleeping medications	Very good	82 (100)	82 (100)	78 (95.1)	78 (95.1)
	Fair good	0 (0)	0 (0)	2 (2.4)	1 (1.2)
	Relatively poor	0 (0)	0 (0)	2 (2.4)	3 (3.7)
	Very poor	0 (0)	0 (0)	0 (0)	0 (0)
Daytime dysfunction	Very good	35 (42.7)	28 (34.1)	41 (50.0)	14 (17.1)
	Fair good	34 (41.5)	31 (37.8)	35 (42.7)	39 (47.6)
	Relatively poor	10 (12.2)	18 (22.0)	5 (6.1)	28 (34.1)
	Very poor	3 (3.7)	5 (6.1)	1 (1.2)	1 (1.2)

Table 3. The results of comparing the PSQI and subscales of PQSI among participants in the experimental (n = 82) and control (n = 82) groups based on McNamar and Wilcoxon tests

PQSI (McNamar test)							
Variable	Measure time	Experimental group			Control group		
		Chi-square	P	Normality	Chi-square	P	Normality
PQSI	BI AI	0.83	0.36	0.00	10.75	0.00	0.00

Subscales of PQSI (Wilcoxon test)									
Variables	Measure time	Experimental group				Control group			
		Mean Rank	Z	P	Normality	Mean Rank	Z	P	Normality
Subjective sleep quality	BI AI	18.00 18.00	-0.154	0.87	0.00	29.65 30.22	-1.58	0.11	0.00
Sleep latency	BI AI	27.58 25.39	-3.47	0.00**	0.00	24.73 26.33	-0.05	0.95	0.00
Sleep duration	BI AI	22.84 23.96	-1.23	0.21	0.00	23.54 30.46	-4.40	0.00**	0.00
Sleep efficiency	BI After intervention	10.88 14.67	-2.34	0.01**	0.00	11.50 17.82	-2.29	0.02*	0.00
Sleep disturbances	BI AI	16.70 14.00	-2.90	0.00**	0.00	12.50 12.50	-3.26	0.00**	0.00
Use of sleeping medications	BI AI	0.00 2.50	-1.85	0.00**	0.00	0.00 2.50	-1.89	0.05*	0.00
Daytime dysfunction	BI AI	27.07 22.24	-1.54	0.122	0.00	26.79 27.95	-1.67	0.09	0.00

*$p \leq 0.05$, ** $p \leq 0.001$ * Normality > 0.05 BI: Before intervention AI: After intervention

According to the results in Figure 1, 7.3% of workers in the experimental group showed an improvement in good sleep quality after the exercise intervention, although this change was not statistically significant. In contrast, the good sleep quality decreased by 28.1% in the control group, which was statistically significant as shown by the McNemar test (Table 3). Possible reasons for these results could be the long working hours of the workers compared to pre-intervention period, increased stress due to the rise in COVID-19 Omicron cases, variable work shifts, and the impact of exercise timing on sleep quality and changes in body temperature during different shifts. However, a complex array of physiological and psychological factors may have contributed to these results (Arslan et al., 2019; Buman & King, 2010; Ezati et al., 2020; Kredlow et al., 2015; Ots et al., 2021). The release of endorphins, which leads to reduced stress levels, can improve relaxation sleep and regulate circadian rhythms. This, in turn, can help facilitate a faster onset of sleep. Furthermore, exercise promotes the release of serotonin and norepinephrine, which play a role in regulating mood. This effect can contribute to a reduction in sleep latency and an improvement in sleep maintenance (Alnawwar et al., 2023). Based on national recommendations, engaging in at least 150 minutes per week of moderate-intensity aerobic exercise or at least 75 minutes per week of vigorous aerobic physical activity can improve sleep quality. However, in the current study, meeting these exercise guidelines was challenging due to the diverse working conditions and varying shifts within the industry. This lack of exercise time could explain the minimal improvement in sleep quality observed in the experimental group (Arslan et al., 2019; Buman & King, 2010). The results of this study, which found no statistical significance between exercise and sleep quality align with the studies conducted by Oates *et al.* (Ots et al., 2021) and Arslan *et al.* (Arslan et al., 2019). However, these results contradict the findings of Rubio-Arias *et al.* (Rubio-Arias et al., 2017) and Ezati *et al.* (Ezati et al., 2020). This difference could be attributed to various factors such as the population studied, different age groups, types of exercise, durations of exercise, intensity of training, working conditions, and light conditions in the work environment. Based on the results in Table 2 and the Wilcoxon test in Table 3, the subscales of sleep latency and sleep disturbances showed improvement in the experimental group. Specifically, there was a 24.4% improvement in the "very good" category for sleep latency and a 13.4% improvement in the "very good" category for sleep disturbances. This means that participants in the experimental group reported taking less than 15 minutes to fall asleep and experiencing fewer nighttime awakenings and disturbed dreams. Previous studies have demonstrated that engaging in moderate-intensity physical activities can reduce sleep latency and decrease the frequency of nighttime awakenings (Alnawwar et al., 2023). According to the results, the mean rank of daytime dysfunction decreased. This indicates that rotation shift workers, after exercising, no longer have as much trouble staying awake to perform daily activities as they did before the intervention and can engage in their daily tasks with interest. Based on the results of the Wilcoxon test (Table 3), there was no improvement in the sub-scales of sleep duration, sleep efficiency, and use of sleeping medications in the experimental group. This lack could be attributed to forced overtime and long working hours in the organization (Leitaru et al., 2019; Wang & Boros, 2019). In line with the present study, Kredlow *et al.* also concluded that regular exercise can improve all PSQI subscales, except for sleeping medications. However, its effects on total sleep time and sleep efficiency were minimal (Kredlow et al., 2015). According to Table 2, the experimental group experienced a 9.8% decrease in the subscale of sleep duration specifically in the category of very good after exercise. This decrease in sleep duration impacts sleep efficiency, leading to a significant decrease in sleep efficiency in the experimental group as shown in Table 3. This indicates that the duration of time workers spend sleeping in bed has decreased.

4. Conclusion

Based on the results, it was found that performing exercises in the workplace under supervision and in a group can improve the sleep quality of rotating shiftwork workers. In addition, the subscales of sleep latency and sleep disturbances were decreased.

Authors' Contributions

Faeze Dehghan Banadaki: Project administration; Writing-original draft. Ali Safari Variani: Methodology; Investigation. Sakineh Varmazyar: Supervision; Data curation; Writing-review & editing.

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Conflicts of Interest

The authors declare they have no conflict of interest.

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Ethical considerations

All ethical principles are considered in this article. The participants were informed of the purpose of the research and its implementation stages. They were also assured of the confidentiality of their information. Participants had the freedom to withdraw from the study at any time, and if desired, the research results would be made available to them. Written consent was obtained from all participants. This study was approved by the Ethics Committee of the University of (Qazvin University of Medical Sciences) (Code: IR.QUMS.REC.1400.443).

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