

Investigating the Effect of a Fatigue Management Program on Daytime Alertness among Emergency Nurses: An Interventional Study

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Received: 01 Nov. 2023 Accepted: 01 Dec. 2023

Abstract

Background and Objective: Shift work can lead to irregular circadian rhythms, sleep loss, and fatigue. This study aimed to determine the effect of a fatigue management program on the alertness of emergency nurses.

Materials and Methods: This quasi-experimental study was conducted among emergency nurses at an educational hospital in Mashhad City, Iran. All participants completed the Depression, Anxiety, and Stress Scale (DASS), the Karolinska Sleepiness Scale (KSS), and the Swedish Occupational Fatigue Inventory (SOFI), and underwent the Psychomotor Vigilance Test (PVT) before and after the intervention. The intervention included optimizing the shift schedule to a fast-rotating clockwise system with one day off after each night shift. In a one-day pre-intervention workshop, nurses were trained to take 2-hour naps during the night shift and to drink coffee at a recommended dose equivalent to 50-150 mg of caffeine. Environmental light exposure was optimized using an adjustable light box. Data were analysed using SPSS software.

Results: The study cohort comprised 25 participants, with a mean age of 30.88 ± 5.75 years, of whom 16(64%) were men. Two dimensions of SOFI (indifferent and uninterested) showed a significant improvement after the intervention ($P = 0.027$ and $P = 0.016$, respectively). The mean reaction time on the PVT did not differ significantly before and after the intervention ($P = 0.70$).

Conclusion: Optimizing the shift schedule and implementing a fatigue management program alone did not significantly improve alertness. Other contributing factors, such as sleep-wake behavior on non-working days, second-job status, and personal habits, should also be addressed.

Keywords: Fatigue; Psychomotor performance; Shift work schedule; Circadian rhythm sleep disorder

Citation: Afshari Saleh L, Dehghani Z, Zakeri H. Investigating the Effect of a Fatigue Management Program on Daytime Alertness among Emergency Nurses: An Interventional Study. *J Sleep Sci* 2023; 8(3-4): 90-98.

Introduction

According to published statistics, 25% of the total workforce are shift workers (1). With the growing global population and the increasing need for services and industrialization, the prevalence of shift work is expected to continue rising. Given its effects on employee health and safety, as well as on production and productivity, this

issue warrants greater attention (1).

Shift work affects both sleep duration and sleep quality, establishing sleep disturbances as a highly prevalent complaint among shift workers. Studies have shown that approximately 62% of night shift workers experience sleep disorders (2), although the body's response to shift work appears to vary among individuals with different genetic profiles (3). On average, night shift workers experience 5 to 7 hours of sleep deprivation per week (4).

Sleep deprivation has wide-ranging effects on performance, including impairments in cognition,

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emotional regulation, safety, interpersonal relationships, and judgment (5). Studies have consistently demonstrated that sleep deprivation prolongs response times on the Psychomotor Vigilance Test (PVT) and increases the number of lapses, which are thought to reflect microsleeps (6). It has been estimated that moderate to severe sleep deprivation can impair cognitive and motor function to a degree comparable with a blood alcohol concentration of 0.1%. Fatigue in work environments arises not only from disruptions to individuals' circadian rhythms and sleep but also from work-related pressures such as task complexity, intensity, and duration (7).

Fatigue is a state that develops during a work period, characterized by reduced mental and physical capacity and willingness to work, resulting in decreased efficiency (8). Akerstedt et al. described fatigue as resulting from a combination of sleep disorders, high work pressure, excessive work demands, low social support, female gender, older age, and holding a supervisory or managerial role (9). Fatigue can affect a person's dynamism, productivity, performance, and decision-making, and can lead to cognitive impairment, errors, and accidents (10). Previous research has shown that increased fatigue is associated with reduced concentration and a higher rate of errors (11). Among medical staff, fatigue increases the frequency and severity of medical errors, thereby reducing the safety and quality of patient care. Attention to personal and occupational risk factors, together with the implementation of appropriate management strategies, can improve patient safety, mitigate the negative consequences of fatigue, and consequently reduce errors (12, 13).

Given these consequences, fatigue management has become an important occupational health priority. The Occupational Safety and Health Administration (OSHA) recommends that a fatigue management program should include several key components: modifications to work schedules, such as limiting extended shifts, ensuring adequate breaks, and guaranteeing sufficient opportunity for sleep; improvements to the work environment, including the optimization of lighting, temperature, and air quality, to promote alertness and reduce stress; effective management of staffing and workload; and designated rest areas that provide quiet, private spaces for recovery, particularly in high-risk or isolated settings (14).

Emergency nurses need special attention due

to the stressful nature of their work and the need for high alertness while providing services. However, it is usually less feasible to implement shift optimization programs due to the lack of resources or ignorance of methods to prevent fatigue and sleepiness. Limited studies have examined the effectiveness of fatigue management interventions in this occupational group. Addressing this gap, the present study aims to investigate the effect of fatigue management on daytime alertness among emergency nurses of an educational hospital in Mashhad City, Iran.

Materials and Methods

This quasi-experimental study was conducted at an educational hospital affiliated with Mashhad University of Medical Sciences, in 2019. The study protocol was approved by the regional ethics committee (ethics code: IR.MUMS.REC.1397.321). Inclusion criteria were current employment as an emergency nurse with a rotating or night shift schedule for at least one year and an average of at least 6 night shifts per month during the previous year. Exclusion criteria were psychiatric illness, chronic physical illness, and use of medications affecting sleep.

The required sample size was calculated as 26 participants using PASS software, based on the non-parametric Wilcoxon test, with a power of 90%, a Type I error rate of 5%, a standard deviation (SD) of 45, and a minimum detectable difference of 30 units. One participant withdrew during the study, resulting in a final sample of 25 participants.

After obtaining informed consent, all participants completed the following instruments: a demographic and clinical checklist (including age, sex, education level, employment history, work shift pattern, smoking status, and medical and medication history); the Persian version of the Swedish Occupational Fatigue Inventory (SOFI) (14, 15); the single-item Karolinska Sleepiness Scale (KSS) (16, 17); and the 21-item Depression, Anxiety, and Stress Scale (DASS-21) (18, 19). In addition, the PVT was administered during the first 24 hours of the one-month intervention period to assess attention and alertness. The PVT is a computer-based test that measures alertness on a second-by-second basis and is sensitive to both sleep deprivation and time of day (20, 21). Participants were instructed to respond to a digital signal via a computer terminal by pressing a key, with both errors of omission and commission

being recorded. The primary outcome of the PVT was reaction time (22), with mean reaction time, number of performance lapses (reaction time exceeding 500 ms), failures to respond, median reaction time, and the fastest and slowest 10% of reaction times considered the most sensitive measures of fatigue (23, 24).

The intervention was performed as a fatigue management program for all participants. For this purpose, a one-day workshop was held and facilitated by the researcher, covering sleep hygiene training, fatigue management, and stress control. Following the educational phase, all participants were informed of the changes to the work schedule, and shifts were reorganized according to the optimal schedule, consisting of rapid clockwise rotation. Nurses were instructed to take a break after night shifts, and during each work shift, a 2-hour nap and breaks for coffee consumption (equivalent to 50-150 mg of caffeine) were considered. Environmental light and the physical conditions of the nurses' station were optimized using an adjustable light box. Accordingly, after completing their nap, the nurses were exposed to bright light from a light box installed in a designated area of the nursing station. The average duration of light exposure was approximately 3 hours per nurse.

This fatigue management program was implemented over one month for all study participants. At the end of this period, each participant was asked to complete SOFI and KSS again. In addition, the PVT was administered during the first 24 hours of the program (on the first day) and again during the first 24 hours after completion of the one-month intervention. PVT assessments were conducted at the same time of day (at the start of the shift), before and after the intervention to minimize the circadian effect.

After all participant information had been recorded, data collection and extraction processes were completed. The data were then entered into SPSS software (version 22, IBM Corporation, Armonk, NY, USA) for statistical analysis. Kolmogorov-Smirnov test was used to assess the normality of data distribution. Independent sam-

les t-test or Mann-Whitney U test and chi-square test or Fisher's exact test were used for comparisons between two groups. Paired samples t-test or Wilcoxon signed-rank test was used to compare the changes during the study.

Results

A total of 26 emergency department nurses were initially enrolled in the study. One participant was excluded before the second assessment due to personal reasons related to lifestyle that prevented continued participation, resulting in a final sample of 25 nurses. Among the participants, 16 (64%) were men and 9 (36%) were women, with a mean age of 30.88 ± 5.74 years. Other background characteristics of the participants are presented in table 1.

Table 1. Background characteristics of the participants at the beginning of the study (n = 25)

Characteristics	Value
Age (year)	30.88 ± 5.74
Employment history (year)	6.38 ± 5.46
Gender	Men 16 (64.0)
	Women 9 (36.0)
Educational level	Bachelor's 24 (96.0)
	Master's 1 (4.0)
Smoking	Yes 3 (12.0)
	No 22 (88.0)
Work shifts	Night 2 (8.0)
	Rotating 23 (92.0)
Drug taking	Yes 3 (12.0)
	No 22 (88.0)

Data are presented as mean $\pm$ standard deviation (SD) or n (%).

Depression, anxiety, and stress were assessed using the DASS-21 scale, and the results are presented in table 2. The mean total DASS-21 score was 29.20 ± 16.63 , with mean scores of 10.16 ± 7.76 for depression, 6.32 ± 5.52 for anxiety, and 12.72 ± 6.82 for stress. Most nurses scored within the normal range for depression (56%) and anxiety (64%), whereas only 40% scored within the normal range for stress (Table 2).

On the PVT, mean, minimum, and maximum reaction times did not differ significantly before and after the intervention (Table 3).

Table 2. Assessment of depression, anxiety, and stress levels

Criteria	Depression	Anxiety	Stress
Score	10.16 ± 7.76	6.32 ± 5.52	12.72 ± 6.82
Intensity	Normal 14 (56.0)	16 (64.0)	10 (40.0)
	Mild 2 (8.0)	2 (8.0)	10 (40.0)
	Moderate 7 (28.0)	5 (20.0)	5 (20.0)
	Severe 1 (4.0)	2 (8.0)	-
	Very severe 1 (4.0)	-	-

Data are presented as mean $\pm$ standard deviation (SD) or n (%).

Table 3. Results of reaction time in Psychomotor Vigilance Test (PVT), Swedish Occupational Fatigue Inventory (SOFI) indices, and occupational fatigue severity before and after the intervention

Variable		Before intervention	After intervention	P-value*
Reaction time*	Mean	315.20 ± 42.28	321.48 ± 78.16	0.797
	Minimum	209.08 ± 29.60	208.64 ± 28.47	0.637
	Maximum	868.40 ± 421.26	892.44 ± 561.82	0.778
SOFI questionnaire*	Palpitation	2.44 ± 2.39	2.96 ± 3.03	0.164
	Lack of concern	3.96 ± 2.92	4.44 ± 2.34	0.299
	Burnout	5.60 ± 3.08	5.56 ± 2.75	0.616
	Tense muscles	4.44 ± 3.16	4.54 ± 2.68	0.734
	Falling asleep	2.84 ± 3.00	2.44 ± 2.38	0.548
	Numbness	2.88 ± 2.60	2.76 ± 2.36	0.730
	Sweating	3.48 ± 3.39	3.00 ± 2.78	0.459
	Spent	4.92 ± 2.48	5.08 ± 3.05	0.827
	Drowsy	5.12 ± 2.84	5.28 ± 2.99	0.440
	Passive	3.80 ± 2.78	4.40 ± 2.81	0.263
	Stiff joints	3.28 ± 3.00	3.32 ± 2.54	0.897
	Indifferent	2.54 ± 2.73	3.84 ± 2.67	0.027
	Out of breath	2.88 ± 2.65	3.12 ± 2.65	0.930
	Yawning	5.16 ± 3.00	4.84 ± 3.07	0.496
	Drained	6.48 ± 2.66	6.12 ± 2.84	0.529
	Sleepy	6.04 ± 3.00	5.64 ± 2.88	0.386
	Overworked	5.67 ± 3.00	6.56 ± 2.88	0.302
	Aching	4.56 ± 3.25	4.36 ± 3.06	0.954
	Breathing heavily	2.64 ± 2.54	3.32 ± 2.85	0.103
	Uninterested	4.32 ± 2.76	5.48 ± 3.17	0.016
Occupational fatigue severity*	Total score	82.28 ± 36.91	83.00 ± 39.07	0.888
	Mild	5 (22.7)	3 (12.5)	0.739
	Moderate	8 (36.4)	14 (58.3)	
	Severe	9 (40.9)	6 (25.0)	
	Very severe	0 (0)	1 (4.2)	

Data are presented as mean ± standard deviation (SD) or n (%).

*Wilcoxon test was used to compare two groups.

SOFI: Swedish Occupational Fatigue Inventory

The mean KSS score was 4.80 ± 2.21 before the intervention and 4.12 ± 2.00 afterward, a difference that

was not statistically significant ($P = 0.282$). Pre- and post-intervention SOFI scores are presented in table 4.

Table 4. Results of Swedish Occupational Fatigue Inventory (SOFI) before and after the intervention

Index	Before intervention	After intervention	P-value*
Palpitation	2.44 ± 2.39	2.96 ± 3.03	0.164
Lack of concern	3.96 ± 2.92	4.44 ± 2.34	0.299
Burnout	5.60 ± 3.08	5.56 ± 2.75	0.616
Tense muscles	4.44 ± 3.16	4.54 ± 2.68	0.734
Falling asleep	2.84 ± 3.00	2.44 ± 2.38	0.548
Numbness	2.88 ± 2.60	2.76 ± 2.36	0.730
Sweating	3.48 ± 3.39	3.00 ± 2.78	0.459
Spent	4.92 ± 2.48	5.08 ± 3.05	0.827
Drowsy	5.12 ± 2.84	5.28 ± 2.99	0.440
Passive	3.80 ± 2.78	4.40 ± 2.81	0.263
Stiff joints	3.28 ± 3.00	3.32 ± 2.54	0.897
Indifferent	2.54 ± 2.73	3.84 ± 2.67	0.027
Out of breath	2.88 ± 2.65	3.12 ± 2.65	0.930
Yawning	5.16 ± 3.00	4.84 ± 3.07	0.496
Drained	6.48 ± 2.66	6.12 ± 2.84	0.529
Sleepy	6.04 ± 3.00	5.64 ± 2.88	0.386
Overworked	5.67 ± 3.00	6.56 ± 2.88	0.302
Aching	4.56 ± 3.25	4.36 ± 3.06	0.954
Breathing heavily	2.64 ± 2.54	3.32 ± 2.85	0.103
Uninterested	4.32 ± 2.76	5.48 ± 3.17	0.016
Total score	82.28 ± 36.91	83.00 ± 39.07	0.888

Data are presented as mean ± standard deviation (SD).

*Wilcoxon test was used to compare two groups.

Of the SOFI dimensions, only two, indifferent and uninterested, showed a significant change after the intervention ($P = 0.027$ and $P = 0.016$, respectively). No significant differences were observed in the remaining dimensions or in the total occupational fatigue score.

Figure 1 presents a box plot comparing the distribution of total occupational fatigue scores (SOFI) before and after the intervention.



Figure 1. Comparison of the total scores on the Swedish Occupational Fatigue Inventory (SOFI) before and after the intervention

Based on the SOFI total score, the severity of occupational fatigue was also classified, with results shown in table 5. No significant difference was found in the distribution of fatigue severity categories before and after the intervention ($P = 0.739$).

Table 5. Comparison of occupational fatigue levels before and after the intervention

Occupational fatigue severity	Before intervention	After intervention	P-value*
Mild	5 (22.7)	3 (12.5)	0.739
Moderate	8 (36.4)	14 (58.3)	
Severe	9 (40.9)	6 (25.0)	
Very severe	0 (0)	1 (4.2)	

Data are presented as n (%).

*Wilcoxon test was used to compare two groups

Table 6. Correlation between the measured variables

Spearman's rho	Age	Employment history	Stress	Anxiety	Depression	Pre PVT	Post PVT	Pre SOFI	Post SOFI	Pre KSS	Post KSS
Age	1	0.950**	0.218	-0.037	0.307	-0.079	0.036	-0.373	-0.034	-0.232	-0.164
Employment history	0.950**	1	0.135	-0.194	0.222	-0.084	0.001	-0.445*	-0.100	-0.269	-0.190
Stress	0.218	0.135	1	0.643**	0.455*	0.213	0.079	0.379	0.440*	0.324	0.273
Anxiety	-0.037	-0.194	0.643**	1	0.561*	-0.118	0.060	0.447*	0.330	0.316	0.288

*P-value ≤ 0.05 ; Spearman correlation test was used to calculate the correlation.

**P-value ≤ 0.001

KSS: Karolinska Sleepiness Scale; PVT: Psychomotor Vigilance Test; SOFI: Swedish Occupational Fatigue Inventory

Table 6 presents the correlations among the quantitative variables measured in the study. Significant correlations were observed between employment history and pre-intervention occupational fatigue ($r = 0.445$, $P = 0.038$); post-intervention stress and post-intervention occupational fatigue ($r = 0.440$, $P = 0.031$); anxiety and pre-intervention occupational fatigue ($r = 0.447$, $P = 0.037$); depression and pre-intervention sleepiness ($r = 0.478$, $P = 0.016$); post-intervention PVT score and post-intervention occupational fatigue ($r = 0.436$, $P = 0.033$); and pre-intervention occupational fatigue and pre-intervention sleepiness ($r = 0.544$, $P = 0.009$).

Discussion

In this study, a total of 25 emergency department nurses participated, most of whom were men and relatively young (mean age: approximately 30 years). While depression (56%) and anxiety (64%) levels were within normal limits for most participants, only 40% demonstrated normal stress scores. The reaction time obtained from the PVT did not differ significantly between pre- and post-intervention assessments. Among the SOFI indices, only two indices, indifferent and uninterested, showed significant differences; all other SOFI indices, including the total occupational fatigue score, remained statistically unchanged. Similarly, based on the KSS, the mean score of nurses' sleepiness showed no statistically significant variations between the pre- and post-intervention periods.

Numerous studies have examined occupational fatigue and sleepiness across various professions.

Healthcare workers, particularly nurses, work in high-stress clinical environments that warrant special attention. For example, a study involving approximately 400 nurses reported that most participants worked shifts longer than 12 hours, often extending beyond their scheduled duration.

Such prolonged duty cycles, along with weekly working hours surpassing 40, were associated with a substantial increase in the risk of work-related errors (25). These findings underscore the importance of shift-length and schedule management for maintaining patient safety within the healthcare system (25).

In a 2019 study of 14 Italian nurses with rotating shifts, Di Muzio et al. found that sleepiness, assessed by the KSS, was significantly higher during night shifts; conversely, psychomotor performance, measured via the PVT, was significantly lower (13).

In a cross-sectional study involving 112 nurses in Kermanshah City, Iran, Yarmohammadi et al. used the SOFI to assess occupational fatigue. The results indicated that 67.9% of nurses had mild-to-moderate fatigue, 23.2% had severe fatigue, and 8.9% had very severe fatigue. Fatigue was more severe among men and married nurses, as well as among those with a master's degree, those working evening or night shifts, those holding a second job, and those reporting dissatisfaction with their occupation or colleagues (15).

In the present study, at baseline (before the intervention), approximately 59% of participants had mild-to-moderate occupational fatigue and 41% had severe fatigue, indicating a higher prevalence of severe fatigue among our participants compared with that in the study by Yarmohammadi et al. (15). In addition, pre-intervention occupational fatigue in our study was inversely correlated with employment history and positively correlated with anxiety; these associations were not examined in the aforementioned study.

In another study, Tanaka et al. conducted a randomized crossover trial in 2011 involving 61 nurses working 12-hour rotating shifts, including night shifts. Participants were exposed to bright light for 10 minutes daily over one month. Compared with the control period, during which participants did not receive light exposure, one month of light exposure was associated with a significant improvement in sleepiness, measured by the KSS, and in reaction time, measured via the PVT (26).

While the randomized controlled design of the study by Tanaka et al. (26) allowed for a more rigorous comparison between intervention and control periods, our single-group pre-post design precludes a direct comparison. Nonetheless, contrary to our findings, the aforementioned study

reported a significant effect of environmental light exposure on sleepiness and psychomotor vigilance scores among nurses. This discrepancy may be attributable to several factors, including the difference in study design, the smaller sample size in our study, the shorter daily light exposure used in the former study (10 minutes) compared with the longer exposure applied in ours (approximately 3 hours per shift), and the fact that our intervention combined multiple components (shift restructuring, napping, caffeine intake, and light exposure) rather than isolating the effect of light alone.

Zamanian et al. examined the effects of bright light on the circadian rhythm of body temperature, plasma melatonin and cortisol levels, and alertness among 34 shift-working nurses at a university hospital in Shiraz City, Iran. Nurses were exposed to bright light (4500 lux) during the night shift, from 21:15 to 22:00 and from 03:15 to 04:00, for four consecutive weeks. Bright light exposure significantly inhibited nocturnal melatonin secretion, particularly at 02:00, and significantly increased cortisol levels, body temperature, and alertness, along with a significant reduction in sleepiness as measured by the KSS (27).

Unlike the aforementioned study, our findings did not yield statistically significant improvements in sleepiness, fatigue, or psychomotor vigilance. This discrepancy may be due to differences in the intensity and duration of exposure to light. Furthermore, high levels of occupational stress can affect cortisol secretion.

Several studies have examined the effects of environmental light and caffeine on the performance of individuals experiencing sleep deprivation and shift work, and the effectiveness of these interventions has generally been supported. Evidence suggests an additive effect of environmental light and caffeine on nocturnal melatonin secretion and body temperature, possibly through antagonism of adenosine receptors (28, 29). Through this mechanism, these interventions may improve performance during night shifts—an approach reflected in the combined light and caffeine components of the fatigue management program used in the present study (28, 29).

In a similar intervention study published in 2006, Smith-Coggins et al. examined the effect of a 40-minute nap at 03:00 on the cognitive and psychomotor functions of 49 physicians and nurses who worked 12-hour shifts for three consecutive nights. The results of the intervention were

evaluated before, during, and after the shift, using tests such as the PVT in the intervention and control groups (without short sleep), and it was found that 90% of the intervention group successfully achieved an average sleep duration of approximately 25 minutes. At the end of the shift, analysis revealed that people in the intervention group reported significantly fewer functional errors, less fatigue and sleepiness, and greater physical strength. In addition, the speed and accuracy of the intervention group were significantly higher than those of the control group (30).

These results are not directly comparable with our findings due to differences in study design; however, they were generally inconsistent with our results, because the effects of intervention among nurses in our study were not obvious or statistically significant. This discrepancy may be attributed to the differences in sample size, criteria used to assess fatigue and sleepiness, and intervention type, as well as fixed work shifts in the aforementioned study compared with rotating shifts in our study.

In a study published in 2009, Borges et al. examined the effect of napping while working on the sleepiness of nurses who worked 12-hour night shifts over two 4-day periods. The nurses slept an average of 138 minutes during the shifts. The results showed that the KSS score was significantly lower when a nap occurred in the first half of the night (1:00 to 3:00) or the second half of the night (3:00 to 6:00) than when nurses had no nap during the shift. In addition, nurses who slept for a short time during the shift had a significantly lower demand for compensatory sleep after the shift (31). Although the findings of this study were different from our study, they can generally indicate the effectiveness of short naps during night shifts in reducing sleepiness.

The results of our study, which assessed the effects of different interventions on nurses at the same time, did not show a significant effect on sleepiness, fatigue, and psychomotor vigilance, unlike the abovementioned study. This difference may be due to differences in sample size, intervention type, and individual characteristics of nurses.

In a cohort study conducted by Saadat et al., twenty-three nurses who had a night shift schedule with a 3-hour nap and 24 day-shift nurses working in a hospital in Tehran City, Iran, were surveyed. The results showed that the rate of occupational fatigue according to the SOFI criterion

was not significantly different before and after the shift. However, according to Stanford Sleepiness Scale, the rate of sleepiness in night-shift nurses was significantly higher than that in day-shift nurses (32). This study demonstrates that day shifts, even without a three-hour break, cause less fatigue in nursing staff.

In a prospective pilot study, Zion and Shochat examined the effect of scheduled 30-minute naps on drowsiness and cognitive function among 109 female nurses engaged in 8-hour night shifts. For this purpose, each nurse was evaluated across four consecutive nights: two nights without a nap and two nights with a nap. The results indicated that both scheduled naps and caffeine consumption significantly reduced drowsiness levels on the KSS compared to control nights. In addition, the administration of a nap was associated with a significant improvement in cognitive function (33).

Han et al. examined the effect of scheduled workplace naps on nurses' drowsiness. A total of 38 nurses were provided with 30-minute scheduled nap opportunities during their shifts and completed pre- and post-shift diaries assessing sleepiness, fatigue, work demands, work pace, and the quality of nursing care. Drowsiness was also continuously monitored in a subset of 13 nurses using infrared reflectance oculography. Nurses who received scheduled naps reported reduced fatigue on the first night shift, followed by improved nursing care quality on the second night and day shifts. In contrast, nurses who did not nap showed no significant improvement. The frequency of moderate-to-severe drowsiness episodes also decreased among nurses who napped (34). The results of this study also confirmed the effect of naps on improving sleepiness and performance of nurses on the night shift, which was different from our results. These discrepancies may be attributed to variations in intervention timing and shift scheduling. Specifically, the duration of the intervention appears to be a critical factor, suggesting that shorter, more controlled interventions may yield more consistent outcomes.

A key strength of this study is its multidimensional approach, which simultaneously integrated several interventions such as environmental lighting, caffeine administration, optimized shift scheduling, and sleep hygiene protocols, along with the use of several scales to measure fatigue and sleepiness. To the best of our knowledge, such a multifaceted intervention has not been previously im-

plemented in studies conducted on medical professionals and emergency department staff.

One of the limitations of this study was its small sample size. Due to the substantial restrictions on interventions in the emergency department, especially among nurses, changing shift schedules and work environments in this group of healthcare workers is challenging and requires considerable coordination. Therefore, implementing such study designs with a large sample size was difficult. In addition, the quasi-experimental design of the study and the absence of a control group were other limitations of the study. Finally, the inability to fully assess second-job employment and control for its potential effects on nurses' burnout, fatigue, and sleepiness was another limitation. We could not be certain that none of the participants had a second job, as we relied solely on their responses to self-report forms and were unable to independently verify the accuracy of their statements. However, we tried to minimize the potential effects of the second-job employment on the results of this study and reduce the risk of bias as much as possible by including this issue among the exclusion criteria.

Conducting similar studies with larger sample sizes and randomized designs that include a control group allows for more rigorous evaluation of the intervention.

Conclusion

Optimizing work shift schedules and implementing fatigue management programs alone may not be sufficient to improve the level of alertness among shift workers. It is necessary to pay attention to other effective factors such as sleep-wake behaviors on non-working days, second-job status, and personal habits. Adherence to sleep hygiene principles and appropriate adjustment of shifts related to second-job employment may also contribute to improving nurses' alertness and reducing fatigue.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgments

The authors would like to thank Mashhad University of Medical Sciences and all participants for their support and contribution to this study. This study was supported by Mashhad

University of Medical Sciences as part of a specialty residency thesis.

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