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The Effect of Bright Light Intervention on Sleepiness and Oral Temperature of Night Health Care Workers in Hospital: A Clinical Trial Study

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Abstract

Background: Productivity and safety of night shift workers are affected by sleepiness during work. Therefore, interventions to reduce sleepiness are very important. This study was conducted with the aim of determining the effect of light on sleepiness and mouth temperature of hospital night shift workers.
Materials and Methods: This clinical trial study was conducted using light intensity intervention in 140 hospital night shift workers in 2018 with targeted sampling. The Stanford Sleepiness Scale (SSS) was used to determine the sleepiness score. This scale was completed one hour after light interventions at 23 and 1, 3 and 5 in the morning. Also, mouth temperature was measured one hour after starting work at 23, 1, 3, 2, and 4. Finally, the data before and after the intervention were compared and the results were analyzed.
Results: The average sleepiness and mouth temperature were 1.04±2.67 and 36.56±0.13, respectively. The effect of the intervention on sleepiness was significant (P-value <0.001). The correlation between mouth temperature and sleep was significant (0.033, r = 0.22, P-value). The trend of changes in employees' oral temperature was also significant (P-value < 0.001).
Conclusion: The results showed that the light intensity had a significant effect on sleepiness. But there was no significant effect of light intensity on the mouth temperature of employees and there was a significant inverse relationship between sleepiness and mouth temperature.

Keywords: Sleepiness, Shift Work, Iran

Introduction

Shifts are expanding as a result of the need for 24-hour services in many facets of contemporary life [1]. The decrease in attention and wakefulness throughout the day is one of the significant effects of shift employment. Following the reduction of attention, and awakens during daily activities, many damages are caused, including casualties during working in factories, road accidents and reduced quality of products [2]. Research showed that common complaints in people working in industrial or health-care settings that work based on shift work schedule are sleep pattern disorder. Moreover, daytime sleep in these people cannot be qualitatively replaced by nighttime sleep [3] because it disrupts the body's biological clock. The human biological clock has a 24-hour period, which is called the circadian rhythm, which means about one day [4].

The most important factor in regulating human circadian rhythm is sunlight [5]. The real importance of the human biological clock increases when some problems are observed in people with impaired circadian rhythms [6]. Sleepiness can cause problems, such as occupational errors and non-occupational injuries, such as traffic accidents, excessive use of sleeping pills, and physical injuries during sleepiness [7]. It was known that different levels of sleepiness affect people's performance in different ways. Mild sleepiness only causes a slight disruption in social or occupational functions. Moderate sleepiness is associated with accidents during which the person falls asleep, and requires a moderate degree of attention and care, and may cause significant impairment in occupational and social functioning, as well as severe sleepiness, which leads to a wide range of neuropsychological disorders such as depression and irritability, and reducing energy and increasing fatigue [8, 9, 10].

According to the findings of a research by Suzuki et al. on nurses' sleep habits and prior history of occupational accidents, there is a statistically significant link between drowsiness and past 12-month history of occupational accidents [11]. Therefore, maintaining awakens, and reducing sleepiness is important. There are various ways to deal with sleep disorders, including non-pharmacological interventions, such as behavioral interventions, sleep restriction, stimulation control, relaxation techniques, biofeedback, imagination guidance, sleep hygiene, and cognitive techniques [12].

Recently, light was used to adjust the biological clock via the changes in circadian rhythm in shift workers. The control of these rhythms is mediated by light through the retina, and the melatonin system in humans [13]. Bright light therapy has the potential to reduce melatonin and phase-shifter circadian rhythms [14]. The melatonin hormone secreted by the pineal gland increases sleepiness, and decreases performance, suggesting that the synchronization of melatonin secretion peak with the sleep period is beneficial for shift workers [15]. The circadian rhythm is associated with factors, such as body temperature, lung function, secretion of various hormones, etc. Among these variables, body temperature was considered by researchers in terms of its easy measurement [16]. The normal body temperature is not a fixed number but depends on race, sex, temperature measurement location and it is different during the day and night [17].

The maximum and minimum body temperature corresponds to the level of mental alertness of individuals [18]. Results of studies showed that body temperature is lower in the people who work at night, which is led to sleepiness. [19]. The medical staff, including nurses, are among those at risk for insomnia [20]. Occupational accidents are more common in nurses who work at night than those who work in morning, and evening shifts [21, 22]. Considering above-mentioned cases, this study was conducted with the aim of studying the effect of bright light intervention on sleepiness, and oral temperature of staff working at night shift in the hospital.

Materials and Methods

This was a double-blind, crossover intervention study. The statistical population of the study in 2019 was 140 hospital shift staff in Tehran. The sampling method of this study was targeted sampling. After providing information to the hospital's shift staff about the research, the goals and risks, and potential benefits of the study, they were entered into the study with conscious consent, and they could be excluded if they did not wish to cooperate. Night shift workers with at least a year's worth of shift work experience were required to meet the entry criterion, while participants who were over 50 years old and unwilling to continue cooperating with the study were required to leave. This project has received the code of ethics (IR.USWR.REC.1396.77) in University of Social Welfare and Rehabilitation Sciences which has a trial registration number of IRQ201804412039280N1.

The nurses work schedule was as follows: 2 days of morning shift, 2 days of evening shift and 2 days of night shift and they were off for 2 days and this program was repeated. The staff was allowed to have 4 short break times each night for 10 ± 1 min in a room without window with the dimensions of 3 x 4 m.

Due to the fact that the present study is an intervention type, the participants were matched to two groups 1 and 2 based on the same type of work, sex and ages. In the first round of study, group 1 was the intervention group and group 2 was the control group. 70 participants in this study were the intervention group and 70 were the control group. In two night shifts, the intervention team was exposed to bright light during break time, whereas the control group saw regular light. Then measurements were made at predetermined intervals. After 6 days of washout period, the control and intervention groups were interchanged, and the experiment was repeated based on this procedure. Therefore, all 140 people participated in these two stages. Figure 1 schematically shows the study stages.

There were 2 rooms for rest: one with bright light and one with normal light. In a room with normal light, a row of three fluorescent lamps was installed 2 meters apart on the wall of room. Each fluorescent lamp produced white light with a luminosity level of 300-350 lux, which is approximately equal to the average brightness in the workplace. Ten fluorescent lights with three lamps were mounted in two rows on the ceiling of the other room where the light intervention took place. The individuals were exposed to an average of 3,000 to 3,500 lux and were confronted at a one-meter distance between the lights. This much light is preferable, according to earlier research [1].

In the first stage of study, the intervention group entered the room with bright light during all the breaks (ten-minute breaks), and the control group entered the room with normal light. In the second stage of the study, two groups switched rooms, and in this stage, Group 2 was the intervention group and Group 1 was the control group.

Stanford Sleepiness Scale (SSS) was used to determine the levels of sleepiness. Stanford sleepiness scale (SSS test) is a 7-degree scale: (1) "feeling active, very sleepy, fighting sleep" to (7) "trying to stay awake and is a valid test to measure the sleepiness test. SSS is an individual assessment criterion for assessing the response to the best sleep-related status. In this test, a decrease of more than three scores indicates a sharp decrease in performance due to lack of sleep. The reliability of the SSS test, based on its mean scores, was established through a Wilkinson addition test and a Wilkinson vigilance test correlation of 0.68 and 0.47, respectively [23]. Its reliability was reported to be 0.88 using similar types of tests [23]. This scale was completed every 2 hours during the night shift (22.00 h to 6.00 h) at 11 PM, 1 A.M., 3 A.M. and 5 A.M. (one hour after the light interventions).

The measurement of the body temperature of staff was carried out via the bellow of mouth one hour after the start of work and every hour until the end of the work, at 11 P.M. and 12 A.M., 1 A.M., 3 A.M., 2 A.M. and 4 A.M. For this purpose, the temperature gauge was placed under the tongue for one minute, and then the displayed temperature was recorded.

Data analysis was performed by SPSS version 22 software using descriptive and analytical statistics. Mean ± SD was used to describe the continuous variables of the study, and in the analytical statistics section, pre- and post-analysis, and repeated major ANOVA analysis were used. A significance threshold of 0.05 was taken into account for all tests. Major ANOVA analysis was utilized to examine the impact of a light intervention on staff sleepiness levels for the intervention and control groups. The effects of Time, Treatment, Period, and Carry-over were monitored. The t-test variance test, the Pearson correlation test were used to analyze the variables. Tests were performed at a significance level lower than 0.005.

Light intensity measurement: light intensity measurement was locally performed by EC1 Lux meter device (Hogner Sweden) and by placing Luxmeter at the optical level of the shift workers based on all the necessary conditions to measure the light intensity in the whole work and rest environment [24].

Digital oral thermometer: The temperature of the body is measured with this thermometer. The temperature gauge was positioned under the tongue for one minute in order to do this, after which the temperature reading was recorded.

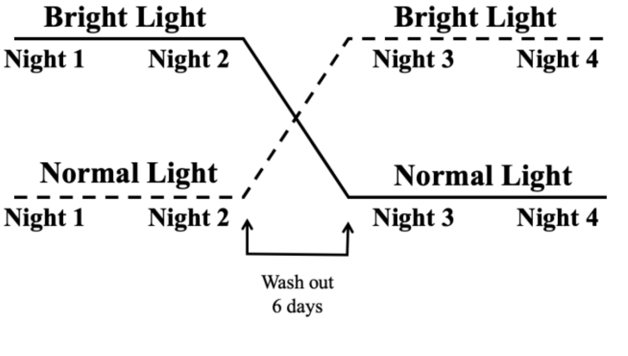

Fig. 1. General schematic of study in 4 nights of study

Results

140 participants were divided into two groups based on matching demographic characteristics. There was no significant difference between mean ages, sex and type of work of two groups.

The mean prevalence of sleepiness in staff was studied and was shown in Table 1.

Table 1. Mean prevalence of staff sleepiness

Group	N	Mean	Standard deviation	Min	Max
Control and intervention	140	2.67	1.04	1.21	4.79
Control	70	2.09	0.43	1.22	2.71
Intervention	70	3.25	1.16	1.21	4.79

The rate of oral temperature for hospital shift staff is separately shown for each of two groups in Table 2.

The effect of the light intervention on the sleepiness, and oral temperature of staff in two groups of intervention and control was compared and the results were shown in Table 3.

Table 2. Mean oral temperature of staff

Group	N	Mean	Standard deviation	Min	Max
Control and intervention	140	36.56	0.13	36.42	36.9
Control	70	36.55	0.12	36.42	36.80
Intervention	70	6.57	0.13	36.44	36.9

It was observed that the effect of time was significant in the study; it means that the trend of changes in the sleepiness of staff was found to be significant (P-value <0.001). The effect of intervention was significant (P-value <0.001). While the effects of the intervention period (P-value = 0.714) and the transfer effect (P-value = 0.942) were not significant; in other words, the changes in staff sleepiness were only in terms of the intervention and the duration of the period considered the wash-out period was effective. The following describes the pattern of variations in drowsiness for the two treatment groups. Figure 2 depicts the trajectory of variations in fatigue levels over two nights for the two treatment groups, the two intervention groups, and the control group.

Table 3. Investigating the effect of changes in sleepiness and oral temperature of staff

Effect	Sum of squares	F-value	P-value
Time	14.34	74.29	0.001<
Treatment	5.24	27.12	0.001<
Period	0.089	0.46	0.714
Carry-over	0.025	0.127	0.942
Time	0.72	315.52	0.000<
Treatment	0.001	0.56	0.62
Period	0.002	0.996	0.420
Carry-over	0.002	0.844	0.482

It was observed that the effect of time in the study was significant, which means that the trend of changes in the oral temperature of staff was found to be significant (P-value <0.001), while the effect of intervention was not significant (P-value = 0.62). Moreover, the effects of intervention period (P-value = 0.42), and carry-over effect (P-value = 0.482) were not significant. In other words, the intervention had no impact on changes in the staff members' oral temperatures, and the wash-out period was successful. For the two treatment groups, the pattern of changes in oral temperature was as follows. The trend of change showed that in all nights of two measurement periods, at 1 a.m., the oral temperature of the staff increased significantly compared to the time before and after. There was a significant negative relationship between oral temperature and sleepiness. In other words, by increasing the oral temperature of staff, their sleepiness has increased (0.033, r = - 0.22 = P-value).

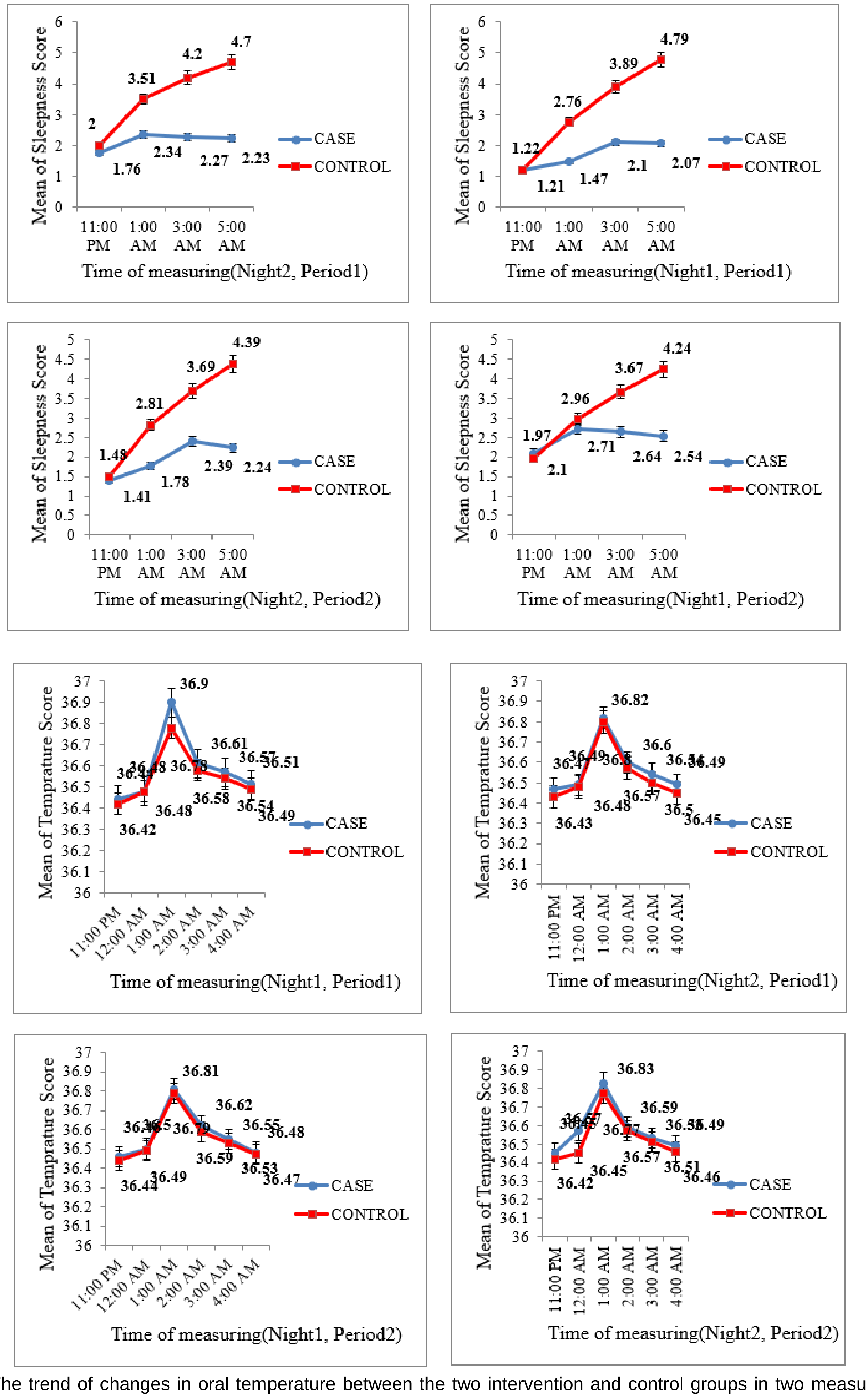

Fig.2. The trend of changes in oral temperature between the two intervention and control groups in two measurement periods

Discussion

This study aimed to compare the rate of sleepiness, and oral temperature of hospital staff working at night between two intervention and control groups, each of which had 70 subjects. The intervention was a shock of bright light. The results showed that the mean rate of sleepiness and was 2.67±1.04, and the mean rate of oral temperature was 63.65%±0.13. The highest rate of sleepiness in both intervention and control groups was at 5 o'clock in the morning. This is consistent with the results of a study by Karchani et al. conducted on night workers [1].

While in the study of Lowden et al., the highest rate of sleepiness was reported at 2, 4 and 6 AM [25]. The greatest levels of tiredness were associated with the hours between 2 AM and 4 AM, according to the findings of a research by Golbabaei et al. on shift employees in the glass sector. The regularity of the workplace and an increase in melatonin hormone release may be two factors contributing to the rise in employee tiredness after 2 AM [19]. Based on the results of the present study, it was found that the trend of changes in the rate of staff sleepiness of the intervention group was ascending which had a significant difference with the control group, so that this difference has increased with getting closer to day. The results of the study by Karchani et al. implemented on night workers of a metallurgical industry showed that there was a significant difference between the rate of mental sleepiness in the first and second stages between the two groups [1]. While the intervention period's impacts and carryover were not significant, the wash-out period's length and effectiveness were. In other words, changes in staff sleepiness were solely attributable to the intervention. The results of a study conducted by Deacon and Arendet showed that bright light increases weakness and improves temporary performance, and light intensity from 2000 to 2500 lux reduces mental sleepiness [26]. When light comes to a person and was affected by the study, its effect on sleepiness occurs in the form of transitional and temporary, and it may be affected by the excitement caused by the bright light, which reduces sleepiness. In the study of Lowden, it was found that exposure to bright light at two 20-min periods at 3 and 4 a.m. would be effective in reducing sleepiness [25].

The findings of our study showed that bright light intervention did not have a significant effect on the oral temperature of staff. Although the trend of change was significant, there was no significant difference between the oral temperature of two intervention and control groups. According to Golbabaei's research, which is similar with our findings [19], there is no statistically significant difference in the mean oral temperatures of employees at various hours over the course of two nights. This can be in terms of the sustainability of oral temperature, as the oral temperature increases in people who have adapted to work shifts, and it usually takes a month for a person to adapt to a night's work. In our study, this measurement was performed during 2 nights and this has made the changes not very tangible because the temperature is a more resistive, and sustainable cycle and during this short period of time, it does not show tangible and measurable changes and these factors indicate the stability of Circadian cycle during day and night.

However, the rise in oral temperature has been noticeable all night long till one in the morning. As a result, until 1 AM, there was a rising trend in both the control and intervention groups, followed by a declining trend. There was no similar growing tendency in the rate of drowsiness. For justification of this result, the people in the hospital environment had higher activity and workload up to 1 AM, which caused to rise of the oral temperature and after 1 AM, the workload was lower and the temperature decreased. In the study by Froberg et al., the oral temperature has an increasing trend at 1 am and decreased after that [27], which is consistent with our results. However, in the study of Golbabaei, the oral temperature increased until 2 AM, and then decreased [19]. Studies have shown that in people who work in a day, the temperature rises up to 9 PM, and then decreases [28].

The duration of our study intervention was 10±1 minutes, and the results showed that this duration had an effect on reducing sleepiness and increasing weakness. The duration of intervention in the studies conducted by Karchani (1) and Lowden was 15 and 20 min [25]; thus, one of the strengths of this study is the intervention with less time.

The test was performed one hour after the intervention, while in the study of Lowden et al, interventions and measurements were performed simultaneously [25]. A person's genuine oral temperature may be affected by the usage of a hot and edible drink during the break time, therefore separating the intervention from the test will lessen the inaccuracy and more accurately gauge the influence of light. In the study of Karchani, adaptation increased during next nights [1]. The results of studies conducted by Khammar et al. and Poursadeghiyan et al. (2017) showed that the rate of sleepiness among night shift staff was decreased in the second night of the intervention,

compared to the first night, which could be in terms of adaptation to cope with night work as a result of exposure to BL [29, 30].
According to the findings of this study, there was a significant inverse relationship between the rate of drowsiness and oral temperature; that is, their alterations occurred in the opposite direction. Based on the results of a study by Golbabaei et al. (2014), oral temperature showed an inverse correlation with sleepiness after a few hours of exposure to heat, which is consistent with the findings of our study. These results were consistent with studies performed on night workers and showed that the rate of oral temperature at night increased and then decreased [27]. In general, it can be concluded that light increases weakness, and reduces mental sleepiness. Even, in some studies, it proposed that providing rest rooms equipped with bright light in industrial workplaces is more economic compared to providing the entire workplace with bright light [1].
Based on intervention studies, sample downfall during the study was one of the limitations. Lack of melatonin test or lack of placebo can be mentioned.

Conclusion

Findings showed that light intervention has a significant effect on sleepiness in the short term. Also, based on previous evidence, despite the fact that drowsiness has a significant inverse correlation with oral temperature, there was no correlation between light intervention and oral temperature. It seems that due to the persistence of oral temperature and its greater stability, it is less like sleepiness affected by light shock and is associated with long periods of change and adaptation periods than temporary, and transient shocks.

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Conflict of interest: None declared.

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