Work 77 (2024) 789–797
DOI:10.3233/WOR-220700
IOS Press



# Evaluating the effect of daytime sleepiness and sleep quality on balance, fatigue and life quality of shift workers

Semanur Doğan[a] and Gulay Aras Bayram[b,*]
[a]*Institute of Health Sciences, Physiotherapy and Rehabilitation, Istanbul Medipol University, Istanbul, Turkey*
[b]*Faculty of Health Sciences, Physiotherapy and Rehabilitation, Istanbul Medipol University, Istanbul, Turkey*

Received 14 December 2022
Accepted 20 July 2023

**Abstract**.
**BACKGROUND:** Changes in the sleep-wake cycle in shift workers can cause many health problems.
**OBJECTIVE:** The aim of this study was to investigate the relationship between daytime sleepiness and sleep quality on balance, physical activity level, fatigue and quality of life in shift and non-shift workers.
**METHOD:** A total of 58 employees, 29 shifts and 29 non-shifts, were included in the study. Data were collected using the Epworth Sleepiness Scale, the Pittsburgh Sleep Quality Index, the Tandem Posture Test, the One-Foot Stand Test, the Ten-Step Tandem Walking Test, the International Physical Activity Questionnaire-Short Form, the Fatigue Severity Scale, and the Nottingham Health Profile.
**RESULTS:** Individuals working in shifts had higher fatigue severity and daytime sleepiness levels ($p < 0.05$), while physical activity levels and sleep quality were lower than those working without shifts ($p < 0.05$). It was determined that as the daytime sleepiness of individuals working in shifts and non-shifts increased, their quality of life decreased ($p < 0.05$).
**CONCLUSION:** According to the data obtained from the study, individuals working in shifts compared to individuals working without shifts experienced higher levels of daytime sleepiness and fatigue severity level while sleep quality and physical activity level were lower.

Keywords: Balance, daytime sleepiness, sleep quality, shift work, worker, quality of life

## 1. Introduction

Shift work is defined as working hours that include 2 or more teams that differ according to the start and end times of work, outside of typical working hours. Especially in the business lines in the industry and service sector, the full-time production situation has necessitated a shift work system [1]. Due to atypical working hours, shift work causes conflict with the circadian rhythm that regulates sleep-wake and causes this rhythm to be disrupted. Circadian rhythms are regulated by a master clock located in the superior chiasmatic nuclei of the brain. While this clock helps the organism adapt to the environment, it regulates the sleep-wake cycle and controls the release of vital hormones such as growth hormone, melatonin and cortisol. Disruption of the circadian rhythm as a result of shift work causes many physical, mental and social problems in individuals [2].

It has been determined that many physical diseases such as cardiovascular, gastrointestinal, metabolic diseases, cancer and psychological diseases such as depression-anxiety occur in shift workers. At the same time, many problems such as increased daytime

*Address for correspondence: Gulay Aras Bayram, PT, PhD, Faculty of Health Sciences, Physiotherapy and Rehabilitation, Istanbul Medipol University, Istanbul, Turkey. E-mail: garas@medipol.edu.tr; Orcid: 0000-0002-5592-7546

sleepiness, decrease in sleep quality, fatigue, decrease in quality of life and daytime work performance have been detected due to the change in the sleep-wake cycle [3–6]. It has been reported that the main sleep duration is 1–4 hours shorter than night sleep in shift workers, and insufficient sleep is associated with poor health, decreased productivity, poor quality of life, increased accidents at work, and absenteeism [7]. It was determined that the use of cigarettes, sleeping pills and alcohol was high in workers with variable shifts [8]. Along with these problems, it has been determined that sleep deprivation may also cause disturbances in balance and postural stability in shift workers [9, 10].

In the literature, parameters such as daytime sleepiness, sleep quality, balance, physical activity level, fatigue, and quality of life in shift workers were evaluated, and no comprehensive study was found in which these parameters were correlated with sleep quality and daytime sleepiness. In this context, in our study, it was aimed to compare shift workers and non-shift workers in terms of daytime sleepiness, sleep quality, balance, fatigue, quality of life and physical activity level; It was aimed to evaluate the relationship between daytime sleepiness and sleep quality and balance, fatigue, quality of life and physical activity level.

## 2. Materials and methods

This study was conducted with the approval of the Non-Interventional Research Ethics Committee of Istanbul Medipol University (date: 21.01.2021, decision number: 114).

The study was carried out with the shift ($n = 29$) and non-shift workers ($n = 29$) in two textile factories. All participants were informed about the study and a signed informed consent form was obtained from the individuals who volunteered to participate in the study. A total of 58 people between the ages of 18 and 65, who cooperated to apply for the tests and worked in the same workplace for at least 3 months, was included in the study. Individuals with orthopedic, neurological and psychological problems that prevented them from completing the study were excluded from the study.

Evaluations were made during daylight hours in the environment where the individuals worked. At the beginning of the study, demographic information such as age, gender, height, weight, cigarette-alcohol use, type of shift, duration of work in the same workplace, presence of chronic disease were obtained through anamnesis form. Before each test, the participant was informed about the evaluation to be made. Daytime sleepiness of the participants was evaluated with the Epworth Sleepiness Scale, sleep quality with the Pittsburgh Sleep Quality Index, balance assessment with the Tandem Stance Test, One Foot Stand Test, and Ten-Step Tandem Walking Test. In addition, the physical activity level of the participants was evaluated using the International Physical Activity Questionnaire-Short form, the fatigue level with the Fatigue Severity Scale and the quality of life with the Nottingham Health Profile.

### 2.1. Measurement instrument

The Epworth Sleepiness Scale (ESS) consists of 8 questions in total and individuals are asked to evaluate their probability of falling asleep while doing certain activities during the day, with a score between 0–3, considering the last month. The total score is between 0–24, and a high score indicates an increased level of daytime sleepiness [11].

The Pittsburgh Sleep Quality Index (PSQI) has 11 subsections, including subjective sleep quality (SQ), sleep latency (SL), sleep duration (SD), habitual sleep efficiency (HSE), sleep disorder (SDI), sleep medication use (SMU), and it is a scale with 7 parameters, including daytime dysfunction (DD). There are 24 questions in total, 19 of which are answered by the individual himself, and 5 by his roommate or spouse. Each parameter is scored between 0–3. At the end of the evaluation, individuals obtain a sleep quality score between 0–21 points. Scores of 5 and higher than 5 indicate poor sleep quality [12].

The Tandem Stance Test (TST) was applied in the static balance evaluation of the participants. The individual was asked to stand without support for 30 seconds, with the arms hanging at the sides, the heel of one foot touching the tip of the other foot, and the dominant leg in front. The test was repeated 3 times with eyes closed. The average of the score of 3 trials was recorded [13].

The One-Foot Stand Test (OFST) was applied to evaluate the static balance of individuals. For the test, the individual was asked to lift one foot without touching the other foot. The individual was then asked to close their eyes and stop for 30 seconds. The test was performed on both feet, right and left. The average of the score from 3 trials was recorded [14].

The Ten Step Tandem Walking Test (TSTWT) was applied to assess the dynamic balance of individuals.

A straight line was drawn on the floor for evaluation. Subjects were asked to walk at a comfortable pace with the heel of one foot touching the toes of the other foot and arms together on the chest. In the version with eyes closed; The maximum number of steps taken by the individuals without stepping out of the line, without stopping to walk, without letting go of their hands and keeping the upright posture was recorded. Ten-step tandem walking time was recorded in the test with eyes open. Three trials were performed for both evaluations and the mean value was recorded [15].

In the International Physical Activity Questionnaire-Short Form (IPAQ-SF) questionnaire, information was obtained from the individuals about activities that required 10 minutes or more in the last 7 days, requiring strength and accelerating breathing. The weekly MET-min (Metabolic Equivalent) scores of the individuals were obtained by calculating the time and energy spent by the individuals in walking, vigorous activity and moderate-intensity activities [16].

The Fatigue Severity Scale (FSS) consists of 9 questions in total and the questions are evaluated with a score between 1–7. The total score ranges from 9 to 63, and the average of 9 questions is recorded as a score. The higher the score obtained, the higher the level of fatigue severity indicates [17].

The Nottingham Health Profile (NHP) scale consists of 38 questions and 6 subsections. These parts are emotional reactions, pain, sleep, energy, physical activity, and social isolation. Each question is answered as yes or no. High scores indicate low quality of life [18].

### 2.2. Data analysis

The data we obtained as a result of the research were analyzed with the SPSS (Statistical Package for Social Sciences) for Windows 25.0 program. The sample size was determined using the "G*power sample size calculator" and was calculated as 58 subjects, with a power of 80% ($\alpha = 0.05$) and an effect size of 0.757. In order to compare the quantitative data, it was first investigated whether the parametric test requirements were met. The independent *t*-test was used when comparing normally distributed data, and the Mann-Whitney U test was used when comparing data that did not show normal distribution. Correlation test was applied to evaluate the relationship between quantitative data, Pearson and Spearman coefficients were taken into account. Chi-square analysis was used when comparing categorical data. $p < 0.05$ was accepted as a statistical significance level.

## 3. Results

Table 1 shows the characteristics of study participants (Table 1). Table 2 shows the differences between the variables in the groups. Among the shift and non-shift workers groups, TSTWT (s) ($p = 0.043$), FSS ($p = 0.002$), IPAQ-SF ($p = 0.032$), ESS ($p = 0.002$) and PSQI 's SQ ($p = 0.000$), SL ($p = 0.006$), SDI ($p = 0.001$) sub-parameters and PSQI total score ($p = 0.000$) values were significantly different (Table 2).

There was a moderate positive correlation between daytime sleepiness and NHP in shift workers ($r = 0.406$, $p = 0.029$). In non-shift workers, the correlation between daytime sleepiness and IPAQ-SF value was weak ($r = 0.389$, $p = 0.037$), moderate positive correlation between FSS ($r = 0.505$, $p = 0.005$), and moderately positive correlation between NHP ($r = 0.530$, $p = 0.003$), (Table 3).

There was a moderate positive correlation between SD and FSS ($r = 0.465$, $p = 0.011$), negatively moderated between SL and TSTWT (s) ($r = –0.462$, $p = 0.012$), positive moderately between DD and OFST (Right) (s) ($r = 0.415$, $p = 0.025$), positive weak between DD and OFST (Left) (s) ($r = 0.378$, $p = 0.043$), and positive weak between DD and NHP ($r = 0.387$, $p = 0.038$) in shift workers.

There was a weak positive correlation between SQ and TST (s) ($r = 0.389$, $p = 0.037$), and a moderate positive correlation between SL and TST (s) ($r = 0.441$, $p = 0.017$) in non-shift workers. There was a moderate positive correlation between NHP and SQ, SD and total score ($r = 0.599$, $p = 0.001$; $r = 0.454$, $p = 0.013$; $r = 0.474$, $p = 0.009$ respectively), (Table 4).

## 4. Discussion

This study aimed to compare the daytime sleepiness, sleep quality, balance, physical activity level, fatigue, quality of life of individuals working in shifts and non-shifts, and to evaluate the effects of daytime sleepiness and sleep quality on balance, physical activity level, fatigue and quality of life. As a result of the study, it was concluded that shift work had a negative effect on individuals' daytime sleepiness, sleep quality, fatigue and physical activity level.

Table 1
Demographic information of participants

| Variables | | Shift Workers ($n=29$) | | Non-shift Workers ($n=29$) | | $P$ |
|---|---|---|---|---|---|---|
| | | n | % | n | % | |
| Gender | Male | 29 | %56.9 | 22 | %43.1 | **0.005** |
| | Female | 0 | %0.0 | 7 | %100.0 | |
| Smoke | Yes | 15 | %62.5 | 9 | %37.5 | 0.110 |
| | No | 14 | %41.2 | 20 | %58.8 | |
| Alcohol | Yes | 1 | %100.0 | 0 | %0.0 | 0.313 |
| | No | 28 | %49.1 | 29 | %50.9 | |
| Chronic Disease | Yes | 5 | %41.7 | 7 | %58.3 | 0.517 |
| | No | 24 | %52.2 | 22 | %47.8 | |

Chi-square analysis; $p<0.05$.

Table 2
Differences variables between the groups

| Variables | Shift Workers Mean ± SD | Non-shift Workers Mean ± SD | p |
|---|---|---|---|
| Age (years) | 35.24 ± 11.28 | 40.79 ± 10.62 | 0.059 |
| BMI (kg/m²) | 26.78 ± 2.93 | 29.12 ± 4.07 | **0.015** |
| Working time (years) | 7.87 ± 8.74 | 11.67 ± 9.44 | 0.117 |
| TST (s) | 18.84 ± 9.15 | 16.46 ± 10.07 | 0.350 |
| OFST (Right) (s) | 13.92 ± 8.26 | 13.73 ± 8.31 | 0.930 |
| OFST (Left) (s) | 9.02 ± 6.37 | 10.16 ± 8.83 | 0.577 |
| TSTWT (s) | 9.86 ± 1.83 | 8.82 ± 2.02 | **0.043** |
| TSTWT (10 foot) | 6.25 ± 1.68 | 5.51 ± 2.91 | 0.245 |
| FSS | 3.36 ± 1.65 | 2.13 ± 1.18 | **0.002** |
| IPAQ-SF | 1620.19 ± 1547.06 | 3473.71 ± 4202.83 | **0.032** |
| ESS | 5.34 ± 3.76 | 2.48 ± 2.63 | **0.002** |
| PSQI | | | |
| *SQ* | 1.72 ± 1.00 | 0.69 ± 0.81 | **0.000** |
| *SL* | 1.34 ± 0.86 | 0.66 ± 0.97 | **0.006** |
| *SD* | 1.14 ± 0.79 | 0.83 ± 0.66 | 0.110 |
| **HSE* | 28.50 | 30.50 | 0.304 |
| *SDI* | 1.24 ± 0.51 | 0.76 ± 0.51 | **0.001** |
| *SMU* | 0.00 | 0.00 | – |
| *DD* | 0.38 ± 0.56 | 0.21 ± 0.41 | 0.188 |
| *Total Score* | 5.86 ± 2.55 | 3.24 ± 2.68 | **0.000** |
| NHP | | | |
| **Pain* | 28.83 | 30.17 | 0.749 |
| **Emotional reactions* | 27.02 | 31.98 | 0.234 |
| *Sleep* | 19.29 ± 25.70 | 14.59 ± 25.40 | 0.486 |
| *Social isolation* | 14.60 ± 24.41 | 14.67 ± 25.74 | 0.991 |
| **Physical activity* | 30.81 | 28.19 | 0.502 |
| *Energy* | 16.52 ± 21.99 | 12.90 ± 24.65 | 0.557 |
| *Total Score* | 81.13 ± 79.32 | 77.04 ± 70.07 | 0.836 |

Independent *t*-test; *Mann Whitney U test; $p<0.05$; SD: Standart deviation; kg/m²: kilogram/meter*meter. BMI: Body Mass Index, TST: Tandem Stance Test, OFST: One-Foot Stand Test, TSTWT: Ten Step Tandem Walking Test, FSS: Fatigue Severity Scale, IPAQ-SF: International Physical Activity Questionnaire-Short Form, ESS: Epworth Sleepiness Scale, PSQI: The Pittsburgh Sleep Quality Index, SQ: Sleep quality, SL: Sleep latency, SD: Sleep duration, HSE: Habitual sleep efficiency, SDI: Sleep disorder, SMU: Sleep medication use, DD: Daytime dysfunction, NHP: Nottingham Health Profile.

Vidya et al. [19] determined that shift workers had a higher daytime sleepiness score than non-shift workers. In our study, while none of the non-shift workers had excessive daytime sleepiness, 6.9% of the shift workers were found to have excessive daytime sleepiness. This result is thought to be due to the fact that shift workers do not sleep despite the increased homeostatic pressure at night due to working hours and a short and fragmented sleep during the rising phase of the daytime circadian warning signal.

Table 3
Correlation of Epworth sleepiness scales with other variables

| Variables | | Epworth sleepiness scale | |
|---|---|---|---|
| | | Shift Workers | Non-shift Workers |
| TST (s) | r | 0.105 | 0.272 |
| | p | 0.589 | 0.154 |
| OFST (Right) (s) | r | –0.174 | –0.086 |
| | p | 0.366 | 0.658 |
| OFST (Left) (s) | r | –0.048 | –0.076 |
| | p | 0.804 | 0.696 |
| TSTWT (s) | r | 0.187 | 0.204 |
| | p | 0.332 | 0.289 |
| TSTWT (0–10 foot) | r | –0.142 | –0.055 |
| | p | 0.462 | 0.776 |
| IPAQ-SF | r | –0.367 | **0.389** |
| | p | 0.050 | **0.037** |
| FSS | r | –0.196 | **0.505** |
| | p | 0.307 | **0.005** |
| NHP | r | **0.406** | **0.530** |
| | p | **0.029** | **0.003** |

Pearson correlation test; $p < 0.05$; r: correlation coefficient. TST: Tandem Stance Test, OFST: One-Foot Stand Test, TSTWT: Ten Step Tandem Walking Test, IPAQ-SF: International Physical Activity Questionnaire-Short Form, FSS: Fatigue Severity Scale, PSQI: The Pittsburgh Sleep Quality Index.

In our study, it was determined that shift workers had worse sleep quality than non-shift workers. These results show that our study is compatible with the literatüre [19, 20] and suggest that shift workers have working hours that conflict with their circadian rhythms so, accordingly, they have to sleep at times of the day that are unsuitable for sleep due to light and noise.

Shift work causes individuals to experience disruptions in sleep-wake cycles and sleep-related problems due to atypical working hours. In humans, sleep deprivation has been shown to cause a decrease in the activation of corticothalamic networks, resulting in impaired alertness, attention, and higher-level cognitive functions [21]. It has been shown that the negative effect of this situation, which occurs in sleep deprivation, on alertness and attention to environmental stimuli, affects balance functions [22]. When the literature is examined, there are many studies showing that sleep deprivation causes deterioration in postural control [21–23]. In our study, no difference was found between the groups in terms of static balance tests TST and OFST, and dynamic test TSTWT (number of steps). In the TSTWT (s) evaluation, there was a significant difference between the groups, and shift workers completed the test slower than non-shift workers. Although the result in this balance parameter supports the view that shift work may have a negative effect in terms of balance and postural control, the absence of a significant difference in other balance assessments contradicts the literature. The reason for this difference may be the diversity in the measurement methods. While in our study, balance was evaluated with subjective methods, unlike our study in the literature, it was evaluated with objective methods.

The study showed the physical activity level of non-shift workers was found to be higher than those of shift workers. Flahr et al. [24] reported that shift workers are less physically active than non-shift workers. Atkinson et al. [25] reported that shift workers' participation in social and sports activities was restricted due to atypical working hours. At the same time, it is assumed that the negative effects of shift workers' physical activity at an hour that is not suitable for their circadian rhythms is a hindrance to the physical activity of shift workers. The results of our study support the literature.

Ferri et al. [26] reported that nurses working on alternating night shifts suffered from chronic fatigue symptoms more frequently than their day shift colleagues. Severe fatigue was found in 51.72% of shift workers and 10.34% of non-shift workers in our study. This result, in parallel with the literature, showed that shift workers have a higher fatigue severity level than non-shift workers. It can be shown as a possible reason that shift work causes a decrease in sleep quality and quantity due to atypical working hours.

In our study, when the quality of life of shift and non-shift workers was evaluated, no statistically significant difference was found between the groups. When we look at the literature, the general view is that the shift work system affects the quality of life negatively [19, 27]. Among the factors affecting the quality of life, the body mass index of individuals is also shown as a determinant. Yildirim et al. [28] found a significant relationship between the body mass index and quality of life of employees, and showed that the quality of life decreased as the body mass index increased. At this point, the reason why there was no significant difference between the groups in terms of quality of life in our study may be considered as the fact that the body mass index of the individuals working without shifts was higher than the individuals working in shifts.

The study showed when the relationship between the ESS of shift and non-shift workers and static and dynamic balance data was examined, no significant relationship was found in either group. There are studies in the literature showing that sleep deprivation and

daytime sleepiness have negative effects on balance and postural control [22, 29]. In our study, the effect of chronic insomnia on balance was investigated using subjective methods. In this respect, it seems possible that the results obtained from our study are not compatible with the literature.

In our study, moderate and weak correlations were found between some sub-parameters of PSQI and static and dynamic balance measurements in both groups. Although there is a widespread opinion in the literature that sleep quality has a negative effect on balance, there are also studies in which there is no relationship between sleep quality and balance [30, 31]. Moreover, these studies do not include workers who are included in the shift system. It is clear that the results we have obtained in this context need to be supported.

Wadley et al. [32] found no relationship between daytime sleepiness and physical activity level of truck drivers working at night. Similarly, in our study, no relationship was found between daytime sleepiness and physical activity levels of shift workers. In non-shift workers, a positive but weak relationship was found between daytime sleepiness and physical activity level.

In our study, a statistically significant relationship could not be established between the daytime sleepiness of shift workers and the severity of fatigue. In non-shift workers, a moderately positive relationship was found between daytime sleepiness and the severity of fatigue. Kaliyaperumal et al. [33] determined that there is a positive relationship between daytime sleepiness and fatigue in nurses working in shifts. In our study, shift workers work in the night shift for 1 week and the day shift for 1 week, in this study the shifts change every 2 weeks. In other words, individuals are exposed to night work for two weeks. It is thought that the difference between our study and this study is due to the higher number of consecutive night work in this study. Gunawardane et al. [34] found a weak but significant relationship between daytime sleepiness and severity of fatigue. There is a parallelism between our study and the results of this study in terms of individuals working without shifts.

The study showed a moderate positive correlation was found between daytime sleepiness and quality of life of shift and non-shift workers. The findings obtained from the literature seem to be compatible with the results of shift and non-shift workers in our study [35]. In addition to the physical effects of being sleepy during the daytime, it is thought that experiencing problems in activities such as participating in social activities, maintaining family relationships, and performing activities of daily living have a negative impact on the quality of life.

In the literature, there are studies showing that there is a relationship between sleep quality and physical activity level, as well as studies showing that there is no relationship [36, 37]. In addition, the number of studies examining the relationship between sleep quality and physical activity level of shift workers is quite limited. In this context, more studies are needed to understand the relationship between sleep quality and physical activity level of shift workers. In our study, no statistically significant relationship was found between sleep quality and physical activity levels of both shift and non-shift workers. The possible reason for this result in our study is thought to be factors such as working hours and conditions that affect sleep quality.

In our study, there was a moderate positive correlation between the fatigue level of shift workers and the SD value, which is a sub-parameter of PSQI, but no significant correlation was found between other PSQI parameters and the total PSQI score. In non-shift workers, no significant relationship was found between any parameter of the PSQI and the severity of fatigue. Vlahoyiannis et al. [38] found a positive relationship between sleep quality score and fatigue severity of shift participants in their study with 20 day workers and 20 shift workers. There was no relationship between sleep quality score and fatigue severity in daytime workers. The findings obtained from this study and the findings obtained from non-shift workers in our study show parallelism with each other. We think that the difference between this study and ours in terms of shift workers may be due to the working time. In this study, the average working time of shift workers was 18.0 years, while in our study, the average working time of shift workers was 7.87 years. From this point of view, it seems possible that working in shifts for longer periods may strengthen the relationship between sleep and fatigue.

Palhares et al. [39] found a statistically significant relationship between sleep quality and quality of life in nurses working in shifts, regardless of shifts. In our study, it was determined that the deterioration of sleep quality of non-shift workers affected the quality of life of individuals negatively. While a significant relationship was found between only PSQI-DD and quality of life value in shift workers, no significant relationship was found between other PSQI. While the results obtained from non-shift workers were in line with the literature, no relationship was found

Table 4
Correlation of Pittsburgh sleep quality index with other variables

| Variables | | | Pittsburgh sleep quality index | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | SQ | SL | SD | HSE | SDI | SMU | DD | Total |
| TST (s) | Shift | r | 0.116[a] | 0.352[a] | 0.068[a] | 0.219[b] | 0.052[a] | – | 0.317[a] | 0.283[a] |
| | | p | 0.550 | 0.061 | 0.725 | 0.253 | 0.789 | – | 0.093 | 0.137 |
| | Non-shift | r | **0.389**[a] | **0.441**[a] | 0.021[a] | 0.137[b] | 0.116[a] | – | 0.277[a] | 0.348[a] |
| | | p | **0.037** | **0.017** | 0.915 | 0.477 | 0.549 | – | 0.145 | 0.064 |
| OFST (Right) (s) | Shift | r | –0.034[a] | 0.273[a] | –0.001[a] | 0.136[b] | 0.034[a] | – | **0.415**[a] | 0.183[a] |
| | | p | 0.861 | 0.152 | 0.995 | 0.483 | 0.861 | – | **0.025** | 0.343 |
| | Non-shift | r | 0.132[a] | 0.278[a] | –0.103[a] | 0.217[b] | –0.008[a] | – | 0.211[a] | 0.159[a] |
| | | p | 0.494 | 0.144 | 0.595 | 0.259 | 0.967 | – | 0.272 | 0.410 |
| OFST (Left) (s) | Shift | r | 0.032[a] | 0.136[a] | –0.151[a] | 0.034[b] | 0.013[a] | – | **0.378**[a] | 0.096[a] |
| | | p | 0.870 | 0.483 | 0.434 | 0.861 | 0.949 | – | **0.043** | 0.622 |
| | Non-shift | r | 0.249[a] | 0.338[a] | –0.103[a] | 0.176[b] | 0.083[a] | – | 0.267[a] | 0.233[a] |
| | | p | 0.192 | 0.073 | 0.597 | 0.360 | 0.668 | – | 0.162 | 0.224 |
| TSTWT (s) | Shift | r | 0.112[a] | **–0.462**[a] | –0.170[a] | 0.226[b] | 0.011[a] | – | –0.034[a] | –0.156[a] |
| | | p | 0.564 | **0.012** | 0.377 | 0.239 | 0.955 | – | 0.861 | 0.419 |
| | Non-shift | r | –0.017[a] | –0.011[a] | –0.107[a] | 0.298[b] | 0.144[a] | – | 0.085[a] | 0.027[a] |
| | | p | 0.931 | 0.956 | 0.582 | 0.117 | 0.456 | – | 0.662 | 0.889 |
| TSTWT (0–10 foot) | Shift | r | – 0.028[a] | 0.119[a] | 0.089[a] | 0.181[b] | –0.060[a] | – | 0.350[a] | 0.134[a] |
| | | p | 0.885 | 0.539 | 0.645 | 0.347 | 0.757 | – | 0.063 | 0.490 |
| | Non-shift | r | 0.132[a] | 0.317[a] | –0.281[a] | 0.109[b] | 0.135[a] | – | 0.225[a] | 0.153[a] |
| | | p | 0.494 | 0.093 | 0.140 | 0.575 | 0.484 | – | 0.240 | 0.428 |
| IPAQ-SF | Shift | r | –0.105[a] | 0.230[a] | 0.071[a] | –0.181[b] | –0.032[a] | – | –0.160[a] | 0.004[a] |
| | | p | 0.589 | 0.230 | 0.715 | 0.347 | 0.869 | – | 0.408 | 0.983 |
| | Non-shift | r | 0.057[a] | 0.060[a] | –0.008[a] | 0.027[b] | 0.196[a] | – | –0.069[a] | 0.048[a] |
| | | p | 0.770 | 0.759 | 0.966 | 0.889 | 0.308 | – | 0.721 | 0.805 |
| FSS | Shift | r | 0.014[a] | 0.154[a] | **0.465**[a] | 0.272[b] | 0.346[a] | – | 0.053[a] | 0.300[a] |
| | | p | 0.941 | 0.426 | **0.011** | 0.154 | 0.066 | – | 0.785 | 0.114 |
| | Non-shift | r | 0.360[a] | 0.047[a] | 0.244[a] | 0.109[b] | 0.311[a] | – | 0.285[a] | 0.292[a] |
| | | p | 0.055 | 0.809 | 0.202 | 0.574 | 0.100 | – | 0.134 | 0.125 |
| NHP | Shift | r | 0.285[a] | –0.059[a] | 0.183[a] | 0.316[b] | 0.315[a] | – | **0.387**[a] | 0.336[a] |
| | | p | 0.134 | 0.762 | 0.343 | 0.095 | 0.096 | – | **0.038** | 0.074 |
| | Non-shift | r | **0.599**[a] | 0.228[a] | **0.454**[a] | –0.020[b] | 0.311[a] | – | 0.312[a] | **0.474**[a] |
| | | p | **0.001** | 0.234 | **0.013** | 0.917 | 0.101 | – | 0.100 | **0.009** |

Pearson ([a]) ve Spearman ([b]) correlation test; $p < 0.05$; r: correlation coefficient. TST: Tandem Stance Test, OFST: One-Foot Stand Test, TSTWT: Ten Step Tandem Walking Test, IPAQ-SF: International Physical Activity Questionnaire-Short Form, FSS: Fatigue Severity Scale, PSQI: The Pittsburgh Sleep Quality Index.

between all sub-parameters of shift workers except DD, and total PSQI score and quality of life, unlike the literature. It is thought that the difference between the shift workers in this study and our study may be due to the number of female employees. Palhares et al.'s [39] study was conducted among nurses, and the number of female employees is 87% of the total number of employees. In our study, there were no female employees among shift workers. Since many responsibilities in daily life are accepted as women's duties in our society, women have to assume more than one role and their role area is expanding. Atypical working hours in shift work create difficulties for women to fulfill these multiple roles. Therefore, these roles that women have in both work and home life increase the negative impact of shift work on their quality of life [40]. From this point of view, it seems possible to see a stronger relationship between sleep quality and quality of life in this study, which has a high number of women, unlike our study.

It is critical for shift workers to establish a healthy work-life balance. Therefore, this issue needs to be addressed and attention should be paid to strategies to improve sleep quality and quality of life in shift workers in industries. In addition, cognitive–behavioral therapy and education programs activity should be tried in these groups [41].

### *4.1. Limitations*

The fact that all the evaluations applied in our study were subjective methods, size of the study and the inability to achieve homogenization between groups in terms of body mass index and gender data can be shown as the limitation of our study.

## 5. Conclusions

With the data we obtained from the study, it was concluded that the individuals working in shifts had higher daytime sleepiness and fatigue severity levels, while the sleep quality and physical activity levels were lower than those working without shifts. In our study, no significant difference was found between shift workers and non-shift workers in terms of quality of life. In order to better understand the relationship between daytime sleepiness and sleep quality and balance, fatigue, physical activity level and quality of life, it is recommended that more studies be conducted to eliminate existing limitations.

## Ethical approval

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Non-Interventional Research Ethics Committee of Istanbul Medipol University (decision number: 114, date of approval: 21 January 2021).

## Informed consent

All participants were informed about the study and a signed informed consent form was obtained from the individuals who volunteered to participate in the study.

## Conflict of interest

The authors declare that they have no conflict of interest.

## Funding

The authors report no funding.

## Acknowledgments

The authors thank all participants who participated in the study.

## References

[1] Alhifzi S, Al-Ghonimy A, Al Aboudi M, Al Abdullah R, Olaish A, Bahammam AS. Assessment of sleep quality, daytime sleepiness, and depression among emergency physicians working in shifts. J Nat Sci Med. 2018;1:17-21.
[2] Zee PC, Abbott SM. Circadian Rhythm Sleep-Wake Disorders. Continuum (Minneap Minn). 2020;26(4):988-1002.
[3] Torquati L, Mielke GI, Brown WJ, Kolbe-Alexander T. Shift work and the risk of cardiovascular disease. A systematic review and meta-analysis including dose–response relationship. Scand J Work Environ Health. 2018;44(3):229-38.
[4] Lim YC, Hoe VCW, Darus A, Bhoo-Pathy N. Association between night-shift work, sleep quality and metabolic syndrome. Occup Environ Med. 2018;75(10):716-23.
[5] AlAwadhi DA, Sharif AK, Faraj AE, Mohammed SJ, AlShomili HY, Abdulla DK, et al. Relationship of insomnia, stress, and anxiety with shift work among nurses in the Kingdom of Bahrain. Majmaah Journal of Health Sciences. 2020;8(2):32-41.
[6] Rashnuodi P, Afshari D, Shirali GA, Amiri A, Zadeh MR, Samani AS. Metabolic syndrome and its relationship with shift work in petrochemical workers. Work, (Preprint). 2022;71(4):1175-82.
[7] Olawale OO, Taiwo OA, Hesham A. Quality of sleep and well-being of health workers in Najran, Saudi Arabia. Indian J Psychiatry. 2017;59:347-51.
[8] Krishnaswamy UM, Chhabria MS, Rao A. Excessive sleepiness, sleep hygiene, and coping strategies among night bus drivers: A cross-sectional study. Indian J Occup Environ Med. 2016;20:84-7.
[9] Aguiar SA, Barela JA. Sleep deprivation affects sensorimotor coupling in postural control of young adults. Neuroscience Lett. 2014;574:47-52.
[10] Siu KC, Huang CK, Beacom M, Bista S, Rautiainen R. The association of sleep loss and balance stability in farmers. J Agromedicine. 2015;20(3):327-31.
[11] Ağargün MY, Çilli AS, Kara H, Bilici M, Telcioğlu M, Semiz ÜB, et al. Epworth uykululuk ölçeğinin geçerliği ve güvenirliği. Türk Psikiyatri Dergisi. 1999;10(4):261-7.
[12] Ağargün MY, Kara H, Anlar Ö. Pittsburgh uyku kalitesi indeksinin geçerliliği ve güvenilirliği. Türk Psikiyatrist Dergisi. 1996;7(2):107-15.
[13] Lark SD, Pasupuleti S. Validity of a functional dynamic walking test for the elderly. Arch Phys Med Rehabil. 2009;90(3):470-4.
[14] Balaban Ö, Nacır B, Erdem HR, Karagöz A. Denge fonksiyonunun değerlendirilmesi. FTR Bil Der. 2009;12(3):133-9.
[15] Robertson M, Gregory R. Concurrent validation of the tandem walk test as a measure of dynamic walking balance in a healthy population. Phys Ther Rehabil. 2017;4(12).
[16] SavcıS, Öztürk M, Arıkan H, İnal İnce D, Tokgözoğlu L. Physical activity levels of university students. Turk Kardiyol Dern Ars. 2006;34(3):166-72.
[17] Armutlu K, Cetisli Korkmaz N, Keser I, Sumbuloglu V, Akbiyik DI, Guney Z, et al. The validity and reliability of the Fatigue severity scale in turkish multiple sclerosis patients. Int J Rehabil Res. 2007;30(1):81-5.
[18] Küçükdeveci AA, Mckenna SP, Kutlay S, Gürsel Y, Whalley D, Arasıl T. The development and pyscometric assesment of the Turkish version of the Nottingham Health Profile. Int J Rehabil Res. 2000;23(1):31-8.
[19] Vidya S, Patlolla VR, Kamuju NR, Ampalam P, N. Kalyan VK. Impact of shift work on sleep and quality of life in

industrial workers: A cross sectional study. Archives of Mental Health. 2019;20(2):45-9.

[20] Elhami Athar M, Atef-Vahid MK, Ashouri A. The influence of shift work on the quality of sleep and executive functions. J Circadian Rhythms. 2020;18:4.

[21] Thomas M, Sing H, Belenky G, Holcomb H, Mayberg H, Dannals R, et al. Neural basis of alertness and cognitive performance impairments during sleepiness. J Sleep Res. 2000;9(4):335-52.

[22] Fabbri M, Martoni M, Esposito MJ, Brighetti G, Natale V. Postural control after a night without sleep. Neuropsychologia. 2006;44(12):2520-5.

[23] Narciso FV, Barela JA, Aguiar SA, Carvalho ANS, Tufik S, de Mello MT. Effects of shift work on the postural and psychomotor performance of night workers. PLoS One. 2016;11(4):e0151609.

[24] Flahr H, Brown WJ, Kolbe Alexander TL. A systematic review of physical activity-based interventions in shift workers. Prev Med Rep. 2018;10:323-31.

[25] Atkinson G, Fullick S, Grindey C, Maclaren D. Exercise, energy balance and the shift worker. Sports Med. 2008;38(8):671-85.

[26] Ferri P, Guadi M, Marcheselli L, Balduzzi S, Magnani D, DiLorenzo R. The impact of shift work on the psychological and physical health of nurses in a general hospital: a comparison between rotating night shifts and day shifts. Risk Manag Healthc Policy.2016;9:203-11.

[27] Özdemir PG, Ökmen AC, Yılmaz O. Vardiyalı çalışma bozukluğu ve vardiyalı çalışmanın ruhsal ve bedensel etkileri. Psikiyatride Güncel Yaklaşımlar. 2018;10(1): 71-83.

[28] Yıldırım D, Yıldırım A, Eryılmaz M. Sağlık çalışanlarında fiziksel aktivite ile yaşam kalitesi ilişkisi. Cukurova Med J. 2019;44(2):325-33.

[29] Aguiar SA, Barela JA. Adaptation of sensorimotor coupling in postural control is impaired by sleep deprivation. PLoS ONE. 2015;10(3):e0122340.

[30] Hita-Contreras F, Zagalaz-Anula N, Martinez-Amat A, Cruz-Diaz D, Sanchez-Montesinoz I, Aibar-Almazan A, et al. Sleep quality and its association with postural stability and fear of falling among Spanish postmenopausal women. Menopause. 2018;25(1):62-9.

[31] Saraiva M, Marouvo J, Fernandes O, Castro MA, Villas-Boas JP. Postural control and sleep quality in cognitive dual tasking in healthy young adults. Multidisciplinary Scientific Journal. 2021;4(3):257-65.

[32] Wadley AL, Iacovides S, Roche J, Scheuermaier K, Venter WDF, Vos AG, et al. Working nights and lower leisure-time physical activity associated with chronic pain in Southern African long-distance truck drivers: A cross-sectional study. PLoS ONE. 2020;15(12):e0243366.

[33] Kaliyaperumal D, Elango Y, Santhanakrishnan I. Fatigue, depression and anxiety among nurses working in shift in a tertiary care hospital in South India. International Journal of Research in Medical Sciences. 2019;7(7):2655-9.

[34] Gunawardane DA, Dharmaratne SD. Level of fatigue and daytime sleepiness among heavy vehicle drivers in Sri Lanka. South East Asia Journal of Public Health. 2014;4(1):9-16.

[35] Alami YZ, Ghanim BT, Zyoud SH. Epworth sleepiness scale in medical residents: quality of sleep and its relationship to quality of life. J Occup Med Toxicol. 2018;13:21.

[36] Youngstedt SD, Perlis ML, O'Brien PM, Palmer CR, Smith MT, Orff HJ, et al. No association of sleep with total daily physical activity in normal sleepers. Physiol Behav. 2003;78(3):395-401.

[37] Park H, Suh B. Association between sleep quality and physical activity according to gender and shift work. J Sleep Res. 2020;29(6):e12924.

[38] Vlahoyiannis A, Karali E, Giannaki CD, Karioti A, Pappas A, Lavdas E, et al. The vicious circle between physical, psychological, and physiological characteristics of shift work in nurses: a multidimensional approach. Sleep Breat Mar. 2022;26(1):149-56.

[39] Palhares VC, Corrente JE, Matsubara BB. Association between sleep quality and quality of life in nursing professionals working rotating shifts. Rev Saúde Pública. 2014;48(4):594-601.

[40] Ekici G, Demirbaş M. Vardiyalı çalışan kadın hemşirelerde rol-aktivite dengesi ve yaşam kalitesi arasındaki ilişkinin incelenmesi. Ergoterapi ve Rehabilitasyon Dergisi. 2020;8(2):91-8.

[41] McKenna H, Wilkes M. Optimising sleep for night shifts. BMJ. 2018;360:j5637.