Original Article / *Özgün Makale*

DOI: 10.4274/jtsm.galenos.2022.48278

*Journal of Turkish Sleep Medicine 2022;9:269-277*

# *The Relationship Between Nutritional Status and Cognitive Functions of Shift Health Workers*

## *Vardiyalı Çalışan Sağlık Çalışanlarının Beslenme Durumu ile Bilişsel İşlevleri Arasındaki İlişki*

Aslı Yağmur Kulak, Esen Yeşil

*Başkent University Faculty of Health Sciences, Department of Nutrition and Dietetics, Ankara, Turkey*

### Abstract

**Objective:** In this study was aimed to determine the nutritional status, and to evaluate the cognitive functions of healthcare workers working shifts and the ones not working shifts.

**Materials and Methods:** This study was conducted between July and August 2021 100 volunteers (shift: 50, non-shift: 50) between the ages of 25 and 50. Socio-demographic characteristics, nutritional status and cognitive functions of individuals were evaluated.

**Results:** The mean age of individuals is 36.2±6.82 years. It was determined that individuals working shifts drank alcohol, had chronic diseases and skipped meals at a higher rate than individuals who worked non-shifts. Additionally, it was observed that individuals working shifts had less daily water consumption and more coffee and tea consumption than non-shift individuals ($p<0.05$). It was determined that women working shifts had a higher body mass index (BMI) than women who worked non-shifts ($p<0.05$). The cognitive assessment score of individuals in the normal BMI range (25.9±2.54) was statistically significantly higher than that of obese individuals (24.2±2.93) ($p<0.05$). There was a positive correlation between the Montreal cognitive asssessment scale score and dietary intake of polyunsaturated fatty acids, omega-6, vitamin E, vitamin K in shift workers.

**Conclusion:** It was concluded that the cognitive assessment scores of shift workers were lower than those of non-shift workers. We observed that the shift work system also creates significant differences in terms of eating habits and nutritional status.

**Keywords:** Nutritional status, cognitive dysfunction, shift, circadian rhythm

### Öz

**Amaç:** Bu çalışmada, vardiyalı çalışan sağlık personelinde sirkadiyen ritmin bozulmasına bağlı olarak beslenme durumlarındaki değişiklikler ile bilişsel fonksiyonlar üzerinde görülen bozulmaların araştırılması amaçlanmıştır.

**Gereç ve Yöntem:** Bu çalışma Temmuz-Ağustos 2021 tarihleri arasında 25-50 yaş aralığındaki 100 gönüllü (vardiyalı: 50, vardiyasız: 50) birey ile yürütülmüştür. Bireylerin sosyo-demografik özellikleri, beslenme durumları ve bilişsel fonksiyonları anket formu ile değerlendirilmiştir.

**Bulgular:** Bireylerin yaş ortalaması 36,2±6,82 yıldır. Vardiyalı çalışan bireylerin vardiyasız çalışan bireylere göre daha fazla oranla alkol kullandığı, kronik hastalıklara sahip olduğu ve öğün atladığı belirlenmiştir. Ayrıca vardiyalı çalışan bireylerin vardiyasız çalışan bireylere göre günlük su tüketimlerinin daha az, kahve ve çay tüketimlerinin daha fazla olduğu görülmüştür ($p<0,05$). Vardiyalı çalışan kadınların vardiyasız çalışan kadınlara göre daha yüksek beden kütle indeksi (BKİ) değerine sahip olduğu belirlenmiştir ($p<0,05$). Normal BKİ aralığında bulunan bireylerin bilişsel değerlendirme puanı (25,9±2,54) obez bireylerin puanına (24,2±2,93) göre istatistiksel açıdan anlamlı şekilde yüksek bulunmuştur ($p<0,05$). Vardiyalı çalışan bireylerin Montreal bilişsel değerlendirme ölçeğinden aldıkları puan ile diyetle çoklu doymamış yağ asidi, omega-6 ve E vitamini alımları arasında pozitif; vardiyasız çalışan bireylerin ise bitkisel protein, posa, çözünmez posa, A vitamini, B1 vitamini, B3 vitamini, folat, magnezyum, demir, çinko ve bakır alımları arasında negatif bir ilişki saptanmıştır.

**Sonuç:** Vardiyalı çalışanların bilişsel değerlendirme puanlarının vardiyasız çalışanlara göre daha düşük olduğu sonucuna varılmıştır. Vardiyalı çalışma sisteminin beslenme alışkanlıkları ve beslenme durumu açısından da önemli fark yarattığı gözlemlenmiştir.

**Anahtar Kelimeler:** Beslenme durumu, bilişsel değerlendirme, vardiya, sirkadiyen ritim

**Address for Correspondence/Yazışma Adresi:** Esen Yeşil PhD, Başkent University Faculty of Health Sciences, Department of Nutrition and Dietetics, Ankara, Turkey
**Phone:** +90 533 243 54 50 **E-mail:** esezer@baskent.edu.tr **ORCID-ID:** orcid.org/0000-0003-0234-204X
**Received/Geliş Tarihi:** 07.03.2022 **Accepted/Kabul Tarihi:** 23.05.2022

## Introduction

Shift work is defined as the periodical and successive work of different groups at all times of the day or week without interruption in the workplaces that are constantly active due to the nature of the work (1). The circadian rhythm, which regulates most of the behavioral and physiological processes, allows sleep and rest of the human at night. The circadian system provides the organism's adaptation to the environment and it allows optimal functioning of the temporal lobe, regulates endogenous processes, and ensures a quality life cycle. Therefore, working in a shift system, particularly in the night shift, affects physical and mental performance and social relations negatively, and it also deteriorates circadian rhythm and general wellbeing (2).

Irregular eating habits and metabolic problems brought about by shift work have been growing, and cannot be ignored. Shift workers are at greater risk for physical and mental health conditions such as obesity, type 2 diabetes, cardiovascular disease, hypertension, digestive problems, depression and anxiety (3,4).

The shift work system also changes the eating habits. Particularly in night shifts, the frequency of meals decreases, suppression of hunger with snacking increases, and the habit of eating with the family is affected negatively (3).

In individuals who sleep late, increased consumption of high-fat foods and unhealthy snacks have been correlated with insufficient sleep time and decreased cognitive and decision-making functions. In the studies, it has been mentioned that having breakfast has a positive effect on cognitive functions (5,6). It was concluded that a diet low in saturated fat and cholesterol, and high in carbohydrates, fiber, vitamins (particularly vitamins C, E and folate) and minerals (particularly iron and zinc) would be beneficial in terms of cognitive functions (7). It has been supposed that cognitive decline would slow down with plant foods with anti-inflammatory properties (such as fruits, cocoa, green tea, coffee and hazelnuts), a diet rich in polyphenols and phytonutrients (8).

Studies have shown the negative effects of shift work on the cognitive level (9,10). In a cross-sectional cohort study by Rouch et al. (9), it was shown that shift work was associated with poorer cognitive processing speed. In shift workers, sleep deprivation showed a significant correlation with hypovigilance and impaired cognitive functions (11).

In the light of the aforementioned literature information, in this study, it was aimed to determine the nutritional status, and to evaluate the cognitive functions of healthcare workers working in shifts and the ones not working in shifts.

## Materials and Methods

### Participants and procedures

This study was carried out between July and August 2021 with the participation of 100 individuals who worked in the hospital (50 shift workers, 50 non-shift workers) between the ages of 25-50 years, in order to determine the nutritional status and cognitive functions of healthcare workers working in fixed and rotational shifts. Healthcare personnel with psychiatric illness were not included in the study. Ethical approval of the study was obtained (KA21/231). The consent form was signed by the individuals participating in the study.

The study data were obtained with a face-to-face interview method, asking the questions of a questionnaire. The questionnaire included questions on the demographic characteristics, eating habits, and the general health status of the individual, and anthropometric measurements were obtained. In addition to the questionnaire, a 24-hour food consumption record was kept, and the Montreal cognitive assessment (MoCA) scale was applied to the participants.

### Anthropometric measurements

Anthropometric measurements (height, weight, waist circumference, hip circumference) of the participants were measred with an inflexible tape measure. Body weight was measured with light clothing and no shoes. The body mass index (BMI) of the individuals was calculated by dividing the body weight by the square meter of the height [body weight (kg)/height$^2$ (m)]. World Health Organization standardizes the individual as underweight if BMI is less than 18.5 kg/m$^2$, as normal if BMI is between ≥18.5-<24.9 kg/m$^2$, as overweight if BMI is between ≥25.0-<29.9 kg/m$^2$ and as obese if BMI is ≥30 kg/m$^2$ (12). The waist/height ratio was calculated by dividing the waist circumference by the height (13). The waist/hip ratio determined by dividing the waist circumference by the hip circumference.

### Nutritional status

Dietary intake of the subjects was assessed by 24-hour recall. The nutrition information system (BEBIS) version 7.2 was used to calculate the energy, macro- and micronutrients consumed daily. Calculated energy and nutrient data were evaluated according to the recommended "Dietary reference intake level" (DRI) in relation with age (DRI) (14).

### MoCA scale

This scale was developed by Nasreddine et al. (15) distinguish normal individuals from the individuals with mild mental problems. It was adapted to Turkish by Selekler et al. (16). The scale includes domains of visuospatial/executive, naming, memory, attention, language, abstraction, delayed recall and orientation. The maximum score that can be obtained from the scale is 30, and the minimum score is 0. A score of 21 and above is considered as normal.

### Statistical Analysis

The research data were recorded for analysis in the Statistical Package for the Social Sciences (IBM SPSS Statistics 22) software. Continuous variables obtained from the questionnaires were expressed as mean ($\bar{x}$), standard deviation and minimum-maximum values, and discrete variables as number (n) and percentage (%). The conformity of the data to the normal distribution was analyzed with Kolmogorov-Smirnov test. The analysis of the relationship between groups was done with chi-square test for categorical variables, Student t-test was employed for analysis of significance between two groups for data with normal distribution, Mann-Whitney U test was used for analysis of difference between two groups in non-normally distributed data, and Kruskal-Wallis test was used to analyze the difference among more than two groups. The analysis of the correlation between numerical variables was done with Pearson correlation for data with normal distributions. The statistical significance level was set at $p<0.05$.

## Results

While 46.0% of the individuals working in shifts were male and 54.0% were female, these rates were found as 38.0% and 62.0%, respectively, in the individuals working non-shifts ($p>0.05$). The mean ages of the individuals working in shifts and non-shifts were found as 37.8±6.0 and 36.7±7.5 years, respectively. The mean number of daily main meals was determined to be lower in shift workers compared to non-shift workers ($p=0.001$). It was determined that there was a statistically significant difference between the type of shift and the skipped meal ($p=0.000$). It was determined that there was a statistically significant difference between the type of shift and the speed of eating ($p=0.003$). A statistically significant difference was found between the types of shifts and the food consumed at snack time ($p=0.003$). A statistically significant difference was found between the daily water, tea-herbal tea and coffee consumption between the individuals working in shifts and non-shifts ($p=0.002$; $p=0.009$; $p=0.000$). The mean total cognitive assessment scores of the individuals working in shifts and not working in shifts were 24.2±2.91 and 25.8±2.37, respectively. It was concluded that the cognitive assessment scores of individuals working non- shifts were significantly higher ($p=0.008$) (Table 1). The BMIs of the women working in shifts was found to be significantly higher than the BMIs of the women working in non-shifts ($p=0.036$) (Table 2).

The mean daily fat consumption of the individuals working in shifts (87.5±30.16 g) was found to be significantly higher than the individuals working in non-shifts (73.0±31.59 g) ($p=0.021$). Dietary total fat, saturated fatty acid, cholesterol, and omega-6 intakes of the individuals working in shifts were found to be higher than those working in non-shifts ($p=0.021$, $p=0.014$, $p=0.040$, $p=0.031$) (Table 3). A statistically significant difference was found between the individuals working in shifts and the ones not working in shifts for intake of vitamin B3 only, one of the micronutrients ($p<0.05$) (Table 3).

There was a positive correlation between the MoCA score of shift workers and their dietary intake of polyunsaturated fatty acids, omega-6, vitamin E and K and a negative correlation was found between the MoCA scores of individuals working in non-shifts and their dietary intake of vegetable protein, fiber, insoluble fiber, vitamin A, vitamin B1, vitamin B3, folate, magnesium, iron, zinc and copper (Table 4).

## Discussion

In order to carry out uninterrupted and continuous healthcare services, healthcare workers need to work in all times (17). The results of shift work showed that the short-term negative effects were sleep disorders, depression and work accidents due to fatigue. In the long term, these conditions may interact, and mental disorders such as depression may cause insomnia, and sleep problems may cause cognitive problems (18). It was planned to determine the nutritional status of the healthcare workers working in shifts and not working in shifts, and to evaluate their cognitive functions.

In order to minimize the negative effects, the individuals aged 45 years and older working in shifts have been recommended to limit night shift work, to allow freedom in shift selection, to reduce workload, to limit working hours, to make more frequent health checks, to encourage adequate sleep, healthy nutrition and physical activity (19). In this study, the mean age of the healthcare workers working in shifts was 37.8±6.0 years, and was 36.7±7.5 years in the ones not working in shifts ($p>0.05$). The mean age of the shift workers included in this study was younger than the specified age range (≥45 years).

A cross-sectional study was conducted by Kim et al. (20) using a web-based questionnaire, and it was reported that nurses working in shifts skipped breakfast and lunch more frequently. It was reported that reasons such as tiredness, and not having time to shop or prepare meals led to skipping meals or choosing unhealthy food in shift workers (21). In this study, 70% of shift workers and 40% of non-shift workers stated that they skipped meals ($p<0.05$). It has been determined that individuals who work in shifts skip breakfast more than the individuals who work in non-shifts ($p<0.05$). This is the most important point because studies discussing the positive effects of having breakfast on cognitive functions are noteworthy in the literature (5,6).

In this study, 42.0% of the individuals working in shifts stated that they preferred candy, chocolate and wafers for snacks, while 50.0% of the individuals not working in shifts stated that they consumed fruits for snacks ($p<0.05$). Due to the busy working hours of healthcare personnel, it should be taken into account that snacks or refreshments in daily nutrition may increase consumption of simple sugars. In this study, when the snack choices of individuals working in shifts were examined, it was recognized that they tended to prefer snacks with high simple sugar contents instead of healthy foods. In a different study conducted by Chan (22), it was determined that the consumption of "junk food" increased during the night shift.

In a study investigating the relationship between working in the night shift and daily caffeine consumption, it was found that coffee consumption was significantly higher in night shift workers (23). Likely, in this study, 74% of shift workers and 46% of non-shift workers reported that they consumed tea and coffee for snacks. Daily consumption of tea, herbal tea and coffee was found to be statistically significantly higher in shift workers than in non-shift workers ($p<0.05$).

While 50% of the individuals working in shifts stated that they ate food fast, this rate was determined as 30% in non-shift workers. It was determined that there was a statistically significant difference between the type of shift and the speed of eating ($p=0.003$). It is thought that this difference is due to not planning enough time for meal time while working in shifts.

BMI results were found above normal in both shift types. The BMI value of women working in shifts was found to be

**Table 1. Distribution of the demographic characteristics of the individuals**

| | Shift (n=50) | | Non-shift (n=50) | | Total (n=100) | | p |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| **Gender** | | | | | | | |
| Male | 23 | 46.0 | 19 | 38.0 | 42 | 42.0 | 0.272$^{\alpha}$ |
| Female | 27 | 54.0 | 31 | 62.0 | 58 | 58.0 | |
| **Age (year) ($\bar{x}$ ± SD)** | 37.8±6.07 | | 36.7±7.53 | | 36.2±6.82 | | 0.581$^{\mu}$ |
| Marital status | | | | | | | |
| Married | 39 | 78.0 | 33 | 66.0 | 72 | 72.0 | 0.133$^{\alpha}$ |
| Single | 11 | 22.0 | 17 | 34.0 | 17 | 28.0 | |
| **Education** | | | | | | | |
| High school | 9 | 18.0 | 7 | 14.0 | 16 | 16.0 | 0.118$^{\alpha}$ |
| Associate degree | 15 | 30.0 | 20 | 40.0 | 35 | 35.0 | |
| Undergraduate degree | 10 | 20.0 | 16 | 32.0 | 26 | 26.0 | |
| Postgraduate degree | 16 | 32.0 | 7 | 14.0 | 23 | 23.0 | |
| **Job** | | | | | | | |
| Doctor/pharmacist | 15 | 30.0 | 8 | 16.0 | 23 | 23.0 | 0.253$^{\alpha}$ |
| Nurse/physiotherapist/midwife | 18 | 36.0 | 25 | 50.0 | 43 | 43.0 | |
| Administrative personnel | 15 | 30.0 | 13 | 26.0 | 28 | 28.0 | |
| Allied health personnel | 2 | 4.0 | 4 | 8.0 | 6 | 6.0 | |
| **Number of main meals ($\bar{x}$ ± SD)** | 2.2±0.73 | | 2.6±0.54 | | 2.4±0.61 | | **0.001$^{\mu}$** |
| **Number of snack ($\bar{x}$ ± SD)** | 2.3±0.92 | | 2.0±0.88 | | 2.1±0.97 | | 0.117$^{\mu}$ |
| **Skipping meals** | | | | | | | |
| Yes | 35 | 70.0 | 20 | 40.0 | 55 | 55.0 | **0.002$^{\alpha}$** |
| No | 15 | 30.0 | 30 | 60.0 | 45 | 45.0 | |
| **Skipped meal** | | | | | | | |
| Breakfast | 30 | 60.0 | 7 | 14.0 | 37 | 37.0 | **0.000$^{\alpha}$** |
| Lunch | 5 | 10.0 | 10 | 20.0 | 15 | 15.0 | |
| Dinner | - | - | 3 | 6.0 | 3 | 3.0 | |
| **Reason for skipping meal** | | | | | | | |
| Lack of time | 6 | 12.0 | - | - | 6 | 6.0 | 0.055$^{\alpha}$ |
| Loss of appetite | 15 | 30.0 | 7 | 14.0 | 22 | 22.0 | |
| The desire to lose weight | 4 | 8.0 | 7 | 14.0 | 11 | 11.0 | |
| No habit | 7 | 14.0 | 2 | 4.0 | 9 | 9.0 | |
| Nobody prepares | 3 | 6.0 | 4 | 8.0 | 7 | 7.0 | |
| **Rate of eating** | | | | | | | |
| Slow | 2 | 4.0 | 8 | 16.0 | 10 | 10.0 | **0.003$^{\alpha}$** |
| Moderate | 9 | 18.0 | 21 | 42.0 | 30 | 30.0 | |
| Fast | 25 | 50.0 | 15 | 30.0 | 40 | 40.0 | |
| Very fast | 14 | 28.0 | 6 | 12.0 | 20 | 20.0 | |
| **Eating outside** | | | | | | | |
| Yes | 48 | 96.0 | 46 | 92.0 | 94 | 94.0 | 0.678$^{\alpha}$ |
| No | 2 | 4.0 | 4 | 8.0 | 6 | 6.0 | |
| **Frequency of eating outside** | | | | | | | |
| Every day | 2 | 4.0 | 6 | 12.0 | 8 | 8.0 | 0.211$^{\alpha}$ |
| Every other day | 11 | 22.0 | 8 | 16.0 | 19 | 19.0 | |
| Once/twice a week | 13 | 26.0 | 9 | 18.0 | 22 | 22.0 | |
| Every two weeks | 9 | 18.0 | 15 | 30.0 | 24 | 24.0 | |
| Once a month | 13 | 26.0 | 8 | 16.0 | 21 | 21.0 | |

**Table 1. Continued**

| | **Shift (n=50)** | | **Non-shift (n=50)** | | **Total (n=100)** | | **p** |
|---|---|---|---|---|---|---|---|
| | **n** | **%** | **n** | **%** | **n** | **%** | |
| **The meal eaten outside** | | | | | | | |
| Breakfast | - | - | 4 | 8.0 | 4 | 4.0 | **0.028**[α] |
| Lunch | 29 | 58.0 | 18 | 36.0 | 47 | 47.0 | |
| Dinner | 19 | 38.0 | 24 | 48.0 | 43 | 43.0 | |
| **Eating at night** | | | | | | | |
| Yes | 7 | 14.0 | - | - | 7 | 7.0 | 0.107[α] |
| No | 25 | 50.0 | 44 | 88.0 | 69 | 69.0 | |
| Sometimes | 18 | 36.0 | 6 | 12.0 | 24 | 24.0 | |
| **Snack food** | | | | | | | |
| Bagel, biscuits, cookies | 7 | 14.0 | 9 | 18.0 | 16 | 16.0 | 0.003[α] |
| Sandwich, toast, pastry | 8 | 16.0 | 1 | 2.0 | 9 | 9.0 | |
| Yogurt, cheese | 9 | 18.0 | 8 | 16.0 | 17 | 17.0 | |
| Fruits | 5 | 10.0 | 25 | 50.0 | 30 | 30.0 | |
| Candy, chocolate, wafer | 21 | 42.0 | 7 | 14.0 | 28 | 28.0 | |
| **Snack beverages** | | | | | | | |
| Milk, yogurt drink | - | - | 16 | 32.0 | 16 | 16.0 | 0.211[α] |
| Fruit juice | 4 | 8.0 | 6 | 12.0 | 10 | 10.0 | |
| Coke | 9 | 18.0 | 5 | 10.0 | 14 | 14.0 | |
| Tea, coffee | 37 | 74.0 | 23 | 46.0 | 60 | 60.0 | |
| **Water consumption ($\bar{x}$ ± SD)** | 9.7±3.12 | | 12.0±3.69 | | 10.9±3.58 | | 0.002[µ] |
| **Tea, herbal tea consumption ($\bar{x}$ ± SD)** | 5.4±3.54 | | 3.8±2.56 | | 4.6±3.18 | | 0.009[µ] |
| **Coffee consumption ($\bar{x}$ ± SD)** | 1.6±0.71 | | 0.8±0.52 | | 1.2±0.78 | | 0.000[µ] |
| Cognitive impairment (<21 points) | 3 | 6.0 | - | - | 3 | 3.0 | 0.242[α] |
| Normal cognitive functions (≥21 points) | 47 | 94.0 | 50 | 100.0 | 97 | 97.0 | |
| MoCA total score ($\bar{x}$ ± SD) | 24.2±2.91 | | 25.8±2.37 | | 25.1±2.75 | | **0.008**[µ] |

[α]: Chi-square test, [µ]: Mann-Whitney U test, SD: Standard deviation

significantly higher than the BMI value of women working in non-shifts ($p<0.05$). It has been supposed that this is due to the irregularity of meal times and the consumption of more sugary foods and beverages at snacks. A similar study on 210 participants reported that shift workers had higher BMIs (27.6±3.92) compared to non-shift workers (26.7±3.61) ($p<0.05$) (24). In shift workers, sleep restriction, decreased glucose tolerance, increased insulin resistance, and disruption of the rhythmicity of adipocyte factors such as leptin and resistin may explain the development of obesity and high waist circumference (25-27).

A cross-sectional study was conducted on 51 nurses working the night shift in Poland. Food consumption records of the nurses were taken for 3 days, before the night shift, during the night shift and on the day off. The results of the study revealed that total energy, water and fiber, Ca, Mg, Fe and vitamin K, vitamin D and folate intakes were lower than the recommended amounts. Higher intakes of animal protein, fat, cholesterol, Na, P, Zn, Cu and vitamins A, E, and C were determined (28). In this study, a statistically significant difference was found only for the intake of vitamin B3, one of the micronutrients, between shift and non-shift workers ($p<0.05$). It has been determined that the intakes of vitamins A, K, C, B1, B6, B12, folate, potassium, calcium, magnesium, iron and zinc are below the DRI recommendations in the shift workers. These results show that shift work is an important issue associated with malnutrition. It is thought that they have insufficient knowledge on issues such as meal planning, healthy food selection, and balanced nutrition.

Fatigue due to shift work impairs cognitive performance and increases the number of problems related to attention deficit (29). In a prospective experimental study (n=62) comparing only the nurses who work during the day and those who work in the evening and at night in alternating shifts (n=62), d2 attention test was employed, and the attention level was found to be statistically significantly lower at 38.99 points in night shift workers ($p<0.05$) (30). Similarly, in this study, it was concluded that the cognitive assessment scores of individuals not working in shifts (25.8±2.37) were significantly higher than the ones working in shifts (24.2±2.91) ($p=0.008$).

A number of studies have investigated the positive effects of dietary components on cognitive functions (31,32). It supports the role of consumption of antioxidant-rich foods such as fruits, vegetables and nuts in delaying, improving and preventing cognitive decline (33,34). Olive oil consumption improves cognitive functions in the short term, and it has positive effects on cognition in the long term (35,36). MoCA scores of the individuals working in shifts showed a positive correlation with dietary intakes of polyunsaturated fatty acids, omega-6, and vitamin E while non-shift workers scores' showed a negative correlation with dietary intakes of vegetable proteins, fiber, insoluble fiber, vitamin A, vitamin B1, vitamin B3, folate, magnesium, iron, zinc and copper. This suggests that malnutrition in shift workers is associated with cognitive function.

### Study Limitations

Recording of the food consumption of the individuals by the dietitian on the shift day and investigating their nutritional status and cognitive functions together increase the value of this study. On the other hand, since this study was planned and conducted as a cross-sectional study, the changes in nutritional status and cognitive functions due to disruption of circadian rhythm could not be determined precisely as a cause and effect relationship in healthcare workers working in shifts. This is a significant limitation of the study. Another limitation is that no conclusions could have been made on the relationship of sleep duration and eating habits. Also the psychiatric disease screening tests (such as Beck depression and Beck anxiety) that play an important role in cognitive assessment but were not used in the study.

## Conclusion

It was concluded that the cognitive assessment scores of shift workers were lower than those of non-shift workers. It was observed that the shift work system also creates significant differences in terms of eating habits. On the other hand, a

**Table 2. Anthropometric measurements**

| | **Male** | | | | |
|---|---|---|---|---|---|
| | **Shift (n=23)** | | **Non-shift (n=19)** | | **$p^{\mu}$** |
| | **$\bar{x}$ ± SD** | **min-max** | **$\bar{x}$ ± SD** | **min-max** | |
| **Height (cm)** | 178.4±7.17 | 168.0-198.0 | 177.1±6.09 | 167.0-190.0 | 0.436 |
| **Weight (kg)** | 88.0±12.43 | 72.0-120.0 | 86.8±12.46 | 70.0-110.0 | 0.761 |
| **BMI ($kg/m^2$)** | 27.6±3.56 | 22.2-33.5 | 27.7±4.21 | 21.6-34.7 | 0.869 |
| **Waist circumference (cm)** | 111.3±15.05 | 86.0-136.0 | 105.5±16.23 | 85.0-132.0 | 0.184 |
| **Hip circumference (cm)** | 113.9±10.64 | 95.0-130.0 | 113.5±14.57 | 95.0-140.0 | 0.810 |
| **Waist/height** | 0.6±0.11 | 0.5-0.8 | 0.6±0.14 | 0.5-0.8 | 0.324 |
| **Waist/hip** | 1.0±0.19 | 0.9-1.1 | 0.9±0.01 | 0.9-1.0 | **0.006** |
| | **Female** | | | | |
| | **Shift (n=27)** | | **Non-shift (n=31)** | | **$p^{\mu}$** |
| | **$\bar{x}$ ± SD** | **min-max** | **$\bar{x}$ ± SD** | **min-max** | |
| **Height (cm)** | 163.0±7.82 | 150.0-180.0 | 162.2±6.94 | 150.0-176.0 | 0.766 |
| **Weight (kg)** | 71.1±13.15 | 54.0-100.0 | 64.6±8.62 | 50.0-80.0 | 0.120 |
| **BMI ($kg/m^2$)** | 26.7±3.98 | 20.5-33.4 | 24.5±3.06 | 19.6-31.2 | **0.036** |
| **Waist circumference (cm)** | 104.1±15.73 | 77.0-135.0 | 101.1±11.46 | 82.0-127.0 | 0.596 |
| **Hip circumference (cm)** | 114.5±13.54 | 95.0-146.0 | 111.8±10.18 | 98.0-139.0 | 0.434 |
| **Waist/height** | 0.6±0.17 | 0.5-0.8 | 0.6±0.14 | 0.5-0.8 | 0.640 |
| **Waist/hip** | 0.9±0.01 | 0.8-1.0 | 0.9±0.07 | 0.8-1.0 | 0.294 |
| | **Total** | | | | |
| | **Shift (n=50)** | | **Non-shift (n=50)** | | **$p^{\mu}$** |
| | **$\bar{x}$ ± SD** | **min-max** | **$\bar{x}$ ± SD** | **min-max** | |
| **Height (cm)** | 170.1±10.72 | 150.0-198.0 | 167.8±9.81 | 150.0-190.0 | 0.274 |
| **Weight (kg)** | 78.9±15.28 | 54.0-120.0 | 73.1±14.86 | 50.0-110.0 | 0.057 |
| **BMI ($kg/m^2$)** | 27.1±3.77 | 20.5-33.5 | 25.7±3.83 | 19.6-34.7 | 0.071 |
| **Waist circumference (cm)** | 107.4±15.73 | 77.0-136.0 | 102.8±13.54 | 82.0-132.0 | 0.113 |
| **Hip circumference (cm)** | 114.2±12.19 | 95.0-146.0 | 112.5±11.92 | 95.0-140.0 | 0.460 |
| **Waist/height** | 0.6±0.11 | 0.5-0.8 | 0.6±0.15 | 0.5-0.8 | 0.310 |
| **Waist/hip** | 0.9±0.18 | 0.8-1.1 | 0.9±0.08 | 0.8-1.1 | **0.410** |

$^{\mu}$: Mann-Whitney U test, SD: Standard deviation, BMI: Body mass index relationship was found between the cognitive functions of shift workers and their dietary fat (in addition to polyunsaturated fatty acids and omega-6) intakes. Nutrition education should be planned for shift workers and they should be informed about healthy foods. Therefore, further studies are needed to investigate the long-term clinical effects of disrupted circadian rhythm in healthcare workers working in shifts.

**Table 3. Nutritional status**

| | **Shift (n=50)** | | **Non-shift (n=50)** | | **Total (n=100)** | | **p**[µ] |
|---|---|---|---|---|---|---|---|
| | **x̄ ± SD** | | **x̄ ± SD** | | **x̄ ± SD** | | |
| Energy (kcal) | 1628.3±526.81 | | 1431.0±557.64 | | 1529.6±548.71 | | 0.072 |
| Carbohydrate (g) | 154.5±73.09 | | 146.2±86.24 | | 150.3±79.69 | | 0.606 |
| Carbohydrate (%) | 37.7±10.93 | | 40.0±15.25 | | 38.9±13.22 | | 0.390 |
| Protein (g) | 51.5±18.47 | | 45.6±18.06 | | 48.5±18.47 | | 0.109 |
| Protein (%) | 13.6±2.88 | | 15.4±3.88 | | 13.3±3.33 | | 0.882 |
| Plant base protein (g) | 21.7±10.72 | | 20.7±12.59 | | 21.2±11.64 | | 0.692 |
| Animal base protein (g) | 29.8±14.95 | | 24.9±12.21 | | 27.3±13.86 | | 0.071 |
| Lipid (g) | 87.5±30.16 | | 73.0±31.59 | | 80.2±31.58 | | **0.021** |
| Lipid (%) | 48.7±10.84 | | 44.6±15.42 | | 47.6±13.31 | | 0.402 |
| Saturated fatty acid (g) | 25.9±10.19 | | 21.1±8.89 | | 23.5±9.72 | | **0.014** |
| Monounsaturated fatty acid (g) | 28.7±11.66 | | 25.2±14.87 | | 27.0±13.36 | | 0.200 |
| Polyunsaturated fatty acid (g) | 27.4±13.13 | | 21.9±11.83 | | 24.7±12.74 | | 0.029 |
| Cholesterol (mg) | 210.2±84.57 | | 176.8±83.45 | | 193.5±85.29 | | **0.040** |
| Omega-3 (g) | 1.5±0.74 | | 1.4±0.88 | | 1.5±0.83 | | 0.282 |
| Omega-6 (g) | 25.9±12.91 | | 20.5±11.56 | | 23.2±12.54 | | 0.031 |
| Fiber (g) | 15.8±6.48 | | 15.7±9.11 | | 15.8±7.95 | | 0.943 |
| Insoluble fiber (g) | 10.4±4.55 | | 10.3±6.19 | | 10.4±5.34 | | 0.862 |
| Soluble fiber (g) | 4.6±2.12 | | 4.7±3.03 | | 4.7±2.66 | | 0.755 |
| | **Shift (n=50)** | | **Non-shift (n=50)** | | **Total (n=100)** | | **p**[µ] |
| | **x̄ ± SD** | **DRI %** | **x̄ ± SD** | **DRI %** | **x̄ ± SD** | | |
| Vitamin A (µg) | 624.4±247.84 | 91.4 | 579.4±250.62 | 82.7 | 601.5±249.03 | 86.9 | 0.282 |
| Vitamin E (mg) | 18.3±13.24 | 122.0 | 13.5±13.44 | 90.0 | 15.9±13.48 | 106.0 | 0.084 |
| Vitamin K (mcg) | 60.8±71.44 | 67.5 | 68.9±77.09 | 76.5 | 65.9±13.48 | 73.2 | 0.094 |
| Vitamin C (mg) | 85.3±34.02 | 85.3 | 92.4±57.48 | 90.0 | 88.9±47.35 | 87.8 | 0.560 |
| Vitamin B1 (mg) | 0.7±0.24 | 59.5 | 0.6±0.28 | 54.8 | 0.7±0.26 | 57.1 | 0.458 |
| Vitamin B2 (mg) | 1.2±0.43 | 104.3 | 1.1±0.43 | 92.3 | 1.2±0.43 | 98.1 | 0.214 |
| Vitamin B3 (mg) | 9.4±3.63 | 143.0 | 8.0±3.29 | 117.1 | 8.7±3.52 | 129.6 | **0.045*** |
| Vitamin B6 (mg) | 1.0±0.33 | 78.4 | 0.9±0.34 | 68.9 | 1.0±0.33 | 73.5 | 0.151 |
| Vitamin B12 (µg) | 3.2±1.71 | 82.7 | 2.8±1.61 | 69.4 | 3.0±1.67 | 75.8 | 0.232 |
| Folate (µg) | 264.1±82.20 | 81.7 | 243.9±99.53 | 72.5 | 253.8±93.77 | 76.9 | 0.207 |
| Potassium (mg) | 2028.9±676.29 | 44.0 | 1954.8±776.20 | 40.8 | 1991.1±726.25 | 42.3 | 0.412 |
| Calcium (mg) | 665.4±261.93 | 69.6 | 626.8±245.73 | 63.0 | 645.7±253.25 | 66.2 | 0.490 |
| Magnesium (mg) | 226.8±77.87 | 71.5 | 211.5±100.93 | 65.1 | 219.0±90.24 | 68.2 | 0.113 |
| Phosphorus (mg) | 877.3±279.08 | 162.8 | 788.1±306.86 | 140.5 | 831.8±295.52 | 151.2 | 0.133 |
| Iron (mg) | 7.9±2.60 | 61.7 | 7.5±3.12 | 54.2 | 7.7±2.87 | 57.8 | 0.196 |
| Zinc (mg) | 9.0±2.45 | 76.6 | 8.3±2.63 | 69.2 | 8.6±2.55 | 72.8 | 0.104 |
| Copper (mg) | 1.9±0.54 | 132.0 | 1.8±0.60 | 127.9 | 1.9±0.57 | 129.9 | 0.475 |

µ: Mann-Whitney U test, SD: Standard deviation, DRI: Dietary reference intake

**Table 4. MoCA and nutrients**

| | Shift (n=50) | | Non-shift (n=50) | |
|---|---|---|---|---|
| | r[γ] | p | r[γ] | p |
| Energy (kcal) | 0.203 | 0.158 | -0.189 | 0.189 |
| Carbohydrate (g) | 0.045 | 0.756 | -0.226 | 0.115 |
| Carbohydrate (%) | -0.065 | 0.654 | -0.134 | 0.352 |
| Protein (g) | 0.145 | 0.314 | -0.242 | 0.091 |
| Protein (%) | -0.255 | 0.074 | -0.005 | 0.970 |
| Plant base protein (g) | 0.049 | 0.736 | -0.294 | 0.038* |
| Animal base protein (g) | 0.145 | 0.316 | -0.055 | 0.702 |
| Lipid (g) | 0.308 | 0.030* | -0.008 | 0.956 |
| Lipid (%) | 0.111 | 0.441 | 0.144 | 0.319 |
| Saturated fatty acid (g) | 0.205 | 0.154 | -0.029 | 0.840 |
| Monounsaturated fatty acid (g) | 0.180 | 0.211 | -0.048 | 0.739 |
| Polyunsaturated fatty acid (g) | 0.385 | 0.011* | 0.072 | 0.619 |
| Cholesterol (mg) | 0.002 | 0.988 | 0.012 | 0.933 |
| Omega-3 (g) | 0.086 | 0.553 | -0.209 | 0.146 |
| Omega-6 (g) | 0.359 | 0.010* | 0.088 | 0.543 |
| Fiber (g) | 0.075 | 0.604 | -0.319 | 0.024* |
| Insoluble fiber (g) | 0.058 | 0.687 | -0.349 | 0.013* |
| Soluble fiber (g) | 0.063 | 0.664 | -0.277 | 0.051 |
| Vitamin A (µg) | 0.009 | 0.952 | -0.280 | 0.049* |
| Vitamin E (mg) | 0.360 | 0.010* | 0.041 | 0.778 |
| Vitamin K (mcg) | 0.297 | 0.039* | 0.028 | 0.844 |
| Vitamin C (mg) | 0.084 | 0.562 | -0.208 | 0.147 |
| Vitamin B1 (mg) | 0.027 | 0.851 | -0.325 | 0.021* |
| Vitamin B2 (mg) | 0.193 | 0.179 | -0.166 | 0.248 |
| Vitamin B3 (mg) | 0.135 | 0.352 | -0.408 | 0.003* |
| Vitamin B6 (mg) | 0.127 | 0.379 | -0.346 | 0.014 |
| Folate (µg) | 0.096 | 0.507 | -0.313 | 0.027* |
| Potassium (mg) | 0.256 | 0.076 | 0.049 | 0.732 |
| Vitamin B12 (µg) | -0.022 | 0.880 | -0.168 | 0.245 |
| Calcium (mg) | 0.225 | 0.116 | -0.040 | 0.782 |
| Magnesium (mg) | 0.114 | 0.429 | -0.333 | 0.018* |
| Phosphorus (mg) | 0.227 | 0.117 | 0.160 | 0.263 |
| Iron (mg) | 0.035 | 0.809 | -0.381 | 0.006* |
| Zinc (mg) | 0.122 | 0.400 | -0.314 | 0.026* |
| Copper (mg) | 0.138 | 0.339 | -0.321 | 0.023* |

[γ]Pearson correlation, *p<0.05, MoCA: Montreal cognitive assessment

## Ethics

**Ethics Committee Approval:** This study was approved by Başkent University Institutional Review Board and Ethics Committee [project no: (KA21/231)]. All study procedures were applied in compliance with the Helsinki Declaration.

**Informed Consent:** The consent form was signed by the individuals participating in the study.

**Peer-review:** Externally peer-reviewed.

## Authorship Contributions

Concept: A.Y.K., E.Y., Design: E.Y., Data Collection or Processing: A.Y.K., Analysis or Interpretation: A.Y.K., E.Y., Literature Search: A.Y.K., Writing: E.Y.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study received no financial support.

## References

1. Pati AK, Chandrawshi A, Reinberg A. Shift work: consequence and management. Curr Sci 2002;81:32-47.
2. Laposky AD, Bass J, Kohsaka A, Turek FW. Sleep and circadian rhythms: key components in the regulation of energy metabolism. FEBS Lett 2008;582:142-51.
3. Atkinson G, Fullick S, Grindey C, Maclaren D. Exercise, energy balance and the shift worker. Sports Med 2008;38:671-85.
4. Antunes LDa C, Jornada MN, Ramalho L, Hidalgo MP. Correlation of shift work and waist circumference, body mass index, chronotype and depressive symptoms. Arq Bras Endocrinol Metabol 2010;54:652-6.
5. Bahşi İ, Çetkin M, Kervancıoğlu P, Orhan M, Ayan H, Sayın S. Tıp fakültesi derslerinin verimliliği, işleniş şekli ve öğrencilerin devam kontrolünün değerlendirilmesi. Genel Tıp Derg 2018;28:89-95.
6. Faydaoğlu E, Energin E, Sürücüoğlu MS. Ankara Üniversitesi Sağlık Bilimleri Fakültesinde okuyan öğrencilerin kahvaltı yapma alışkanlıklarının saptanması. Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi 2013;2:299-311.
7. Ortega RM, Requejo AM, Andrés P, López-Sobaler AM, Quintas ME, Redondo MR, Navia B, Rivas T. Dietary intake and cognitive function in a group of elderly people. Am J Clin Nutr 1997;66:803-9.
8. Frith E, Shivappa N, Mann JR, Hébert JR, Wirth MD, Loprinzi PD. Dietary inflammatory index and memory function: population-based national sample of elderly Americans. Br J Nutr 2018;119:552-8.
9. Rouch I, Wild P, Ansiau D, Marquié JC. Shiftwork experience, age and cognitive performance. Ergonomics 2005;48:1282-93.
10. Rollinson D, Rathlev N, Moss M, Killiany R, Sassower K, Auerbach S, Fish SS. The effects of consecutive night shifts on neuropsychological performance of interns in the emergency department: a pilot study. Ann Emerg Med 2003;41:400-6.
11. Leproult R, Colecchia EF, Berardi AM, Stickgold R, Kosslyn SM, Van Cauter E. Individual differences in subjective and objective alertness during sleep deprivation are stable and unrelated. Am J Physiol Regul Integr Comp Physiol 2002;284:R280-90.
12. World Health Organization. Waist circumference and waist-hip ratio report of a who expert consultation. Geneva, 2008;1-47.
13. Ashwell M, Browning LM. The Increasing Importance of Waist-to Height Ratio to Assess Cardiometabolic Risk: A Plea for Consistent Terminology. The Open Obesity Journal 2011;3:70-7.
14. National Institutes of Health. Nutrient Recommendations: Diatary Reference Intakes (DRI). Available from: https://ods.od.nih.gov/Health_Information/Dietary_Reference_Intakes.aspx
15. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, Cummings JL, Chertkow H. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005;53:695-9.
16. Selekler K, Cangöz B, Uluç S. Montreal bilişsel değerlendirme ölçeği (MOBİD)'nin hafif bilişsel bozukluk ve alzheımer hastalarını ayırt edebilme gücünün incelenmesi. Türk Geriatri Dergisi 2010;13:166-71.
17. Geliebter A, Gluck ME, Tanowitz M, Aronoff NJ, Zammit GK. Work-shift period and weight change. Nutrition 2000;16:27-9.
18. Khosravipour M, Khanlari P, Khazaie S, Khosravipour H, Khazaie H. A systematic review and meta-analysis of the association between shift work and metabolic syndrome: The roles of sleep, gender, and type of shift work. Sleep Med Rev 2021. doi: 10.1016/j.smrv.2021.101427.
19. Costa G, Di Milia L. Aging and shift work: a complex problem to face. Chronobiol Int 2008;25:165-81.
20. Kim MJ, Son KH, Park HY, Choi DJ, Yoon CH, Lee HY, Cho EY, Cho MC. Association between shift work and obesity among female nurses: Korean Nurses' Survey. BMC Public Health 2013;13:1204. doi: 10.1186/1471-2458-13-1204.
21. Nea FM, Pourshahidi LK, Kearney JM, Livingstone MBE, Bassul C, Corish CA. A qualitative exploration of the shift work experience: the perceived effect on eating habits, lifestyle behaviours and psychosocial wellbeing. J Public Health (Oxf) 2018;40:e482-e92.
22. Chan MF. Factors associated with perceived sleep quality of nurses working on rotating shifts. J Clin Nurs 2009;18:285-93.
23. Buchvold HV, Pallesen S, Øyane NM, Bjorvatn B. Associations between night work and BMI, alcohol, smoking, caffeine and exercise--a cross-sectional study. BMC Public Health 2015;15:1112.
24. Barbadoro P, Santarelli L, Croce N, Bracci M, Vincitorio D, Prospero E, Minelli A. Rotating shift-work as an independent risk factor for overweight Italian workers: a cross-sectional study. PLoS One 2013;8:e63289. doi: doi: 10.1371/journal.pone.0063289
25. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. PLoS Med 2004;1:e62.
26. Garaulet M, Madrid JA. Chronobiology, genetics and metabolic syndrome. Curr Opin Lipidol 2009;20:127-34.
27. Gómez-Abellán P, Gómez-Santos C, Madrid JA, Milagro FI, Campion J, Martínez JA, Ordovás JM, Garaulet M. Circadian expression of adiponectin and its receptors in human adipose tissue. Endocrinology 2010;151:115-22.
28. Naghashpour M, Amani R, Nematpour, S, Haghighizadeh MH. Dietary, anthropometric, biochemical and psychiatric indices in shift work nurses. Food and Nutrition Sciences 2013;4:1239-46.
29. Dorrian J, Paterson J, Dawson D, Pincombe J, Grech C, Rogers AE. Sleep, stress and compensatory behaviors in Australian nurses and midwives. Rev Saúde Pública 2011;45:922-30.
30. Niu SF, Chu H, Chen CH, Chung MH, Chang YS, Liao YM, Chou KR. A comparison of the effects of fixed-and rotating-shift schedules on nursing staff attention levels: a randomized trial. Biol Res Nurs 2013;15:443-50.
31. Soutif-Veillon A, Ferland G, Rolland Y, Presse N, Boucher K, Féart C, Annweiler C. Increased dietary vitamin K intake is associated with less severe subjective memory complaint among older adults. Maturitas 2016;93:1316.
32. Chouet, J, Ferland, G, Féart, C, Rolland, Y, Presse, N, Boucher, K, Annweiler, C. Dietary vitamin K intake is associated with cognition and behaviour among geriatric patients: the CLIP study. Nutrients 2015;7:6739-50.
33. Chou YC, Lee MS, Chiou JM, Chen TF, Chen YC, Chen JH. Association of Diet Quality and Vegetable Variety with the Risk of Cognitive Decline in Chinese Older Adults. Nutrients 2019;11:1666. doi: 10.3390/nu11071666.
34. Bøhn SK, Myhrstad MCW, Thoresen M, Erlund I, Vasstrand AK, Marciuch A, Carlsen MH, Bastani NE, Engedal K, Flekkøy KM, Blomhoff R. Bilberry/red grape juice decrease plasma biomarkers of inflammation and tissue damage in aged men with subjective memory impairment-a randomized clinical trial. BMC Nutr 2021;7:75.
35. Martínez-Lapiscina EH, Clavero P, Toledo E, Estruch R, Salas-Salvadó J, San Julián B, Sanchez-Tainta A, Ros E, Valls-Pedret C, Martinez-Gonzalez MÁ. Mediterranean diet improves cognition: the PREDIMED-NAVARRA randomized trial. J Neurol Neurosurg Psychiatry 2013;84:1318-25.
36. Mazza E, Fava A, Ferro Y, Rotundo S, Romeo S, Bosco D, Pujia A, Montalcini T. Effect of the replacement of dietary vegetable oils with a low dose of extravirgin olive oil in the Mediterranean diet on cognitive functions in the elderly. J Transl Med 2018;16:10.