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Research article

An evaluation of sleep quality and nutritional status in nurses with different chronotypes

Senanur Gülseven [a], Rana Nagihan Akder [b], Özge Küçükerdönmez [b,*]

[a] Institute of Health Sciences, Ege University, Izmir, Turkey
[b] Department of Nutrition and Dietetics, Faculty of Health Sciences, Ege University, Izmir, Turkey

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ABSTRACT

This study was conducted to investigate the effect of shift work on the sleep quality and nutritional status of nurses with different chronotypes. The study was designed to include 21 people from each chronotype and was completed with 60 participants. The participants were asked to record their food consumption during three different types of shifts they worked over a period of three days. We found that the Pittsburgh Sleep Quality Index (PSQI) score of the evening types was higher than that of the morning types ($p < 0.05$). The evening types had significantly higher weight, BMI, waist circumference, hip circumference, waist-to-height ratio and neck circumference measurements than the morning types ($p < 0.05$). The daily energy, fat and SFA intakes of the morning types were significantly higher for those working 16:00–08:00 and 08:00–08:00 compared to those working 08:00–16:00 ($p < 0.05$). The highest carbohydrate intake was between 08:00–08:00. The amount of carbohydrate, energy and SFA consumed by the intermediate types between 08:00 and 08:00 was significantly higher than that consumed between 08:00 and 16:00. Chronotype and shift hours should also be taken into account when developing nutrition plans for participants who work shifts.

1. Introduction

The circadian system, responsible for regulating sleep, metabolism, hormone secretion, and neurobehavioral processes of living organisms, is an endogenous clock that coordinates the behaviors and physiology of individuals, synchronized with the light-darkness and hunger-fullness periods [1,2]. In mammals, the suprachiasmatic nucleus (SCN) within the hypothalamus serves as the central component of the circadian system, orchestrating various aspects of the sleep-wake cycle [3,4]. This endogenous clock regulates the daily rhythms of peripheral tissues and other regions of the brain, enabling mammals to adapt to the environment [5].

Individuals exhibit variations in their preferred sleep and activity timings based on their internal circadian rhythm, a concept referred to as ‘chronotype’ [6]. People who go to bed early in the evening and wake up early in the morning are called ‘morning type’ people, generally reporting improved well-being and heightened performance in the morning. Conversely, people who go to bed late at night and wake up with difficulty in the morning are called the ‘evening type’. Evening types state that they feel better and their performance is higher in the afternoon. Those who do not fit exclusively into the morning or evening chronotypes, called the ‘intermediate type’, may demonstrate the characteristics of both chronotypes [7,8].

It has been stated that evening type individuals have shorter sleep duration, more frequent use of sleeping pills, longer sleep

* Corresponding author.
E-mail address: ozge.kucukerdonmez@ege.edu.tr (Ö. Küçükerdönmez).

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latency, and therefore poorer sleep quality [9,10]. Additionally, chronotype can affect not only sleep quality but also dietary habits, including the timing of food consumption [11,12]. Studies have shown that chronotype affects nutritional status, nutritional habits, and the intake of macro and micronutrients [2,13–15]. Some studies have emphasized that evening type individuals tend to have lower nutritional quality [15–17]. For instance, healthcare professionals with an evening chronotype were found to have significantly higher daily saturated fat and carbohydrate intake than their counterparts [18]. Evening individuals also exhibited lower adherence to the Mediterranean Diet and a higher tendency to skip breakfast compared to morning individuals [19]. However, a meta-analysis study conducted by Lotti et al. showed that there was no difference in energy intake and anthropometric measurements of individuals with different chronotypes [20]. Similarly, van der Merwe et al. did not find a significant difference in terms of energy and macronutrient intake of morning and evening individuals; it was stated that most of the energy intakes of the evening types were in the late hours [12].

Disruptions or irregularities in the circadian rhythm can lead to changes in biological functions, often associated with adverse health consequences. The shift work system is the leading cause of circadian rhythm disorder [21,22]. Shift workers may have a higher risk of encountering health conditions such as adverse changes in psychosocial factors, physical activity, and nutritional status [23]. In addition, shift work disturbs the sleep-wake cycle, resulting in decreased sleep quality and increased daytime sleepiness due to circadian rhythm sleep disorders [24].

In most countries, healthcare workers hold the highest number of shifts among shift workers [25]. The shift work system is essential in hospitals that provide 24-h health care. Therefore, it is not possible for nurses working in hospitals to abolish this work system [26,27]. Nurses often need to adapt to frequent shifts in their daily work routines, which can make them particularly prone to experiencing circadian misalignment, which is also associated with nutritional status and sleep health [28]. Furthermore, it was observed that the working hours of female nurses had a moderately positive correlation with BMI, waist circumference, body fat percentage, and waist/height ratio [29]. The same study also reported increased carbohydrate, fat, and cholesterol consumption among female nurses during night shifts.

Although the detrimental effects of circadian rhythm disorders are well-established, our understanding of harnessing biological timing for health benefits remains limited [22]. In addition, investigations into the relationship between circadian typology, i.e., individual chronotypes, and nutrition have been deemed insufficient [30]. A comprehensive review of the literature revealed no studies analyzing dietary records within 8, 16, and 24-h study periods among individuals with different circadian rhythm characteristics. Consequently, the objectives of this study are 1) To evaluate the anthropometric measurements, sleep quality, physical activity and nutritional habits of nurses according to their chronotypes, 2) To evaluate energy and macronutrient intakes during different shift hours according to their chronotypes. This endeavor aims to bridge existing gaps in the field and stimulate further research.

2. Materials and methods

2.1. Study type, universe, and sample

This cross-sectional study was conducted with a population of 250 female nurses engaged in shift work at Atatürk State Hospital in Antalya, Turkey. All nurses were assigned to work in three different shifts: 08:00–16:00, 16:00–08:00, and 08:00–08:00. Female nurses between the ages of 18–60 who worked in shifts in this hospital and accepted to participate in the study were included in the study. Exclusion criteria for the study included menopausal status, pregnancy, breastfeeding, adherence to specific dietary plans (gluten-free, elimination, weight loss, etc.), presence of chronic diseases, and the use of dietary supplements.

The selection of the sample involved administering the Morningness-Eveningness Questionnaire (MEQ) to 177 willing participants. Based on the questionnaire results, the nurses were grouped as ‘morning type’ (n = 47), ‘evening type’ (n = 21), or ‘intermediate type’ (n = 109) according to their chronotypes. The study was designed to include 21 participants from each chronotype. Twenty-one participants from the morning and the intermediate type groups were selected using a random number table. Three nurses; one who quit her job, one who became pregnant, and one who received an illness report during part of the study were excluded from the study. Ultimately, the study was completed with 60 participants (morning type: 21, evening type: 18, intermediate type: 21). As a result of the power analysis made with the data obtained at the end of the study, the power of the study was 90.0 % with a 5 % margin of error and an effect size of f = 0.525 for a minimum total number of 54 participants (n1 = 18, n2 = 18, n3 = 18).

2.2. Data collection

Data were collected by face-to-face interviews using a data collection form between July 2019 and October 2019. The chronotypes of the participants were determined using the MEQ. The MEQ, initially developed by Horne and Östberg in 1976, had its Turkish version validated by Pündük et al., in 2005 [31,32]. Consisting of 19 questions, the MEQ classifies people based on their sleep/wake patterns, time of performance, and lifestyle. According to the total score obtained from the questionnaire, participants are grouped under one of the five different chronotypes as ‘definitely morning type’ (70–86 points), ‘moderately morning type’ (59–69 points), ‘intermediate type’ (42–58 points), ‘moderately evening type’ (31–41 points) and ‘definitely evening type’ (16–30 points). In the current study, the participants’ chronotypes were categorized as ‘morning type’ (59–86 points), ‘intermediate type’ (42–58 points), and ‘evening type’ (16–41 points).

Participants were asked whether they skipped 3 main meals, morning, afternoon and evening. Those who did not skip main meals were determined as regular. The participants were asked to maintain their food consumption records for nine days, with each three-day period corresponding to a different shift. A form (see Supplementary Document) was prepared on which participants could record all the food and beverages they consumed in a day, including information such as portion size, cooking methods and ingredients. Participants were trained by the researchers on how to fill in this form before the study. Position sizes were evaluated through the Food and Nutrition Photo Catalogue of Turkey [33]. When necessary, the participants consulted the researchers by sending photographs of their meals via Whatsapp. The energy and macronutrient content of the consumed foods were calculated using the Nutrition Information System (*Beslenme Bilgi Sistemi*, BeBiS) package program [34]. BEBIS is the only programme in Turkey that calculates the macro and micronutrient amounts of foods. The data obtained from the form were entered into the programme by the researchers.

The sleep quality of the participants was assessed using the Pittsburgh Sleep Quality Index (PSQI). The PSQI, developed by Buysse et al., in 1989, had its Turkish version validated by Ağargün et al., in 1996 [35,36]. The questionnaire evaluates the sleep quality of individuals over the last month and comprises 18 questions that determine the frequency and severity of sleep duration, sleep latency, and specific sleep-related problems. The questionnaire includes seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is scored on a questionnaire of 0–3 points. A total score between 0 and 4 indicates 'good' sleep quality, while a score ranging from 5 to 21 signifies 'poor' sleep quality.

The researchers performed the weight measurements using a Tanita MC780 device, height measurements using a stadiometer, and neck/waist/hip circumference measurements using a non-stretchable measuring tape per their techniques [37,38].

2.3. Data analysis

Statistical analyses were performed using the IBM SPSS Statistics 24 software package. Findings were interpreted using frequency tables and descriptive statistics. The Shapiro-Wilk test was used to test for normality. For normally distributed measurement values, parametric methods were employed. In the case of three or more independent groups, the ANOVA test (F-table value) method (or the Kruskal-Wallis H test [χ2-table value] in non-parametric conditions) was used to compare the measurement values. For three or more dependent groups, the one-way ANOVA test (F-table value) method (or the Friedman test [χ2-table value] in non-parametric conditions) was applied. Pairwise comparisons of variables showing significant differences for three or more groups were conducted using Tukey/Tamhane tests (or Bonferroni correction in non-parametric conditions), accounting for variance homogeneity. The relationships between two qualitative variables were assessed using Pearson-χ2 and χ2-slope tables. Results with a p value less than 0.05 were considered statistically significant.

3. Results

The sociodemographic characteristics of the participants are presented in Table 1. A statistically significant relationship was found between chronotypes and education level ($\chi2 = 8.358$; $p = 0.015$). Specifically, participants with an associate degree were predominantly classified as morning types, while those with undergraduate and graduate degrees tended to exhibit an evening chronotype. This difference was particularly pronounced when comparing morning type and evening type participants (Table 1).

The data on the PSQI subcomponent score distributions according to the chronotypes of the individuals are given in Table 2. We determined that 61.9 % (n = 13) of morning type participants, 81.0 % (n = 17) of intermediate types, and 83.3 % (n = 15) of evening participants had poor sleep quality. Notably, different chronotypes showed variation in sleep latency ($\chi2 = 8.372$; $p = 0.015$) and the use of sleep medication ($\chi2 = 9.451$; $p = 0.009$). Specifically, sleep latency scores of the intermediate and evening type participants were significantly higher than those of morning type participants, while the use of sleep medication scores were significantly higher among evening participants compared to both morning and intermediate type participants. We also determined that the PSQI score of the evening type participants was higher than that of morning type participants ($p < 0.05$) (Table 2).

The nutrition and physical activity habits of the participants according to their chronotypes are given in Table 3. As chronotypes shifted from morning type to evening type, there was a significant increase in the frequency of irregular meal times on weekends ($\chi2 = 5.985$; $p = 0.014$). Conversely, the frequency of consuming three main meals saw a significant decrease ($\chi2 = 3.939$; $p = 0.047$) as the

Table 1
Sociodemographic characteristics by chronotype.

Variable	Morning type (n = 21) n (%)	Intermediate type (n = 21) n (%)	Evening type (n = 18) n (%)	Total (n = 60) n (%)	Statistical analysis[a] Probability
Marital status					
Married	18 (85.7)	18 (85.7)	15 (83.3)	51 (85.0)	$\chi^2 = 0.056$
Single/Divorced	3 (14.3)	3 (14.3)	3 (16.7)	9 (15.0)	p = 0.972
Educational level					
Associate degree	8 (38.1)	6 (28.6)	–	14 (23.3)	$\chi^2 = 8.358$
Undergraduate/Graduate	13 (61.9)	15 (71.4)	18 (100.0)	46 (76.7)	**p = 0.015**
Age	42.19 ± 4.02	40.76 ± 5.24	39.17 ± 3.65	40.78 ± 4.49	F = 2.297 p = 0.110

Significant p values are written in bold.

[a] Pearson-χ2 crosstabs were used to evaluate the relationships between two qualitative variables. ANOVA test (F-table value) was used to compare the measurements from three or more independent groups with normally distributed data, while the Kruskal-Wallis H test (χ2-table value) was used to compare measurements from three or more independent groups with non-normally distributed data.

Table 2
PSQI subcomponent scores by chronotype.

Variable	Morning type (n = 21) [1]		Intermediate type (n = 21) [2]		Evening type (n = 18) [3]		Statistical analysis[a] Probability
	$\overline{X} \pm SD$	Median [IQR]	**$\overline{X} \pm SD$**	Median [IQR]	**$\overline{X} \pm SD$**	Median [IQR]	
Subjective sleep quality	1.14 ± 0.85	1.0 [1.5]	1.62 ± 0.67	2.0 [1.0]	1.78 ± 0.81	2.0 [1.3]	χ^2 = 5.843 p = 0.054
Sleep latency	0.86 ± 0.96	1.0 [1.0]	1.62 ± 1.07	2.0 [1.5]	1.89 ± 1.23	2.0 [2.3]	χ^2 = 8.372 **p = 0.015 [1–2,3]**
Sleep duration	0.90 ± 0.94	1.0 [2.0]	1.52 ± 1.03	1.0 [1.5]	1.56 ± 1.15	1.5 [2.3]	χ^2 = 4.719 p = 0.094
Habitual sleep activity	0.38 ± 0.69	0.0 [1.0]	0.43 ± 0.81	0.0 [1.0]	0.67 ± 1.02	0.0 [1.0]	χ^2 = 0.802 p = 0.670
Sleep disturbances	1.10 ± 0.54	1.0 [0.0]	1.29 ± 0.46	1.0 [1.0]	1.39 ± 0.50	1.0 [1.0]	χ^2 = 3.037 p = 0.219
Use of sleep medication	0.05 ± 0.22	0.0 [0.0]	0.00 ± 0.00	0.0 [0.0]	0.67 ± 1.19	1.0 [1.3]	χ^2 = 9.451 **p = 0.009 [1,2–3]**
Daytime dysfunction	1.19 ± 1.03	2.0 [2.0]	0.62 ± 0.97	0.0 [1.5]	0.78 ± 1.06	0.0 [1.3]	χ^2 = 3.661 p = 0.160
PSQI score	5.62 ± 3.14	5.0 [4.0]	7.09 ± 2.86	7.0 [2.5]	8.72 ± 3.94	8.5 [7.0]	F = 4.262 **p = 0.019 [1–3]**

PSQI: Pittsburgh Sleep Quality Index.
Significant p values are written in bold.
[a] ANOVA (F-table value) was used to compare measurements from three or more dependent groups with normally distributed data, while the Kruskal-Wallis H test (χ2-table value) was used to compare measurements from three or more independent groups with non-normally distributed data. The numbers in brackets indicate the corresponding work shift.

Table 3
Nutrition and physical activity habits by chronotype.

Variable	Morning type (n = 21) n (%)	Intermediate type (n = 21) n (%)	Evening type (n = 18) n (%)	Total (n = 60) n (%)	Statistical analysis[a] Probability
Balanced diet					
Yes/Sometimes	10 (47.6)	8 (38.1)	6 (33.3)	24 (40.0)	χ^2 = 0.827
No	11 (52.4)	13 (61.9)	12 (66.7)	36 (60.0)	p = 0.363
Eating speed					
Fast	8 (38.1)	11 (52.4)	9 (50.0)	28 (46.7)	χ^2 = 0.586
Normal/Slow	13 (61.9)	10 (47.6)	9 (50.0)	32 (53.3)	p = 0.444
Meal timing (Weekdays)					
Regular	15 (71.4)	11 (52.4)	8 (44.4)	34 (56.7)	χ^2 = 2.895
Irregular	6 (28.6)	10 (47.6)	10 (55.6)	26 (43.3)	p = 0.089
Meal timing (Weekend)					
Regular	14 (66.7)	8 (38.1)	5 (27.8)	27 (45.0)	χ^2 = 5.985
Irregular	7 (33.3)	13 (61.9)	13 (72.2)	33 (55.0)	**p = 0.014**
Number of main meals					
2	10 (47.6)	15 (71.4)	14 (77.8)	39 (65.0)	χ^2 = 3.939
3	11 (52.4)	6 (28.6)	4 (22.2)	21 (35.0)	**p = 0.047**
Number of snacks					
0–1	6 (28.6)	8 (38.1)	5 (27.8)	19 (31.7)	χ^2 = 0.000
2 and above	15 (71.4)	13 (61.9)	13 (72.2)	41 (68.3)	p = 0.986
Skipping main meal					
Yes/Sometimes	17 (81.0)	18 (85.7)	15 (83.3)	50 (83.3)	χ^2 = 0.046
No	4 (19.0)	3 (14.3)	3 (16.7)	10 (16.7)	p = 0.831
Skipped meal					
Noon	13 (76.5)	14 (77.8)	10 (66.7)	37 (74.0)	χ^2 = 0.369
Other (Morning/Evening)	4 (23.5)	4 (22.2)	5 (33.3)	13 (26.0)	p = 0.738
Physical activity					
Yes *(Every day/1–2 times a week/3–4 times a week)*	10 (47.6)	7 (33.3)	3 (16.7)	20 (33.3)	χ^2 = 4.100 **p = 0.043**
No *(Sometimes/None)*	11 (52.4)	14 (66.7)	15 (83.3)	40 (66.7)	

Significant p values are written in bold.
[a] χ2-slope tables were used to evaluate the relationships between two qualitative variables.

chronotype shifted from morning to evening type. A similar trend was observed with physical activity, which significantly decreased as the chronotype shifted from morning to evening type ($\chi 2 = 4.100$; $p = 0.043$) (Table 3).

Table 4 presents measurements of weight (kg), BMI (kg/m^2), waist circumference (cm), hip circumference (cm), waist/height ratio, and neck circumference (cm) among participants. Evening type participants displayed significantly higher measurements in all these aspects compared to morning type participants ($p < 0.05$) (Table 4).

Table 5 highlights the daily energy, fat, and saturated fatty acid (SFA) intakes based on different chronotypes. The morning types exhibited significantly higher energy, fat, and SFA intakes when working the 16:00–08:00 and 08:00–08:00 shifts compared to the 08:00–16:00 shift ($p < 0.05$). Carbohydrate intake during the 08:00–08:00 shift in comparison to the 16:00–08:00 shift, and vegetable protein intake during the 08:00–08:00 shift in comparison to the 08:00–16:00 shift were significantly higher ($p < 0.05$). The intermediate types also exhibited significantly higher energy, carbohydrate, and vegetable protein intake during the 08:00–08:00 shift compared to the 08:00–16:00 shift, and carbohydrate intake during the 08:00–08:00 shift was significantly higher than both the 08:00–16:00 and 16:00–08:00 shifts ($p < 0.05$). Similarly, evening type participants had significantly higher energy, carbohydrate, and vegetable protein intake during the 08:00–08:00 shift compared to the 08:00–16:00 and 16:00–08:00 shifts, along with higher polyunsaturated fatty acid intake during the 08:00–16:00 shift in comparison to the 08:00–08:00 shift and higher protein intake during the 08:00–08:00 shift compared to the 16:00–08:00 shift ($p < 0.05$).

The percentage of energy from protein was significantly higher in the 08:00–16:00 shift for morning type participants compared to the 16:00–08:00 and 08:00–08:00 shifts ($p < 0.05$). Meanwhile, the percentage of energy from fat was significantly higher in the 16:00–08:00 and 08:00–08:00 shifts compared to the 08:00–16:00 shift ($p < 0.05$). Intermediate type participants also showed higher percentages of energy from protein in the 08:00–16:00 shift compared to the 16:00–08:00 shift and higher percentages of energy from protein in the 16:00–08:00 shift compared to the 08:00–08:00 shift ($p < 0.05$). Moreover, the percentage of energy from fat was significantly higher in the 16:00–08:00 and 08:00–08:00 shifts compared to the 08:00–16:00 shift ($p = 0.013$). Evening type participants displayed significantly higher percentages of energy from fat in the 08:00–08:00 shift compared to the 16:00–08:00 shift ($p < 0.05$) (see Fig. 1).

4. Discussion

In this cross-sectional study, we aimed to investigate how nurses' chronotypes affect their sleep quality, anthropometric measurements, and how their nutritional status is influenced by their shift hours. The study observed variations in sleep quality and anthropometric measurements among nurses working different shifts according to their chronotypes. Additionally, the findings demonstrated that changes in shift hours played a role in the consumption of certain nutrients for each chronotype.

Nurses often experience inadequate sleep due to extended working hours and shift rotations inherent in their profession. Individual characteristics such as chronotype can further influence sleep quality and duration [39]. For example, when a morning person works the evening shift, their sleep preference may conflict with their working hours, resulting in reduced sleep quality and duration [40].

Table 4
Comparison of the anthropometric measurements by chronotype.

Variable	Morning type (n = 21) [1]		Intermediate type (n = 21) [2]		Evening type (n = 18) [3]		Statistical analysis[a] Probability
	$\overline{X} \pm SD$	Median [IQR]	**$\overline{X} \pm SD$**	Median [IQR]	**$\overline{X} \pm SD$**	Median [IQR]	
Body weight (kg)	60.37 ± 6.74	58.5 [11.1]	63.49 ± 10.40	63.0 [15.0]	69.22 ± 10.62	69.5 [11.8]	F = 4.409 **p = 0.017** **[1–3]**
Height (cm)	162.29 ± 5.84	161.0 [5.8]	160.64 ± 4.95	160.0 [6.8]	160.06 ± 5.93	159.0 [9.3]	$\chi^2 = 1.672$ p = 0.433
BMI (kg/m^2)	22.93 ± 2.28	22.4 [3.2]	24.58 ± 3.86	24.7 [3.9]	27.05 ± 4.13	27.1 [6.7]	$\chi^2 = 10.784$ **p < 0.001** **[1–3]**
Waist circumference (cm)	75.81 ± 5.98	76.0 [10.0]	79.93 ± 9.64	77.5 [12.0]	84.44 ± 8.92	84.5 [10.8]	F = 5.247 **p = 0.008** **[1–3]**
Hip circumference (cm)	98.40 ± 5.49	96.5 [9.0]	99.64 ± 7.10	99.0 [7.3]	104.61 ± 7.08	102.8 [11.1]	F = 4.741 **p = 0.012** **[1–3]**
Waist/Height ratio	0.467 ± 0.037	0.468 [0.060]	0.498 ± 0.059	0.485 [0.060]	0.528 ± 0.056	0.529 [0.080]	$\chi^2 = 10.999$ **p = 0.004** **[1–3]**
Neck circumference (cm)	31.79 ± 1.33	32.0 [1.8]	32.05 ± 2.18	32.0 [2.3]	33.83 ± 2.46	33.8 [4.5]	$\chi^2 = 7.855$ **p = 0.020** **[1–3]**

Significant p values are written in bold.

[a] ANOVA (F-table value) was used to compare measurements from three or more dependent groups with normally distributed data, while the Kruskal-Wallis H test ($\chi 2$-table value) was used to compare measurements from three or more independent groups with non-normally distributed data. The numbers in brackets indicate the corresponding work shift.

Table 5
Comparison of the three-day averages of energy and macronutrient intake by shift and chronotype.

Shift Morning type	08:00–16:00 [1] $\bar{X} \pm$ **SD**	Median [IQR]	16:00–08:00 [2] $\bar{X} \pm$ **SD**	Median [IQR]	08:00–08:00 [3] $\bar{X} \pm$ **SD**	Median [IQR]	Statistical analysis[a] Probability
Energy (kcal)	1813.55 ± 148.32	1825.1 [175.6]	1987.33 ± 131.33	1976.8 [203.4]	2006.80 ± 164.62	1987.8 [239.9]	F = 10.749 **p < 0.001 [1–2,3]**
Carbohydrate (g)	214.79 ± 20.38	213.3 [16.1]	225.89 ± 15.10	226.4 [19.3]	238.91 ± 26.04	241.1 [27.9]	χ^2 = 14.231 **p = 0.001 [1–2,3] [2–3]**
Protein (g)	75.47 ± 9.93	78.4 [14.0]	75.62 ± 10.64	78.4 [18.0]	79.22 ± 9.83	79.5 [12.4]	F = 0.924 p = 0.403
Vegetable protein (g)	32.19 ± 5.79	29.8 [8.6]	35.70 ± 4.90	35.1 [8.9]	37.10 ± 5.84	36.1 [8.9]	χ^2 = 8.837 **p = 0.012 [1–3]**
Animal protein (g)	43.28 ± 8.77	44.3 [14.4]	39.93 ± 11.65	39.6 [19.0]	42.09 ± 9.03	41.1 [13.5]	F = 0.617 p = 0.543
Fat (g)	68.90 ± 11.59	70.2 [10.7]	79.70 ± 11.06	80.1 [13.4]	79.44 ± 9.64	79.0 [12.3]	F = 6.849 **p = 0.002 [1–2,3]**
FFA (g)	23.39 ± 4.30	22.9 [6.8]	27.50 ± 4.53	27.7 [7.8]	29.79 ± 3.42	29.7 [5.0]	F = 13.049 **p < 0.001 [1–2,3]**
PUFA (g)	15.77 ± 3.74	15.9 [5.4]	16.17 ± 3.38	16.0 [5.5]	13.73 ± 2.97	13.5 [4.2]	F = 3.161 p = 0.051
MUFA (g)	25.76 ± 3.35	25.0 [5.8]	28.25 ± 4.76	29.4 [6.5]	28.61 ± 3.62	28.2 [4.8]	F = 3.224 p = 0.052
Fiber	24.63 ± 4.65	24.7 [5.4]	21.60 ± 4.62	21.7 [7.8]	19.60 ± 2.98	19.5 [5.2]	F = 7.797 **p = 0.001 [1–3]**
Shift **Intermediate type**	**08:00–16:00** [1] $\bar{X} \pm$ **SD**	**Median [IQR]**	**16:00–08:00** [2] $\bar{X} \pm$ **SD**	**Median [IQR]**	**08:00–08:00** [3] $\bar{X} \pm$ **SD**	**Median [IQR]**	**Statistical analysis**[a] **Probability**
Energy (kcal)	1899.15 ± 147.38	1928.4 [188.5]	1947.27 ± 191.18	1946.9 [291.3]	2063.42 ± 186.10	2077.6 [216.9]	F = 4.837 **p = 0.011 [1–3]**
Carbohydrate (g)	222.36 ± 19.25	223.6 [29.1]	227.19 ± 24.54	227.4 [35.8]	249.93 ± 28.93	249.9 [34.5]	F = 7.787 **p = 0.001 [1,2–3]**
Protein (g)	78.99 ± 9.08	80.0 [12.6]	76.51 ± 8.68	75.1 [8.6]	78.54 ± 9.42	78.8 [13.8]	F = 0.446 p = 0.643
Vegetable protein (g)	32.33 ± 6.04	31.0 [7.8]	32.74 ± 5.43	33.6 [6.1]	37.10 ± 5.90	36.0 [9.3]	F = 4.368 **p = 0.017 [1–3]**
Animal protein (g)	46.66 ± 8.15	47.0 [7.8]	43.86 ± 7.29	42.9 [7.3]	41.44 ± 8.43	40.7 [12.9]	F = 2.257 p = 0.113
Fat (g)	75.35 ± 6.60	75.2 [8.3]	76.11 ± 8.10	76.9 [7.8]	81.11 ± 10.31	81.2 [9.4]	F = 2.861 p = 0.065
FFA (g)	27.28 ± 3.89	27.4 [5.2]	29.15 ± 4.07	29.6 [4.5]	31.92 ± 4.39	32.7 [5.5]	F = 6.771 **p = 0.002 [1–3]**
PUFA (g)	14.60 ± 2.95	14.2 [4.0]	14.63 ± 3.32	14.2 [5.5]	14.56 ± 2.92	15.3 [5.3]	F = 0.003 p = 0.997
MUFA (g)	27.22 ± 3.20	26.6 [6.1]	27.41 ± 3.54	28.5 [4.4]	28.56 ± 3.99	28.7 [4.9]	F = 0.855 p = 0.430
Fiber	21.22 ± 3.28	21.6 [3.9]	20.40 ± 3.48	20.6 [4.7]	19.40 ± 3.41	19.8 [5.1]	F = 1.522 p = 0.227
Shift **Evening type**	**08:00–16:00** [1] $\bar{X} \pm$ **SD**	**Median [IQR]**	**16:00–08:00** [2] $\bar{X} \pm$ **SD**	**Median [IQR]**	**08:00–08:00** [3] $\bar{X} \pm$ **SD**	**Median [IQR]**	**Statistical analysis**[a] **Probability**
Energy (kcal)	2038.78 ± 1230.35	2028.6 [192.2]	2008.62 ± 138.20	1962.0 [262.8]	2189.66 ± 144.53	2175.7 [218.2]	F = 8.916 **p < 0.001 [1,2–3]**
Carbohydrate (g)	228.83 ± 20.93	229.6 [27.3]	224.51 ± 25.09	225.6 [37.7]	283.37 ± 19.28	283.8 [22.3]	F = 40.369 **p < 0.001 [1,2–3]**
Protein (g)	76.91 ± 7.63	76.3	72.61 ± 6.98	72.1	81.28 ± 9.69	82.4	F = 5.051

(*continued on next page*)

Table 5 (*continued*)

Shift Morning type	08:00–16:00 [1]		16:00–08:00 [2]		08:00–08:00 [3]		Statistical analysis[a] Probability
	$\overline{X} \pm SD$	Median [IQR]	**$\overline{X} \pm SD$**	Median [IQR]	**$\overline{X} \pm SD$**	Median [IQR]	
		[10.9]		[6.2]		[18.5]	**p = 0.010 [2–3]**
Vegetable protein (g)	32.14 ± 3.80	33.0 [3.9]	31.67 ± 5.29	32.1 [8.4]	38.23 ± 5.38	37.0 [7.2]	F = 10.113 **p < 0.001 [1,2–3]**
Animal protein (g)	44.76 ± 6.56	44.7 [10.9]	40.94 ± 6.53	39.6 [8.1]	43.05 ± 9.81	41.2 [18.4]	F = 1.084 p = 0.346
Fat (g)	81.68 ± 7.10	79.9 [13.0]	78.33 ± 8.92	79.3 [11.0]	78.66 ± 11.58	76.9 [16.0]	F = 0.699 p = 0.502
FFA (g)	32.50 ± 3.29	32.1 [5.2]	31.61 ± 5.19	32.2 [8.5]	33.69 ± 5.69	33.4 [8.3]	F = 0.841 p = 0.437
PUFA (g)	15.09 ± 2.24	14.7 [1.8]	14.42 ± 2.58	14.2 [3.1]	12.97 ± 2.50	12.4 [3.8]	χ^2 = 6.364 **p = 0.042 [1–3]**
MUFA (g)	29.71 ± 3.50	28.8 [6.2]	28.29 ± 3.33	28.5 [4.8]	27.67 ± 4.38	25.9 [7.4]	χ^2 = 3.579 p = 0.167
Fiber	19.03 ± 3.08	18.9 [5.5]	18.01 ± 2.07	17.3 [2.8]	17.32 ± 1.43	17.1 [2.6]	F = 2.545 p = 0.088

FFA: free fatty acid, MUFA: monounsaturated fatty acid, PUFA: polyunsaturated fatty acid.
Significant p values are written in bold.
[a] One-way ANOVA (F-table value) was used to compare measurements from three or more dependent groups with normally distributed data, while the Friedman test (χ2-table value) was used to compare measurements from three or more independent groups with non-normally distributed data. The numbers in brackets indicate the corresponding work shift.

Consistent with this information and our study findings, many studies have found poor sleep quality to be a common phenomenon among nurses [41–44]. Studies have indicated that 57%–83.2 % of nurses suffer from sleep deprivation, sleep disorders, or poor sleep quality [45]. Similar to our findings, in studies conducted with nurses in our country, evening type individuals had the highest PSQI scores [44,46]. However, a study conducted by Lee et al. did not find chronotype to be a predictor of poor sleep quality, though it identified shift work as such [40]. While this study, along with others, highlights the prevalence of sleep problems among nurses, further research is needed to elucidate the impact of chronotype on sleep issues in this population.

Our study revealed that evening type participants had significantly higher averages for indicators of obesity and chronic disease risks, such as BMI, waist circumference, waist/height ratio, and neck circumference, compared to morning type participants ($p < 0.05$). Furthermore, the number of participants classified as at risk for obesity increased as we shifted from morning type to evening type participants, based on anthropometric measurements like BMI, waist circumference, waist/height ratio, and neck circumference. When we look at the studies investigating the relationship between chronotype and obesity, we come across conflicting results. For instance, the National FINRISK 2007 Study, involving 4421 individuals aged 25–74, concluded that BMI did not significantly differ according to chronotype [16]. In contrast, another study found that BMI tended to increase as the chronotype shifted towards eveningness [47]. In another study in which 4493 individuals between the ages of 25–74 participated, no correlation was found between BMI and the MEQ score [48].

The mechanisms explaining the effect of particular chronotypes on anthropometric measurements are not fully understood. Current evidence emphasizes that factors such as low physical activity levels, the type and timing of the foods consumed, and sleep deprivation or restriction may contribute to this relationship [49]. As a matter of fact, the same study found that the frequency of doing regular physical activity decreased significantly from morningness to eveningness and that only 1/3 of nurses performed regular physical activity. This is not surprising, considering that the shift work system may discourage nurses from participating in regular physical activity or team sports [50].

Evening type individuals may have difficulties in adapting to daily life due to their sleep patterns and often encounter social jetlag [51,52]. It has been reported that the risk of obesity and metabolic syndrome is higher in individuals with higher social jetlag levels [53]. In the current study, the higher BMIs and elevated anthropometric measurements in evening type individuals, indicating an elevated risk for chronic diseases, could be associated with their frequent experiences of social jetlag.

Eating behavior can be affected by shift work due to various biological, social, and cultural factors, particularly during night shifts [54]. Unhealthy dietary choices and meal skipping are common among shift workers since they do not have enough time to buy and prepare food [55]. In a study conducted on nurses in Lebanon, the researchers found that individuals working in shifts had a decreased meal frequency and irregular meal timing [56]. Notably, our study reported that only 35.0 % of nurses had three main meals, while 68.3 % had two or more snacks. Studies have shown that evening type individuals tend to skip meals more frequently, have later main meal times, consume fewer daily meals, and often skip breakfast [19,47,57,58]. A study conducted with university students in our country found that morning type people skipped breakfast during the week and lunch at the weekends less than evening type people [59]. In Maukonen et al.'s study, the authors determined that evening type people had more irregular meal times on weekends compared to the morning types [2]. Our study aligns with this observation in the literature, as we also noted a significant decrease in the frequency of consuming three meals and adhering to regular meal schedules on weekends when shifting from morningness to

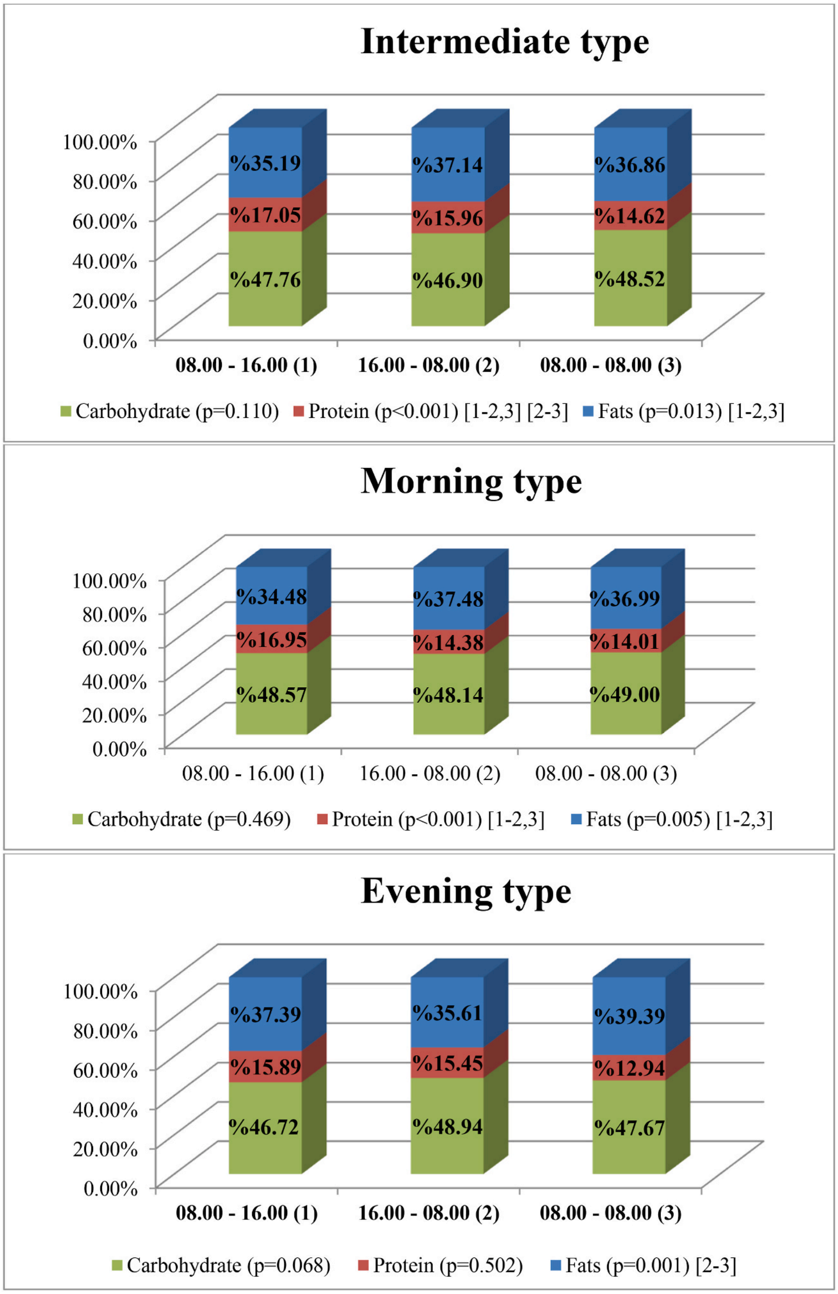

Fig. 1. Daily energy intake (%) from carbohydrates, fats, and protein in different shifts by chronotype.

eveningness.

Daily energy, carbohydrate, fat, and SFA intakes of the morning types were significantly higher in those who worked the 16:00–08:00 and 08:00–08:00 shifts compared to the 08:00–16:00 shift workers ($p < 0.05$). Notably, we observed an increase in energy and fat intake when morning type participants worked in a schedule including night shifts (16:00–08:00 and 08:00–08:00 shifts). Intermediate type participants also consumed more energy and SFA during the 08:00–08:00 shift compared to the 08:00–16:00 shift, and carbohydrate intake during the 08:00–08:00 shift was higher than both the 08:00–16:00 and 16:00–08:00 shifts. When intermediate type participants switched to night shifts, there was a decrease in the percentage of energy from protein and an increase in the percentage from fat. We also found that evening type participants also exhibited higher energy and carbohydrate intake during the 08:00–08:00 shift. In the same shift, the percentage of energy from fats was notably high. In summary, mismatched nurses generally consumed more energy, carbohydrates, and fat, with morning individuals showing the most significant changes. It has been reported that the shift work system appeared to affect the dietary habits of morning individuals more profoundly [60]. For this reason, the eating habits of morning individuals may have been more significantly impacted during night shifts.

Changes in the dietary habits of participants working night shifts may result from sleep deprivation, consumption of snack-style foods at night, and disruptions in circadian rhythms. Samhat et al. reported that nurses consumed more snack-style foods such as sweets and potato chips during night shifts [56]. According to Reed, stress is the main reason why night shift nurses often crave high-fat and high-sugar foods [61]. Moreover, individuals who lacked appetite for breakfast after night shifts may have preferred to go to sleep directly, leading to changes in meal frequency and an increase in late-night snacks. Irregular eating patterns may have further contributed to these dietary shifts.

In conclusion, our study reveals differences in sleep quality and anthropometric measurements among nurses working different shifts, depending on their chronotypes. Variances were also observed in the dietary patterns of nurses with different chronotypes when their shifts differed. Notably, increased intake of energy, carbohydrates, and fats was most evident in mismatched nurses. Therefore, when designing personalized nutrition programs in clinical practice, it is crucial to consider both shift hours and chronotype. Developing shift schedules based on the chronotypes of nurses in shift work can significantly improve their overall nutritional status. Additionally, providing nurses with nutrition education addressing the relationship between chronotype, shift hours, and dietary habits will enhance their awareness of this issue. Further studies with larger sample groups, including both genders, are required to evaluate the timing of nutrient and energy intake of individuals working shifts.

CRediT authorship contribution statement

Senanur Gülseven: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Rana Nagihan Akder:** Writing – original draft, Resources, Investigation, Formal analysis, Data curation. **Özge Küçükerdönmez:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Ethical statement

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Medical Research Ethics Committee of Ege University under decision number 19-5T/24. Written informed consent was obtained from all individuals before they participated in this study.

Data availability statement

Data supporting the results of this study are available from the corresponding author upon request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e39509.

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