

## Evaluation of the Relationship Between the Amount and Type of Carbohydrate Consumed After the Evening Meal and Sleep Quality

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### ABSTRACT

**Objective:** This study's objective is to assess the relationship between the amount and type of carbohydrates consumed after evening meal and sleep quality. **Method:** This study involved 177 university students with an average age of 21. A general information questionnaire, 24-hour dietary recall, and Pittsburgh Sleep Quality Index (PSQI) questionnaire were completed by the participants. Body composition was determined with the TANITA DC 360 ST device using the bioelectrical impedance analysis (BIA) method. Height and waist-hip circumference were measured with a non-stretchable tape measure. Nutritional record data were recorded in the BEBIS program. The final analysis of the study was performed via the SPSS program version 21. **Results:** The average PSQI score of the participants was 7.14. While 18.1% of the participants had good sleep quality (PSQI $\leq$ 5), 81.9% had poor sleep quality (PSQI $>$ 5). No significant correlation was found between the amount of carbohydrates consumed after the evening meal and sleep quality ( $p>0.05$ ). However, there was an important relationship between the amount of carbohydrates, absorbable oligosaccharide consumption and PSQI score ( $p=0.044$ ,  $p=0.013$ , respectively). Also, a significant correlation was found between the consumed protein amount, protein percentage and sleep quality ( $p=0.037$ ,  $p=0.020$ , respectively). In addition, a significant correlation between the amount of water consumed after the evening meal and PSQI score was found ( $p<0.05$ ). **Conclusion:** In this investigation, there was no correlation between the amount and type of carbohydrates consumed after evening meal and sleep quality, but the significant difference which was observed with the percentage of carbohydrates suggests the possibility that food preferences may affect sleep quality. Further studies using larger samples are required.

**Key words:** Carbohydrates, PSQI, Sleep quality.

## Akşam Yemeğinden Sonra Tüketilen Karbonhidrat Miktarı ve Türü İle Uyku Kalitesi Arasındaki İlişkinin Değerlendirilmesi

### öz

**Amaç:** Bu çalışmanın amacı, akşam yemeğinden sonra tüketilen karbonhidrat miktarı ve türü ile uyku kalitesi arasındaki ilişkiyi değerlendirmektir. **Yöntem:** Bu çalışma, yaş ortalaması 21 olan 177 üniversite öğrencisi üzerinde yapılmıştır. Katılımcılara genel bilgi anketi, 24 saatlik diyet hatırlama ve Pittsburgh Uyku Kalitesi İndeksi (PUKİ) anketi uygulanmıştır. TANITA DC 360 ST cihazı ile biyoelektrik impedans analizi (BIA) yöntemi kullanılarak vücut kompozisyonları belirlenmiştir. Boy, bel-kalça çevresi esnemeyen mezura ile ölçülmüştür. Beslenme kayıt verileri BEBIS programında kaydedilmiştir. Çalışmanın son analizi SPSS Inc. Made with Chicago IL v21 programı ile yapılmıştır. **Bulgular:** Katılımcıların ortalama PUKİ puanı 7,14'tür. Katılımcıların %18,1'i iyi uyku kalitesine sahipken (PSQI $\leq$ 5), %81,9'u kötü (PUKİ $>$ 5) uyku kalitesine sahiptir. Akşam yemeğinden sonra tüketilen karbonhidrat miktarı ile uyku kalitesi arasında anlamlı bir ilişki bulunmamıştır ( $p>0,05$ ). Ancak karbonhidrat yüzdesi, emilebilir oligosakkarit tüketimi ve PUKİ skoru arasında anlamlı bir korelasyon gözlenmiştir (sırasıyla;  $p=0,044$ ,  $p=0,013$ ). Ayrıca protein miktarı, protein yüzdesi ve uyku kalitesi arasında anlamlı bir ilişki bulunmuştur (sırasıyla;  $p=0,037$ ,  $p=0,020$ ). Ayrıca akşam yemeğinden sonra tüketilen su miktarı ile PUKİ puanı arasında anlamlı bir ilişki bulunmuştur ( $p<0,05$ ). **Sonuç:** Bu çalışmada, akşam yemeğinden sonra tüketilen karbonhidrat miktarı ve türü ile uyku kalitesi arasında bir ilişki gözlemlenmezken, karbonhidrat yüzdesinde gözlenen anlamlı fark, besin tercihlerinin uyku kalitesini etkileyebileceğini düşündürmektedir. Daha büyük örneklemelerin kullanıldığı çalışmalara ihtiyaç vardır.

**Anahtar kelimeler:** Karbonhidrat, PUKİ, Uyku kalitesi.

## INTRODUCTION

The human body works in a cycle which is called the circadian rhythm where sleeping is considered a normal physiological process within this rhythm. Sleep disorders, which are quite common, can affect health negatively by disrupting the normal functioning of the circadian rhythm (Zhao et al., 2020). The general nutritional status of the individual and the distribution of food items consumed according to meals are important aspects that may impact the quality of sleep (Lindseth et al., 2013).

The number of studies examining the relationship between diet and sleep quality has increased in recent years, and there is a general belief that diet can affect sleep regulation (Godos et al., 2019; Muscogiuri et al., 2020; Zuraikat et al., 2020). Although the mechanisms that may explain the effect of diet on sleep regulation are complex, this effect may be due to a particular dietary component, a metabolite, or long-term nutritional factors (Gérard & Vidal, 2019; Irwin et al., 2016; Shilo et al., 2002). In particular, the timing of meals and their influence on sleeping quality are interesting and the number of studies in this area are very few and have been designed on different populations (Falkenberg et al., 2021; Lehmann et al., 2022; Peuhkuri et al., 2012). Two investigations on healthy men's carbohydrate intake before going to bed were carried out by Afaghi et al. High or low GI meals were given 4 hours and 1 hour before bed in the first research. Compared to low GI meal intake, eating a high GI meal considerably reduced the time until sleep onset. (Afaghi et al., 2007). In the second investigation, Afaghi et al. contrasted a control diet (72% carbohydrates, 12.5% fat, 15.5% protein) with a very low carbohydrate diet (1% carbohydrate, 61% fat, 38% protein) taken four hours prior going to bed. Compared to the control diet, the extremely low-carbohydrate diet improved the quality of sleep (Afaghi et al., 2008). Porter and Horne fed six male participants a high-carb meal (130 g), a low-carb meal (47 g), and a no-carb meal 45 minutes before bed. Increased REM sleep, decreased NREM sleep, and alertness were all found to be influenced by the high-carbohydrate meals (Porter & Horne, 1981). The type of carbohydrates in the meals, however, were not investigated in this study.

The aim of our study is to investigate the effect of the amount and type of carbohydrates taken after the evening meal on the sleep quality of university students. The research questions are as follows;

Q1: Does the amount and percentage of carbohydrates taken after the evening meal affect sleep quality in university students?

Q2: Do total energy and nutrient intakes affect sleep quality in university students?

Q3: Is there a relationship between body fat percentage and sleep quality in university students?

## MATERIAL AND METHOD

One hundred and seventy-seven university students between the ages of 19 and 25 participated in this descriptive and cross-sectional study. The exclusion criteria were sleep apnea, adenoid hypertrophy, and the presence of upper respiratory tract infection. The people who checked the box at the top of the form that read, "I consent to participate in this study voluntarily," and filled out the questionnaire completely made up the study's sample. Before beginning the investigation, the ethical permission which was required was granted by the Gülhane Education and Research Hospital Clinical Research Ethics Committee at the University of Health Sciences with decision number 2022-153. The Declaration of Helsinki was followed in every step of the study's protocols. The anthropometric measurements (body weight, height, fat ratio, waist, and hip circumferences), food consumption information, and sleep quality scores were gathered, along with demographic data (gender, age).

### 24-hour dietary recall

The 24-hour dietary recall method was applied face-to-face by the researchers. The foods which were consumed by the participants in the last 24 hours were recorded. The 'Food and Nutrition Photo Catalogue' was used to determine the portion sizes of consumed food and beverages. The energy and nutrient values were calculated by entering the records kept in the "Nutrition Information System" (BEBIS).

### Pittsburgh sleep quality index

By providing a subjective report on the Pittsburgh Sleep Quality Index, sleep quality was evaluated. The PSQI is a self-report questionnaire with a 0–3 scale. The quality of sleep declines as the score rises. With well-validated sensitivity, a global PSQI score of five or higher indicates clinically severe poor sleep (Du et al., 2023).

### Anthropometric measurements

Body weight (kg) and body fat percentage (%) were measured with the TANITA DC 360 ST body composition measuring device (The measurement of this device is based on the bioelectrical impedance analysis (BIA) method). Height was measured in cm with a stadiometer. Body mass index was calculated from the values of body weight and height (The formula  $BMI = \text{Body weight (kg)} / (\text{Height (cm)})^2$  will be used in the calculation of body mass index). Waist and hip circumference were measured in cm with a tape measure.

### Statistical analyses

All analyses were performed using the Statistical Package for the Social Sciences (version 21.0) program. Descriptive statistics including mean, standard deviation, number, and percentage were used to evaluate the data. The Pearson correlation coefficient is used to show the correlations between the variables. The 95% confidence level,  $p < 0.05$ , and  $p < 0.001$  significance levels were used to analyze the results.

## RESULTS

A 24-hour retrospective food record was taken from 177 undergraduate university students and their anthropometric measurements were determined and their relationship with their sleep quality was evaluated. Participants' anthropometric measurements and age are given in Table 1. According to this table, average age of the participants is  $21.18 \pm 2.4$ . Average height is  $171.34 \pm 5.45$  cm, average weight is  $66.73 \pm 9.95$  kg, average waist circumference is  $76.99 \pm 7.05$  cm, average waist/hip ratio is 1.02 cm, body fat percentage is  $19.7\% \pm 5.9$ , and average BMI is  $22.57 \pm 3.15$  kg/m<sup>2</sup>.

**Table 1.** Average values of age and anthropometric characteristics of individuals

	Mean ± SD
Age	21.18±2.4
Height	171.34±5.45
Weight	66.73±9.95
Waist circumference	76.99±7.05
Hip circumference	96.46±7.06
Waist/hip ratio	1.02 ±0.32
Body fat percentage	19.77±5.9
BMI	22.57±3.15

It was observed that 32 (18.1%) of 177 participants who participated in the study had good sleep quality (PSQI≤5), and 145 (81.9%) had poor sleep quality (PSQI>5). Table 2 exhibits the pattern of the distribution regarding sleep quality of the participants.

**Table 2.** Sleep quality of the participants

	N	%
Good Sleep Quality	32	18.1
Poor Sleep Quality	145	81.9
Total	177	100

Regarding data analysis, the relationship between the anthropometric measurements of the participants and the nutrients they consumed according to the results of the food consumption record and the PSQI scores were examined. These relationships are shown in Table 3. All the nutrients shown here were consumed by the participants after dinner. According to Table 3, no significant relationship was observed between the waist and hip ratios of the participants and their sleep quality ( $p > 0.05$ ). No significant correlation was observed between BMI and sleep quality ( $p > 0.05$ ). There was also no significant relationship between the amount of energy consumed by the participants after the evening meal and their sleep quality ( $p > 0.05$ ). A positive correlation ( $p = 0.000$ )

was observed between the amount of water consumption and the PSQI score, and therefore a negative correlation was observed with sleep quality. A positive correlation was observed between protein consumption and PSQI score ( $p=0.037$ ), thus a negative correlation was observed with sleep quality. No significant correlation was observed between the participants' fat consumption levels and fat percentages and their PSQI scores ( $p>0.05$ ). No significant correlation was observed between the amount of carbohydrates consumed by the participants and their PSQI scores ( $p>0.05$ ). A negative correlation was observed between the percentage of carbohydrates consumed by the participants and their PSQI scores ( $p=0.044$ ), thus a positive correlation was observed with sleep quality. No significant correlation was observed between the amount of fiber consumed by the participants and their PSQI score ( $p>0.05$ ). A positive correlation ( $p=0.013$ ) between the amount of absorbable oligosaccharides consumed by the participants and their PSQI scores was observed, thus a negative correlation was observed with sleep quality.

**Table 3.** Relationship between anthropometric measurements, nutrients and PSQI scores

	N	R	p
<b>Waist circumference</b>	177	0.021	0.781
<b>Hip circumference</b>	177	-0.009	0.904
<b>Waist/hip ratio</b>	177	-0.006	0.935
<b>BMI</b>	177	0.090	0.231
<b>Energy</b>	177	0.128	0.091
<b>Water</b>	177	0.278*	0.000
<b>Protein</b>	177	0.157*	0.037
<b>Protein %</b>	177	0.181*	0.020
<b>Fat</b>	177	0.090	0.233
<b>Fat %</b>	177	-0.043	0.585
<b>Carbohydrate</b>	177	0.091	0.226
<b>Carbohydrate %</b>	177	-0.158*	0.044
<b>Fiber</b>	177	0.116	0.125
<b>Absorbable oligosaccharide</b>	177	0.187*	0.013

\*Correlation is significant at 0.05 level

$p<0.05$  is significant

## DISCUSSION

The current literature shows that diet could be related with sleep quality (St-Onge et al., 2016). In particular, a relationship has been reported between macronutrients and insomnia (Tanaka et al., 2013). In this study, our goal was to assess the association between the quantity and kind of carbs taken after dinner and sleep quality. Our study's key conclusions were: i) There was no apparent correlation between the quantity of carbs consumed following dinner and the quality of sleep; ii) a significant correlation was observed between the percentage of carbohydrates, absorbable oligosaccharide consumption and PSQI score; iii) a significant correlation was found between protein amount, protein percentage and sleep quality. iv) a significant correlation between the amount of water consumed after the evening meal and PSQI score was found.

Detailed studies examining the relationship between carbohydrate intake consumed after the evening meal and sleep quality are scarce in the literature, but there are studies which examine the effect of macronutrients that are consumed throughout the day over sleep quality (Afaghi et al., 2007; Tanaka et al., 2013; Yajima et al., 2014). One study showed that a high-carb, low-fat diet caused less sleep time than a control group (Phillips et al., 1975). Another study showed that a high-carbohydrate diet reduced the time it took to fall asleep compared to the control group (Lindseth et al., 2013). According to our findings that the percentage of carbohydrates is associated with sleep quality indicates that not only macronutrients, but also the whole makeup of the diet and sleep quality may be related with each other. This is also consistent with an observational study that found improved sleep quality was associated with a lower carbohydrate intake in type 2 diabetes patients (Daneshzad et al., 2020).

Lindseth et al. (2013) reported fewer waking episodes during night sleep after a high-protein iso-caloric diet. In addition, high-protein energy-restricted diets have been associated with better sleep quality in overweight and obese individuals (Hudson et al., 2020). However, energy restriction may have been the main factor affecting sleep quality in this study. According to the findings of a systemic review and meta-analysis, there was no correlation between protein intake and sleep quality. However, this review called attention to the

lack of sufficient data and the need for randomized controlled research on the topic (Wirth et al., 2023). High tryptophan levels were also shown to be positively correlated with sleep length, according to a study looking at the connection between protein intake and sleep quality (Sutanto et al., 2022). Contrarily, our research revealed a link between protein intake levels and poor sleep quality. The digestion of carbohydrates is a process that is faster and less likely to cause gastrointestinal symptoms than the digestion of proteins (Sitrin, 2014) and this may explain the potential negative effect of protein intake before sleep over sleep quality. However, both the existing literature and our cross-sectional study do not provide sufficient evidence on the effect of macronutrients on sleep quality. In this context, randomized controlled intervention studies with well-established methods are needed.

### CONCLUSION

In this research, a significant connection was not found between the amount and type of carbohydrates consumed after the evening meal and sleep quality, but significant difference observed with the percentage of carbohydrates suggests the possibility that food preferences may affect sleep quality. Sleep quality is a factor which affects many health and disease states and the potential impact of nutrition on sleep quality is an important element with regards to being and staying healthy. New links and mechanisms yet to be uncovered on this topic will shed light on sleep quality-related problems in the society. In this context, studies using larger samples and a randomized controlled design are needed.

### AUTHOR CONTRIBUTION

Idea/Concept: ZEM; Design: ZEM, HAÇ; Data Collection and/or Processing: HAÇ; Analysis and/or Interpretation: ZEM, HAÇ; Writing the Article: ZEM, HAÇ.

### CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### FINANCIAL DISCLOSURE

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### ETHICAL STATEMENT

The University of Health Sciences Gülhane Research and Education Hospital Clinical Researches Ethics Board approved the protocol (approval number: 2022/153), this study was conducted in accordance with The Declaration of Helsinki. All participants gave their written consent after receiving verbal and written information.

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