

# The Relationship Between Healthy Eating and Sleep Quality

**Author Names:** Beste Küçük, Aslı Cönk

## SUMMARY

The main aim of the project was to investigate the impact of dietary habits on sleep quality. Participants were asked questions about their eating habits and the effects of these factors on sleep quality were analyzed. Categorical data were converted into numerical values and normalization was performed on the data. Since there is a classification problem, models such as K-Nearest Neighbors (KNN), Support Vector Machine (SVM), Decision Tree, Logistic Regression were trained to reach the best accuracy value.

It was observed that factors such as skipping meals, food group consumed, and caffeine consumption were partially determinants of sleep quality. The data obtained provide important information on understanding the effects of dietary habits on sleep patterns. In this context, it was concluded that dietary habits should be reviewed and regulated for a healthier sleep pattern. The research contributes to a deeper understanding of the link between nutrition and sleep. Although a certain consistency was observed between the studies, the study design generally produced a poor to fair result, which does not allow the conclusion of a causal relationship. However, nutrition-related variables are associated with sleep quality. Further studies with larger and more balanced data sets are needed to support this finding.

**Keywords:** dietary habits, healthy eating, sleep quality, sleep duration

## 1. Introduction

Health is a state of complete physical, mental and social well-being. Dietary habits and quality sleep are among the most important activities for human health. The relationship between healthy eating and quality sleep is an extremely important issue in terms of individuals' quality of life, and there is increasing scientific evidence suggesting that there may be a relationship between these two conditions. [1] Within the scope of factors affecting human health, the relationship between sleep and nutrition was proposed about 30 years ago, and sleep duration was generally associated with higher calorie intake. [2] Some recent studies have focused on the role of sleep on diet quality and show a general association between short sleep duration and poor diet quality. [3]

Scientific studies emphasize that a regular and balanced diet has important effects on sleep quality. It has been observed that changes in sleep duration may be related to the body's nutritional balance such as food intake, body mass control, glycemic levels and blood glucose levels. [4]

Studies have found that insufficient sleep duration increases the consumption of high-fat and sugary foods. [5] In addition, it was determined that consumption of foods with high energy content such as carbohydrates and fats increased with decreasing sleep duration, while consumption of vegetables and fruits did not change. [6]

Sleep duration technically affects the hours during which eating takes place. Like all physiological actions, eating practices are regulated in response to the sleep-wake cycle, the basic output rhythm of the biological clock. Moreover, several features of eating practices, such as skipping breakfast, late mealtimes and low meal frequency, have been associated with altered metabolic response, poor diet quality and obesity. In a previous study, it was observed that people with short sleep were more likely to skip breakfast than people with normal sleep hours. [7]

### 1.1 Sleep Quality

Sleep quality is associated with feeling fit and ready to perform daily activities after waking up. Total sleep duration, time to fall asleep, and frequency of nighttime awakenings affect sleep quality. [8] Sleep quality also provides important clues about a person's sleepiness after waking up, resting state and sleep satisfaction. [9]

In studies investigating sleep quality, it has been determined that 11%-35% of people have poor sleep quality. [10] In terms of Turkey, a study conducted in 2010 revealed that 26.3% of women and 17% of men had poor sleep quality. [11]

### **1.1.1 Factors Affecting Sleep Quality**

Many physical, psychological and environmental factors affect sleep quality. These factors can be grouped as gender, age, nutrition, physical activity and psychological state.

#### **Gender**

In studies, it has been determined that women have shorter time to fall asleep, spend less time awake and have better sleep quality than men, [12] while in another study it was determined that women have more nightmares, sleep later and wake up more frequently at night than men. [13] In another study, it was determined that women between the ages of 18-24 years fell asleep and woke up earlier, woke up more frequently at night, had longer time to fall asleep and had lower sleep quality than men. [14] In another study, there was no gender-related difference in the number of nighttime awakenings and time spent asleep among people aged 18-24 years. [15]

#### **Age**

In a study, 54.7% of individuals with an average age of 17 years had poor sleep quality, and 9% of the individuals had problems with excessive sleepiness during the day. Sleep quality was found to be significantly lower in those who consumed excessive tea and coffee (66%), smoked (73.1%) and had problems with appetite change (73.8%). In logistic regression analysis, social and family problems, sleep disturbance and appetite change were among the determining factors responsible for 28% of the reduction in sleep quality. [16]

#### **Nutrition**

The arrangement and content of macronutrients in meals affect sleep quality. The effects of these macronutrients on sleep are also different from each other. [17,18] It has been reported that consumption of high fat and low carbohydrate or low fat and high carbohydrate foods increases sleepiness. [17,19] High-fat foods increase the feeling of sleepiness and sleep duration, while decreasing the time to fall asleep. High carbohydrate foods also shorten the time to fall asleep and increase the duration of sleep.

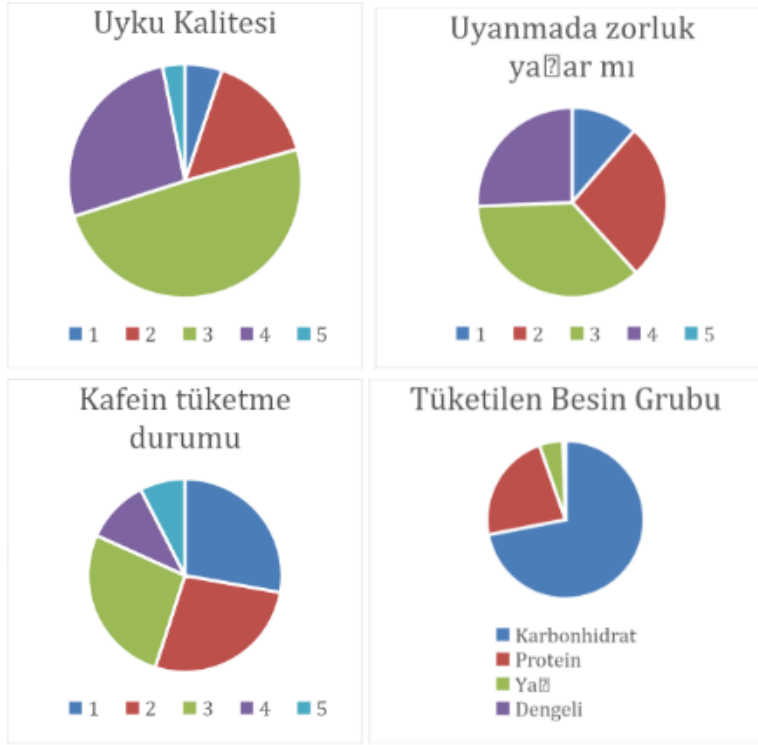
In a study conducted on young female students in Japan, it was found that students with good sleep quality ate breakfast regularly. [20]. In another study, low carbohydrate consumption was found to be associated with problems with sleep maintenance. [21] Caffeine-containing foods such as chocolate, cocoa, coffee, black tea, cola and energy drinks have been found to negatively affect sleep. [22] While caffeine increases the time to fall asleep, it also decreases sleep quality. Consumption of caffeine-containing foods shortly before going to sleep causes daytime fatigue and sleepiness. [23]

#### **Smoking and Alcohol Consumption**

Cigarettes enhance alertness due to the nicotine content. Nicotine intake delays the time it takes to fall asleep. It also plays a role in increasing sleep-related respiratory disorders and worsening sleep quality. [24,25] Alcohol shortens the time to fall asleep when consumed before bedtime. Due to the sudden changes in the body, the changes caused by alcohol on sleep show its effect in the first half of sleep. The fact that it has a temporary effect can negatively affect sleep for the rest of the night. Conditions such as sweating, stomach complaints, headaches and frequent toilet needs due to alcohol consumption also affect sleep quality.

## **2. Description of the Data**

A total of 291 (128 female, 163 male) data were collected in the questionnaire created through Google Forms. The questions related to nutrition were fruit consumption habits, mostly consumed food group, breakfast consumption, skipping meals, number of meals consumed per day, frequency of fastfood consumption, frequency of healthy snacks, supplement or vitamin use, caffeine consumption before sleep, consumption of meals and snacks before sleep. There are 27 columns in total. The output column was determined as sleep quality. We also obtained data assessing sleep quality on a 5-point scale, with 1 representing the worst sleep quality and 5 representing the best sleep quality. The graphical distribution of some of the participants' answers to the questions is as shown in the images below.



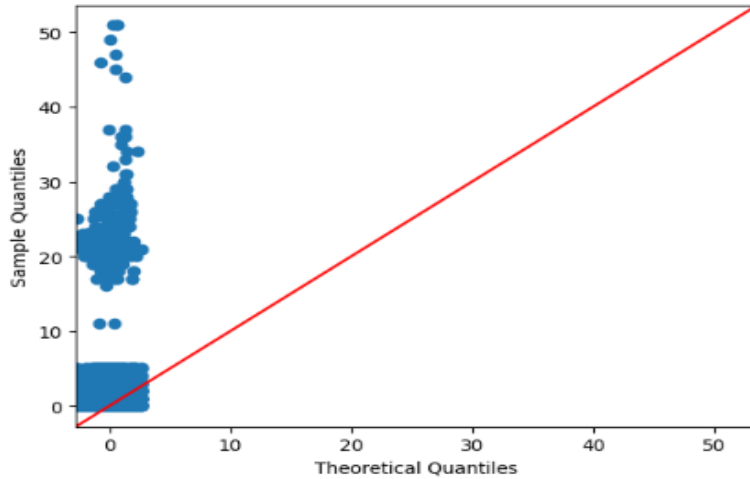
First, values containing anomalies in the data set were deleted. Afterwards, columns with categorical responses were converted into numerical values using Label Encoder and One Hot Encoding. Descriptive statistics were calculated to examine the distribution of the data. The standard deviation of age was found to be 5.655361. This indicates that the data is not balanced, deviates from the average and there are outliers. Since the other columns show a more balanced distribution, their standard deviations are more normal.

**Table 1. Statistical Values for Each Column in the Data Set**

Sütun	Mod	Medyan	Ortalama	Standart Sapma	Varyans
cinsiyet	1	1.0	0.558621	0.497410	0.247417
yas	22	22.0	22.944828	5.655361	31.983105
gunde_uyku_saati	2	2.0	2.358621	0.596134	0.355375
yasadiginiz_yer	1	1.0	0.672414	0.470144	0.221036
uyanma_saati	3	3.0	3.000000	1.100487	1.211073
uykuya_dalmada_sorun_varmi	0	0.0	0.468966	0.499899	0.249899
uyumadan_onceki_aktivite	1	1.0	1.713793	1.151567	1.326107
uyku_kalitesi	3	3.0	3.079310	0.858855	0.737633
uyaninca_yorgun_hissederimi	1	1.0	0.679310	0.467548	0.218602
uyanmada_zorluk_yasarmi	3	3.0	3.162069	1.224579	1.499594
tek_alarmla_uyanirmi	1	1.0	0.589655	0.492747	0.242799
gece_kac_kere_uyanir	1	1.0	1.089655	0.965977	0.933111

kafein_tuketme_durumu	1	1.0	2.420690	1.206493	1.455626
sigara_icerme	0	0.0	0.324138	0.468861	0.219831
alkol_tuketirmi	1	2.0	1.820690	0.861872	0.742823
su_icme_miktari	2	2.0	2.134483	0.875967	0.767319
meyve_tuketme_durumu	1	2.0	2.131034	1.020585	1.041594
tukettigi_besin_grubu	1	1.0	2.103448	1.308604	1.712445
kahvalti_yaparmi	1	1.0	0.734483	0.442372	0.195693
ogun_atlarmi	1	1.0	0.627586	0.484283	0.234530
ogun_sayisi	2	2.0	2.596552	0.757424	0.573690
fast_food_tuketme_durumu	3	3.0	2.755172	1.124772	1.265112
saglikli_ara_ogun_tuketme	2	2.0	2.279310	1.012681	1.025522
ek_takviye_vitamin_kullanma	0	0.0	0.251724	0.434754	0.189011
uykudan_once_kafein_tuketme	0	0.0	0.203448	0.403259	0.162618
uykudan_kac_saat_once_yemek_yer	2	2.0	1.893103	0.710003	0.504105
uyumadan_once_atistirmalik_tuketirmi	0	0.0	0.455172	0.498847	0.248849

Looking at the Q-Q line graph, the values show that the data set does not conform to a theoretical distribution.



We split the dataset into 20% test and 80% train. We trained the train data on 4 different models.

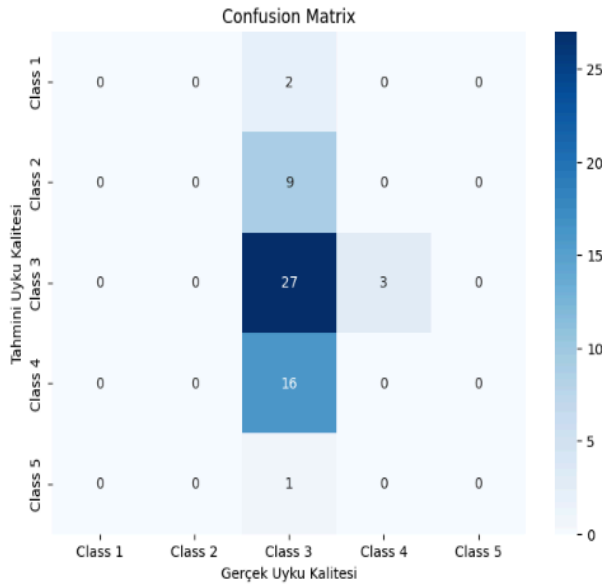
### 3. Proposed Methods

Normal distributions of all continuous variables were evaluated before analyzing the data. General characteristics according to sleep quality were analyzed by Pearson chi-square test. Chi-square value was 3718.7293 and p value was 1. Chi-square showed that the difference between observed and expected

frequencies was large. Methods such as KNN, SVM, Decision Tree, Logistic Regression were studied. Principal Component Analysis (PCA) is a statistical method used to reduce features in multivariate data sets and to express the basic structure of the data set with fewer variables. Principal component analysis was applied to all methods and the results were compared with each other.

### 3.1 K Nearest Neighbor

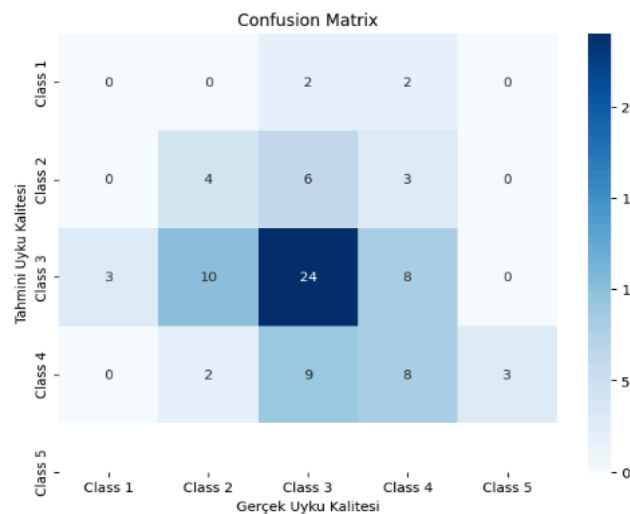
When all columns were included in the algorithm, the accuracy of the KNN algorithm was 0.55. This value was significantly increased by selecting the attributes. After applying PCA (principal component analysis), the value increased to 58%.



In reality, it predicted those with a sleep quality of 3 as 3 most often, with 49% success. Similarly, it predicted those with a sleep quality of 4 as 3.

### 3.2 Decision Tree

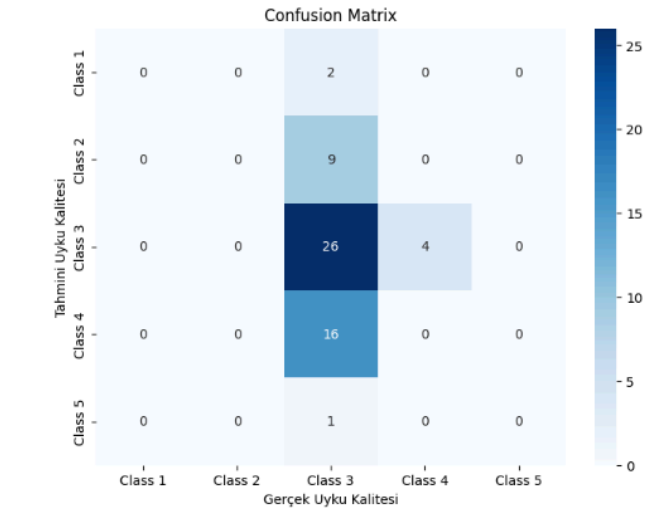
When all columns were included using the Decision Tree method, the accuracy value was 0.44, while the accuracy value increased to 0.57 when columns such as 'sleep\_dipping\_problems\_varmi', 'wake\_up\_fatigue\_hissermi', 'consumed\_food\_group', 'fast\_food\_eat\_status' were included in the solution with attribute selection.



In reality, those with a sleep quality of 3 were predicted as 3 at most. When we look at the dataset, the model memorized the data because the most common answer in sleep quality is 3. In reality, it knew those with sleep quality 4 8 times and showed 38% success. This algorithm showed excessive memorization in 2 answers.

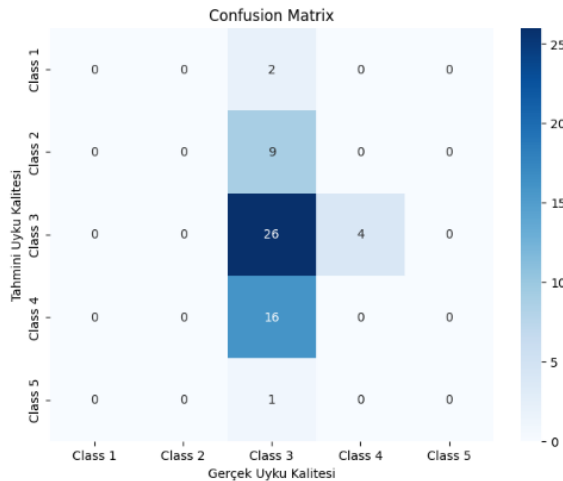
### 3.3 Support Vector Machine

When all columns were included using the Support Vector Machine method, the accuracy value was found to be 0.54, while the result increased up to 60% when kernel selection kernel=rbf was made. When PCA was applied, the accuracy values decreased.



In reality, those with a sleep quality of 3 were recognized as the most 3. The next answers were 4 and 2.

**3.4 Logistic Regression:** When all columns were included using the logistic regression method and the accuracy value was found to be 0.51, the class imbalance was compensated by adding the class weight='balanced' parameter and the accuracy value increased to 60%. When PCA was applied, the accuracy value did not increase.



In reality, those with a sleep quality of 1 were predicted as 3 at most. When we look at the dataset, the model has memorized the data since the most common answer in sleep quality is 3. In reality, it predicted those with sleep quality 4 correctly at a high rate and showed success. Likewise, it predicted those with sleep quality 5 as 3 in case of excessive memorization.

## 4. Experimental Results and Discussion

In each method, feature selection improved the accuracy to a certain extent, but was insufficient to make strong inferences. The table below shows the success metrics for each algorithm used.

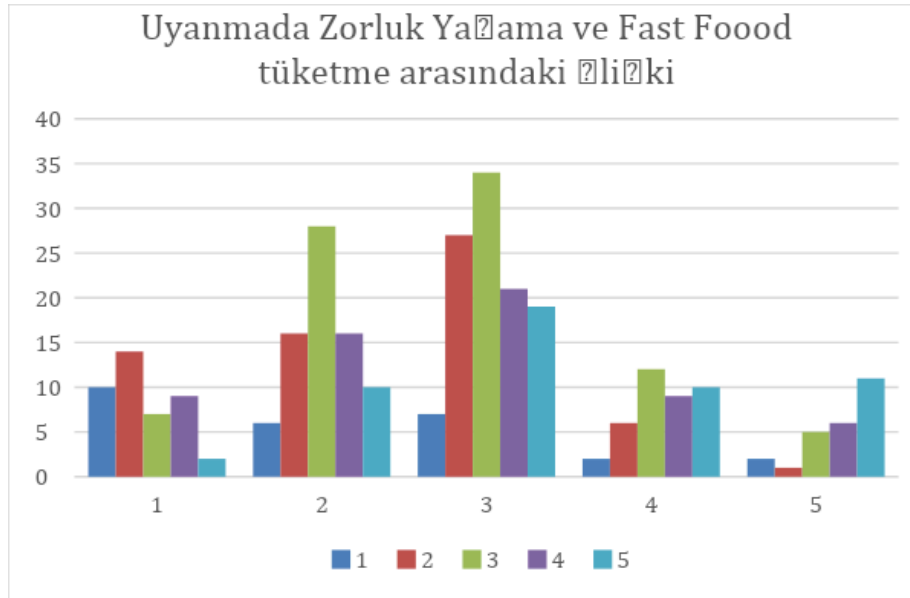
Table 2. Comparison of Metrics by Algorithms

ALGORİTMA	ACCURACY	PRECISION	RECALL	F1-SCORE
KNN	0.5862	0.3015	0.1839	0.1881
Decision Tree	0.5747	0.4251	0.4137	0.4180
SVM	0.6091	0.3155	0.4942	0.3608
Lojistik Regresyon	0.60	0.4578	0.5287	0.4870

Looking at the Accuracy values, SVM and logistic regression are the methods that give the best results. When we look at the Precision values, Logistic Regression gives the highest value with 45%. When we look at the Recall (Sensitivity) values, Logistic Regression was more successful than the other methods by giving the highest value with 53%. In F1-Score values, Logistic Regression gave the best value by reaching 48%.

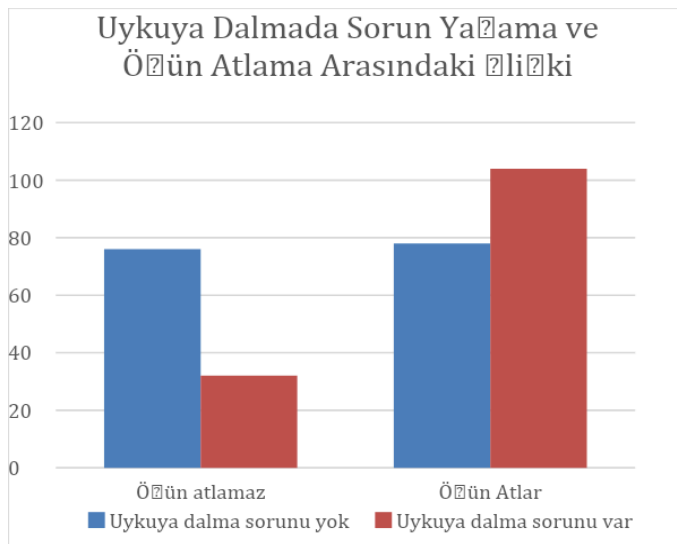
In general, the Logistic Regression model shows the highest performance. However, the best method for each metric varies. For example, the best results for sensitivity were seen in Logistic Regression and SVM algorithms.

According to the graph below, there is a weakly correlated positive relationship of 0.27 between difficulty waking up and fast food consumption. It was found that 31% of people who never consumed fast food had difficulty waking up, while 79% of those who consumed the most fast food had difficulty waking up.



**Consumption of fast food**

According to the graph below, a weakly correlated positive relationship of 0.26 was found between the trait of having problems falling asleep and skipping meals. While 58% of meal skippers have problems falling asleep, 28% of meal skippers have problems falling asleep.



## 5. Conclusion

In summary, in this study, a partial relationship was found between skipping meals, food group consumed, caffeine consumption and sleep quality. Since this study was cross-sectional in nature, which does not allow us to clearly identify cause and effect relationships, the overall quality of the study is moderate. Therefore, the available evidence on improving sleep quality by changing specific components of dietary habits is insufficient. However, the findings are promising.

## Author Contributions

Aslı Cnk and Beste Kk carried out the questionnaire development and data collection. Data preprocessing and normalization steps were performed by Aslı Cnk. KNN, SVM, Decision Tree, Logistic Regression methods were tested on Google Colab by Aslı Cnk and Beste Kk. Report generation steps were performed by Aslı Cnk and Beste Kk.

## Kaynaklar

- [1] Godos, J., Grosso, G., Castellano, S., Galvano, F., Caraci, F., & Ferri, R. (2021). Association between diet and sleep quality: A systematic review. *Sleep medicine reviews*, 57, 101430.
- [2] A.Lundahl , TD Nelson ,Uyku ve yiyecek alımı: ocuklarda ve yetiřkinlerde mekanizmaların oklu sistem incelemesi *J Health Psychol* , 20 ( 6 ) ( 2015 ) , s. 794 – 805
- [3] HS Dashti , FA Scheer , PF Jacques , S. Lamon-Fava , JM Ordovas ,Kısa uyku sresi ve diyet alımı: epidemiyolojik kanıtlar, mekanizmalar ve saęlık aısından etkileri *Adv Nutr* , 6 ( 6 ) ( 2015 ) , s. 648 - 659
- [4] Crispim, CA, Zimberg, IZ, dos Reis, BG, Diniz, RM, Tufik, S. ve de Mello, MT (2011). Saęlıklı bireylerde besin alımı ile uyku dzeni arasındaki iliřki. *Klinik uyku tıbbı dergisi*, 7 (6), 659-664.
- [5] Owens, J., Au, R., Carskadon, M., Millman, R., Wolfson, A., Braverman, P.K. ve dięerleri. (2014). Insufficient sleep in adolescents and young adults: an update on causes and consequences. *Pediatrics*, 134 (3), e921-e932.
- [6] Spiegel, K., Tasali, E., Penev, P.,Cauter, E.V. (2004). Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Annals of Internal Medicine*, 141 (11), 846-850
- [7] Kim, S., DeRoo, L. A., & Sandler, D. P. (2011). Eating patterns and nutritional characteristics associated with sleep duration. *Public health nutrition*, 14(5), 889-895.
- [8] Krystal, A.D.,Edinger, J.D. (2008). Measuring sleep quality. *Sleep Medicine*, 9, Supplement 1, S10-S17.
- [9] Gunaydin, N. (2014). Bir devlet hastanesinde alıřan hemřirelerin uyku kalitesi ve genel ruhsal durumlarına etkisi. *Journal of Psychiatric Nursing*, 5 (1), 33-40
- [10] Chung, K.F.,Tang, M.K. (2006). Subjective sleep disturbance and its correlates in middle-aged Hong Kong Chinese women. *Maturitas*, 53 (4), 396- 404.
- [11] Demir, A. (2010). Eriřkin toplumda ulusal uyku epidemiyolojisi arařtırması ilk sonuları. Eriřim: 28 Aralık 2014, Aę Sitesi: [http://78.189.53.61/-/uyku/11uykusunu/8\\_a\\_demir.pdf](http://78.189.53.61/-/uyku/11uykusunu/8_a_demir.pdf)
- [12] Goel, N., Kim, H.,Lao, R.P. (2005). Gender differences in polysomnographic sleep in young healthy sleepers. *Chronobiology International*, 22 (5), 905- 915.
- [13] Coren, S. (1994). The prevalence of self-reported sleep disturbances in young adults. *International Journal of Neuroscience*, 79 (1-2), 67-73.
- [14] Tsai, L.-L.,Li, S.-P. (2004). Sleep patterns in college students: Gender and grade differences. *Journal of Psychosomatic Research*, 56 (2), 231-237.
- [15] Park, Y.M., Matsumoto, K., Shinkoda, H., Nagashima, H., Kang, M.J.,Seo, Y.J. (2001). Age and gender difference in habitual sleep–wake rhythm. *Psychiatry and Clinical Neurosciences*, 55 (3), 201-202.



- [16] ŞENOL, V., SOYUER, F., AKÇA, R. P., ARGÜN, M. (2012). Adolesanlarda Uyku Kalitesi ve Etkileyen Faktörler. Kocatepe Tıp Dergisi, 13(2), 93-104. <https://doi.org/10.18229/ktd.02830>
- [17] Barot, N., Barot, I. (2013). Nutrition and sleep. C. A. Kushida (Ed.). Encyclopedia of Sleep (s. 108-113). Waltham: Academic Press
- [18] Partinen, M. (2009). Chapter 23 - Nutrition and Sleep. Chokroverty, S. (Ed.). Sleep Disorders Medicine (Third Edition) (s. 307-318). Philadelphia: W.B. Saunders
- [19] Chow, C.M., Herrera, C.P. (2011). Feeding and sleep behavior. Preedy, R. V., Watson, R. R. & Martin, R. C. (Ed.). Handbook of Behavior, Food and Nutrition (s. 783-796). New York, NY: Springer New York.
- [20] Nakade, M., Takeuchi, H., Kurotani, M., Harada, T. (2009). Effects of meal habits and alcohol/cigarette consumption on morningness-eveningness preference and sleep habits by Japanese female students aged 18-29. Journal of Physiological Anthropology, 28 (2), 83-90.
- [21] Grandner, M.A., Jackson, N., Gerstner, J.R., Knutson, K.L. (2014). Sleep symptoms associated with intake of specific dietary nutrients. Journal of Sleep Research, 23 (1), 22-34.
- [22] Lorist, M.M., Snel, J. (2008). Caffeine, sleep and quality of life. Verster, J. C., Pandi-Perumal, S. P., Streiner, D. L. (Ed.). Sleep and Quality of Life in Clinical Medicine. Totowa, USA: Springer.
- [23] Partinen, M., Westermarck, T., Atroshi, F. (2014). Chapter 7-Nutrition, Sleep and sleep disorders – relations of some food constituents and sleep. Atroshi, F. (Ed.). Pharmacology and Nutritional Intervention in the Treatment of Disease: InTech
- [24] Jaehne, A., Loessl, B., Bárkai, Z., Riemann, D., Hornyak, M. (2009). Effects of nicotine on sleep during consumption, withdrawal and replacement therapy. Sleep Medicine Reviews, 13 (5), 363-377.
- [25] Irish, L.A., Kline, C.E., Gunn, H.E., Buysse, D.J., Hall, M.H. (2015). The role of sleep hygiene in promoting public health: A review of empirical evidence. Sleep Medicine Reviews, 22, 23-36.