UYKU VE BESLENME

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ÖZ
Hayatımızın 3/10'unu geçirdiğimiz uyku vücudumuzun evrensel ve doğal bir ihtiyacıdır. Bu süreçte uyku kalitesini ve süresini etkileyen birçok faktör bulunmaktadır. Bu faktörlerden en önemlilerinden birinin beslenme olduğu bilinmektedir. Son zamanlarda giderek popüler hale gelen uyku ve beslenme arasındaki ilişkiyi inceleyen pek çok çalışma bulunmaktadır. Çalışmalarda özellikle diyetle alınan enerji ve makrobesin öğeleri, mikrobesin öğeleri (vitamin ve mineraller), hormonlar (melatonin), alkol ve kafein, atıştırmalıklar, beslenmedeki farklı besin grupları (et ve et ürünleri, tahıllar, meyve ve sebzeler) ve diyet kalitesinin uykuyla ilişkisi incelenmiştir. Bu derlemede beslenmenin uyku ile etkileşiminin ortaya konulması amacıyla PubMed, Science Direct, Google Scholar, BioMed Central ve TR dizini gibi ulusal ve uluslararası veri tabanlarının detaylı bir literatür taramasıyla incelenmesi amaçlanmaktadır.
Anahtar kelimeler: Uyku, besin, beslenme

SLEEP AND NUTRITION

ABSTRACT
We spend 3/10 of our lives in sleeping, which is a universal and natural need of our body. In this process, many factors affect sleep quality and duration. It is known that one of the most important Factors affecting sleep is nutrition. Many studies examine the relationship between sleep and nutrition. Dietary energy and macronutrients, micronutrients (vitamins and minerals), hormones (melatonin), the others (alcohol and caffeine, snacks), different food groups (meat and meat products, cereals, fruit and vegetables) in the diet and diet quality are related to sleep were studied. This review, aims to reveal the interaction of nutrition with sleep using existing literature from databases such as PubMed, Scopus, Google Scholar, BioMed Central and national databases like TR index with a detailed literature in order to reveal the interaction of nutrition with sleep.
Key words: Sleep, food, nutrition

INTRODUCTION

Sleep

Definition and Physiology of Sleep

Sleep, in which we spend approximately 30% of our time, is vital such as feeding and breathing. While our body is in sleep condition, many biological and physiological restorations occur in the body (1-4).

Sleep is one of the basic building blocks necessary for life and health (4-5). Rhythm disturbances may occur in the body of a sleep-deprived creature, and systems (endocrine system, memory, cognitive functions, metabolism, and immune system) may be adversely affected (1,3,4).

Two main mechanisms regulate sleep in the mammalian organisms. The first one is a biological rhythm named as “circadian rhythm” (1,3,4). This rhythm is a feedback loop that affects the body's sleep-wake center in the hypothalamus through the light/dark cycle in 24-hour cycles (4,6-13). Circadian rhythm can be affected by many internal and external factors. The internal factors affecting the circadian rhythm are

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Geliş tarihi/Received: 29.08.2023
Kabul tarihi/Accepted: 13.02.2024
DOI: 10.52881/gsbdergi.1352276

age, gender, and genetic components (genetic clock). The external factors are classified as dietary habits, physical activity, and other environmental factors (10-13).

The second mechanism is the "melatonin" hormone. Melatonin is a sleep-inducing circadian hormone. This hormone is produced by the pineal gland at night and has the highest production around 02:00 a.m. in humans and informs the body about the light/dark cycle under the control of the upper chiasmatic nucleus (3,4,14). Melatonin provides sleep induction by activating the circadian rhythm through melatonin receptors 1 (MT1) and melatonin receptors 2 (MT2) (3,4). Melatonin production generally decreases with age. This decrease is associated with an increased prevalence of insomnia in the elderly (3).

Stages of Sleep

The foundations of the discovery of sleep stages were laid in 1929 by Hans Berger, a German psychiatrist. Berger placed electrodes on the scalp and recorded the electrical activity of the human brain. He found that there was a difference between brain waves in sleep and wakefulness. Berger named these recorded data as electroencephalogram (EEG). In 1935, a group of scientists at Harvard University determined that brain activity also changed during sleep. With this discovery, the idea that there are different stages of sleep according to brain activity that changes during sleep has been adopted. In 1937, the letters "A-B-C-D-E" became more important because Alfred Lee Loomis determined that there were 5 different stages of sleep in EEG and defined by these five letters. Today, the first of these five stages of sleep is called the "non-rapid eye movement (NREM)" stage. However, it is also known that non-dreaming NREM sleep occurs in the first parts of sleep (2,5,7,15,16). The NREM stage of sleep consists of four stages, first, second, third and fourth, in which most of the sleep period occurs (7) (Table 1).

After the discovery of the NREM phase, Kleitman and Aserinsky defined the rapid eye movement stage (REM) at the University of Chicago in 1953. They stated that REM sleep was a different stage of sleep like NREM and REM sleep was associated with dreaming. In 1957, Kleitman and Dement found that NREM and REM phases occur in repetitive cycles throughout the entire sleep period. They revealed that in this process, which is now called "sleep pattern/sleep architecture", the sleep stages are repeated approximately five times, one after the other (15,16).

Table 1: NREM Phase Stages (7)

1) Superficial Sleep	
Stage First: The body is in a state of relaxation. It is the stage of sleep when it is the lightest and most sensitive to external stimuli. It is the phase that makes up 2-5% of the total sleep time.	**Stage Second:** It is the stage that is a deeper sleep stage than stage first and constitutes the largest part of the total sleep time (45-55%).
2) Deep Sleep	
Stages Third and Fourth: Stages third and fourth, often referred to as "deep sleep" or "slow wave sleep (SWS)," come one after the other and occur mostly in the first third of the nighttime sleep session.	

Sleep Requirement

Sleep duration is very important in terms of health. Inadequate sleep duration may cause an increase in the incidence and prevalence of cardiovascular diseases

(hypertension, myocardial infarction, hypercholesterolemia), weakening of the immune system, impaired glucose tolerance, and a decrease in cognitive function. Sleep duration differs in every period of life. The duration of sleep, which is longer in the first years of life, gradually decreases in the following years. The average sleep duration according to the recommendations of the American National Sleep Foundation (NSF) is given in Table 2 (7).

Sleep Quality

Sleep quality is an important component of health, as is sleep time. High sleep quality contributes to being more active during the day, improving cognitive performance such as attention and concentration, and minimizing daytime fatigue and insomnia (17).

Table 2: Average sleep time according to the recommendations of NSF (7)

Life stage	**Age**	**Recommended sleep time (hours)**
Newborns	0-2 months	12-18 h
Babies	3-11 months	14-15 h
Toddlers	1-3 year	12-14 h
Preschool children	<3-5 year	11-13 h
School-age children	6-11 year	10-11 h
Youth	12-17 year	8,5-9,5 h
Adults	≥18 overage	7-9 h

In a study conducted with the participation of healthy individuals between the ages of 19-31 years, it was found that poor sleep quality increased the risk of depressive symptoms in participants (18). Research involving young adults reported that sleep quality affects health-related quality of life components (exercise, stress, nutrition, cognitive performance) (19). In a large study involving adults, poor sleep quality was associated with an increased risk of stroke compared to high sleep quality (20). Conducted with the participation of adult male individuals in the Chinese population, it was stated that poor sleep quality caused an increase in the prevalence of hypertension (21). In another research involving adults aged 18-75 years, poor sleep quality was associated with impaired fasting serum glucose level (22). In a study in the adult USA population, it was found that poor sleep quality was associated with an inflammatory marker, C-reactive protein (CRP) (23). It has been reported that the incidence of type 2 diabetes is high in adults with poor sleep quality aged 40-75 years who apply to primary health care services in the Korean population (24).

Factors Affecting Sleep Quality of Duration

Many factors affect sleep duration and quality. These factors are individual factors such as age and gender; and environmental factors such as nutrition, physical activity, and emotional state (7,13).

Evaluation of Sleep Quality and Duration

Many criteria are used in the evaluation of sleep. These criteria are divided such two subjective and objective evaluation. Subjective assessments based on personal reports. Objective evaluations are based on specific analysis and laboratory results rather than individual statements. The subjective evaluation contains the Epworth Sleepiness Scale (ESS), Pittsburgh Sleep Quality Index (PSQI), Vitalmed Sleep Questionnaire, Stanford Sleepiness Scale, Obstructive Sleep Apnea Symptoms Questionnaire, and Sleep Diaries while objective evaluation contains

Polysomnography and Wrist Actigraphy (2,5).

Polysomnography is accepted as the "Gold Standard Method" used to determine sleep disorders and sleep apnea (sleep breathing disorder). Polysomnography is performed in sleeping rooms in a laboratory environment where people sleep at night. In this process, anodes are placed on the person's face, head, nose, and finger; elastic bands are placed around the chest and abdomen. These anodes are transferred to a computer outside the laboratory via cables. Information about the person's brain waves, eye movements, oxygen level in the blood, respiratory activities, and cardiac muscle activity are obtained from the document in that computer. Wrist actigraphy, which is another method frequently used in the evaluation of sleep quality, due to its low cost, is a method used to evaluate the motor skills of the person in resting/activity situations. Information about the person's motor skills as well as night and day sleep conditions and sleep disorders is obtained by actigraphy. Actigraphy can be placed on any part of the body. It is usually worn on the non-dominant wrist in adults and on the ankle in children (1,25,26). Polysomnography and Wrist Actigraphy are frequently used methods in sleep-related studies (1,25-34).

Sleep and Nutrition

Sleep and nutrition are two important parts of our lives and these two concepts interact with each other. Many studies have been done in this area; showing that nutrition can affect sleep. Dietary energy and macronutrients, micronutrients (vitamins and minerals), hormones (melatonin), the others (alcohol and caffeine, snacks), different food groups (meat and meat products, cereals, fruit and vegetables) in the diet and diet quality are among the important factors affecting sleep (27-34,36-53,56-67).

Dietary Energy and Macronutrients

Macronutrients have many important functions in the body, such as supporting the immune system, forming tissues, repairing wounds, providing heat and energy sources, and regulating the endocrine system. They interact with sleep duration (27-34). The study on adolescents (n=240) who have less than 8 hours of sleep duration on weekdays had a 3.7 percent decrease, in energy from carbohydrates and energy from fats according to having a sleep duration of more than eight hours (27). By the way, in a similar study on children aged between 9-11 years with examining this reaction, it was detected that more than 10 hours of sleep duration associated with lower dietary energy intake and higher polyunsaturated (28). In a research conducted with the participation of healthy young people (n=12), it was found that a high glycemic index diet led to more sleepiness and a tendency to be less alert (29). The intake of saturated fatty acids in male individuals (n=211) with insomnia, was higher than the recommended level. In the same study, low protein intake (<16% of energy) was associated with poor sleep quality and difficulty falling asleep; high protein intake (>19% of energy) was associated with difficulty in maintaining sleep. However, low carbohydrate intake was found to be associated with insomnia (30). In another study conducted with the participation of civil servants (n=4835) in the Japanese population that supported this study, low energy from carbohydrates

(<50%) was associated with difficulty in maintaining sleep (31). In adults (14 men, 13 women), the percentage of energy consumed from saturated fat was associated with reduced time in SWS (32). In a different study conducted on adolescents, it was reported that proteins can improve sleep quality (33). In a similar study, adults who slept for a long time, consumed foods with high protein content (1,5 g/kg) (34).

Micronutrients, Hormones and Others

Vitamin D

Vitamin D, also known as cholecalciferol, is a fat-soluble vitamin that is stored in the liver. The best sources of vitamin D are sunlight and seafood (35). The fact that the consumption of these foods can be related to sleep has been supported by many studies, and it has been stated in many studies that especially vitamin D has a direct effect on the initiation and maintenance of sleep (36-41). In a study conducted on male participants over 65 years of age (n=2966) in the USA, a significant correlation was found between lower vitamin D levels and shorter sleep duration, weaker sleep efficiency, and increased sleep fragmentation (36). Again, in a study conducted with the participation of 95 convicts in a forensic medicine center in the USA, it was observed that the control group consuming chicken/beef/pork three times a week had a delay in sleep onset and a significant decrease in sleep efficiency compared to the group consuming Atlantic salmon three times a week. In addition, it was concluded that daily functioning and activity status were higher in the fish-consuming group. As a result of the tests, it was determined that the serum vitamin D levels of the fish-consuming group were higher than the control group (37). In a study conducted with the participation of adults (n=89), it was stated that the sleep quality of the group that took 50,000 units of vitamin D supplementation every two weeks for eight weeks, increased at the end of the study, the difficulty in starting sleep decreased, and the duration of sleep increased compared to the placebo group (38). Many studies support the results of these studies, low serum vitamin D levels have been associated with shorter sleep duration and poor sleep quality (39-41).

Zinc

It has been supported by studies that zinc has a positive effect on sleep quality (42,43). In a study conducted in a kindergarten (n=777) in the city of Jintan, China, serum samples were taken from children during pre-school and adolescence periods, and serum zinc concentrations and sleep data were compared. As a result of the comparison, it was determined that sleep quality was directly proportional to serum zinc concentration. In addition, poor sleep quality and poor sleep efficiency were associated with low zinc concentration (42). In another research involving intensive care nurses (n=54) at Mazandaran University of Medical Sciences, Iran, it was reported that 220 mg zinc supplementation every 72 hours for one month improved subjective sleep quality and sleep onset delay (43).

Melatonin and Dietary Sources of Melatonin

In a study conducted with the participation of individuals (n=91) aged 21-69 who suffer from mild insomnia, it was concluded that the group consuming milk rich in melatonin half an hour before going

to bed for two weeks had a significant improvement in sleep satisfaction compared to the group consuming regular milk under the same conditions. In the same study, it was found that the group suffering from severe daytime sleepiness had a significant improvement in symptoms after consuming milk rich in melatonin, and daytime sleepiness showed a significant improvement when compared to the group consuming normal milk (44).

In another research examining the interaction of sour *Prunus cerasus* L., which is a food containing melatonin, with sleep, it was reported that individuals aged 50 and over, who complained of insomnia, increased their sleep duration by 84 minutes after consuming 240 ml of *Prunus cerasus* L. juice twice a day for two weeks (45).

Alcohol and Caffeine

In a study conducted with children aged 8-12 (n=309) to examine the relationship between caffeine and sleep, it was found that children who slept nine to eleven hours consumed significantly less caffeine than children who slept 7 to 8 hours. In the same study, it was determined that higher caffeine consumption, bad sleep routine, morning fatigue, and sleep disturbance were significantly associated, and total caffeine intake was positively associated with morning fatigue (46). In another study supporting this study, it was stated that short-term sleep was associated with an increased probability of consuming tea and sweetened tea compared to long-term sleep, and the probability of consuming tea decreased with each hour of sleep duration (47). In undergraduate students (n=920) studying at university, it was found that those who consume alcohol every day or two-three days a week and those who consume caffeinated beverages more than three times a day have impaired sleep quality and there is a significant relationship between them (48).

Snacks

In one of these studies, shorter sleep duration (mean sleep duration of less than eight hours) in adolescents was associated with higher energy intake from snacks. In the same study, shorter sleep duration (<6 hours) was associated with higher soft drink intake (≥5 times per week) and a higher intake of sweets (≥5 times per week) (49). In another study conducted on adolescents (n=14.274) that supported this study, poor sleep quality was associated with ≥5 times-a-week intake of soda, soft drinks, fast food, instant noodles, and sweets. Long-term sleeper children and adolescents are more likely to consume salty snacks, carbonated drinks, and fast food, compared to short-term sleepers (10 hours/day for children younger than 10 years and 9 hours/day for children ≥ 10 years old/adolescents). The diet was associated with reduced consumption of soft drinks, fresh fruits, dried fruits, fresh fruit juices, and packaged fruit juices (50).

Food Groups

Meat and Meat Products

Many studies deal with the relationship of meat with sleep in different ways (47,48). In a study conducted with the participation of undergraduate students (n=920) studying at the university, it was concluded that students whose meat consumption like salami, sausage, etc. is more than two servings per week have higher PSQI and ESS scores. High PSQI and ESS scores were associated with poor sleep quality

and high daytime sleepiness (51). In another study conducted on adolescents (n=458), higher meat and starch-pattern diets were associated with higher social jetlag (the difference between the circadian clock and the time zone in our social life) (33).

Cereals

There are many studies dealing with the relationship of this important food source with sleep (52-54). In a study conducted on adults (n=1612) aged 19-65 years, it was found that those who slept five hours or less had an 18% lower whole-grain score and an 18% higher refined grain score compared to those who slept 7-8 hours (52). There is a two-way interaction between sleep and grain consumption. In a study supporting this proposition, it was stated that consuming more than six servings of cereal food per day reduces sleep quality in adolescents and may lead to daytime sleepiness (53). On the other hand, obstructive sleep apnea (OSA) has been reported to be associated with cereal grain intake, and a higher refined grain cereal intake may be a risk factor for OSA severity (54).

Fruit and Vegetable

In one of the studies dealing with the relationship between fruit and vegetable consumption and sleep, adults who slept for short periods (<7 hours/day) consumed, on average, fewer g/day fruit and vegetables compared to the reference group (7-8 hours/day), and α-carotene and plasma fruit and vegetable biomarkers were found to be lower, excluding vitamin C. In the same study, when adults who slept for a long time (8 hours/day) were compared with the reference group (7-8 hours), it was found that the group who slept for a long time consumed less than five servings of fruit and vegetables per day on average on weekdays (52). In addition, in many studies, short sleep time has been associated with a decrease in vegetable and fruit intake (20,22,23). In a large-scale study (n=21,027) conducted on university students, it was found that the prevalence of poor sleep quality, restless sleep and short sleep decreased with the consumption of five servings or more of vegetables and fruits per day (53).

Nutrition Models

Mediterranean Diet

The “Mediterranean diet” is a general nutritional model of countries with a coast on the Mediterranean. The main food sources in this diet are olive oil, vegetables and fruits, whole grains, legumes, fish and seafood, poultry, eggs, milk and yogurt. It is known that the Mediterranean diet has positive effects on health. It has been reported that the Mediterranean diet reduces the risk of many diseases such as cardiovascular diseases, diabetes, cancer, metabolic syndrome, Alzheimer's, dementia, and obesity (54-58).

The Mediterranean Diet Adherence Scale (MEDAS)/Mini Mediterranean Diet Adherence Scale (mMEDAS) is used to evaluate the Mediterranean diet (55). This nutrition model, which has become more popular in recent years, has an interaction with sleep. In a large-scale study using the mMED score, which is one of these scales, with the participation of individuals between the ages of 45 and 75, it was found that both short (<6 hours/night) and long-term (≥9 hours/night) sleepers were less committed to a healthy diet (56). In another study, when a diet adopting the Mediterranean diet model was compared

with another diet containing lean unprocessed meat, it was found that the dietary model adopting the Mediterranean diet improved sleep quality. In addition, it has been reported that the state of waking up during sleep decreases with the diet model adopting the Mediterranean diet (57). Another study found that adults with high adherence to the Mediterranean diet were less likely to have short sleep duration and poor sleep quality. (58). Conducted with the participation of older adults aged 60 and over, it was stated that higher olive oil and vegetable consumption had a positive effect on sleep. However, a two-point increase in the MEDAS score was associated with a lower risk for changes in sleep duration (59). In a large-scale Cohort study (n=23,829) of individuals aged 45-75 years, both short (<6 hours/night) and long-term (≥9 hours/night) sleepers were found to be less adherent to a healthy diet, using the mMED score (60). It was determined that there was a significant relationship between the Mediterranean diet applied by nursing students (n=334) for 4 months and their sleep quality and academic achievement (61). In another study, when a diet adopting the Mediterranean diet model was compared with another diet containing lean unprocessed meat, it was found that the diet adopting the Mediterranean diet improved sleep quality. In addition, it has been reported that the state of waking up during sleep decreases with the diet model adopting the Mediterranean diet (62). In a study of Costa Rican adults similar to this study, low adherence to the Mediterranean diet was associated with shorter sleep duration on both weekdays and weekends (63). In another research with the participation of adults, it was reported that individuals with high adherence to the Mediterranean diet had a lower risk of poor sleep quality and experienced fewer insomnia symptoms (64). In another research, it was determined that female individuals who slept for short periods during the week had a lower level of adherence to the Mediterranean diet compared to those who slept at an optimal level. It has been reported that these individuals consume less fruit, vegetables, and legumes (65). In a study conducted with adults, it was reported that participants with moderate/high adherence to the Mediterranean diet were less likely to have insomnia symptoms compared to those with a high score level of adherence to the Mediterranean Diet (66). In research, a higher MEDAS score was associated with a lower frequency of experiencing parameters indicative of poor sleep (67).

The Mediterranean diet is an important and qualified diet model with potential positive effects on health. In recent years, scientific evidence has emphasized the importance of the Mediterranean diet. In addition, since it also interacts with sleep, the right public health interventions and promotion should be made to improve the Mediterranean diet compliance level of adults.

CONCLUSION

Nutrition and sleep; these two important topics are essential elements of life. In addition, these two concepts interact with each other. In recent years, there have been many studies in the literature examining this interaction. However, more of them are needed to fully understand the interaction between sleep and nutrition. After this interaction is comprehensively addressed, improvements in adults' sleep quality, eating habits and lifestyles can be implemented.

Author Contributions

Concept – E.B., G.E.C.; Design – E.B., G.E.C.; Supervision – G.E.C.; Materials – E.B.; Data Collection and/or Processing – E.B.; Analysis and/or Interpretation – E.B., G.E.C.; Literature Review – E.B.; Writing – E.B.; Critical Review – G.E.C.

Declaration of Interests

The authors declare that they have no competing interests.

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