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Original article

Sleep quality and its relationship with night eating syndrome, the risk of diabetes, and nutritional status among university students

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Summary. Changes in sleep quality increase the risk of diabetes and obesity by affecting nutrition. This study was conducted to find the correlation between sleep quality and night eating syndrome in addition to obesity predisposition and the risk of diabetes. 550 university students including 330 women and 220 men between the ages of 17-42 years participated in the study. A face to face questionnaire was conducted in order to collect information about their personal characteristics, nutritional habits, and physical activities. Their anthropometric measurements were taken and food consumption in the last 24 hours were recorded. The Night Eating Syndrome Questionnaire, the Pittsburg Sleep Quality Index, and the Finnish Diabetes Risk Score were conducted on the participants. 40% of the students were found to have good sleep quality, while 60% were found to have poor sleep quality. The median values of night eating syndrome, the risk of diabetes, and the sleep quality scores of participants with good sleep quality were significantly lower than that of the participants with poor sleep quality. Also, a positive correlation was found between the sleep quality score along with the night eating and diabetes risk scores. Moreover, night eating syndrome and sleep duration were positively correlated with waist circumference and waist/height ratio which are indicators of obesity. As a result, the study found that poor sleep quality increased night eating syndrome, obesity predisposition, and the risk of diabetes, a metabolic disease. University students may be recommended to improve their sleep quality in order to prevent the above-mentioned metabolic diseases.

Key words: sleep quality, night eating syndrome, diabetes, obesity, nutrition

Introduction

Humans have biological, psychological, social, and cultural needs. One of our basic needs, sleep is a state of physical and mental rest in which people are inactive and unaware of their surroundings (1). Sleep is a natural process which maintains energy homeostasis. It also improves and restores the nervous system. It is correlated with many components of the biological structure, mainly the nervous system which controls stimulation, motor-skills, behaviors and cognitive functions (2). Generally, healthy sleep consists of two dimensions including sleep duration and sleep quality (3). Sleep quality is about feeling energetic, fit, and ready for a new day after waking up. It is also related to quantitative aspects of sleep such as sleep latency, sleep duration, and the number of times one wakes up at night in addition to subjective aspects such as sleep depth and restfulness (4). Although sleep is one of the basic physiological needs to maintain health, sleep disorders have currently become an important issue due to living conditions or physiological and psychological problems. According to the Epidemiology of Sleep Disorders in the Adult Population Survey which drew

up the sleep map of Turkey, 13% of the population has difficulty falling asleep, 30% sleep less than eight hours, and 11% sleep less than six hours (5).

Hunger is correlated with wakefulness. Distortions in sleep duration and quality may cause physiological and behavioral changes resulting in eating disorders (6). Night eating syndrome has been among the most prominent disorders recently (7). It is defined as consuming more than 25% of the daily food intake after dinner, waking up to eat at least twice a week, appetite suppression during morning hours, and appetite increase during evening hours in addition to having difficulty in falling asleep or maintaining the state of sleep at least four times a week (8). It was suggested that sleep disorders take an active role in the occurrence of night eating syndrome, the sleep quality of individuals with the syndrome is significantly low, they often wake up to eat, and have difficulty falling asleep (9).

Distortions in sleep duration and quality may significantly affect appetite, nutrition, in addition to energy balance and thus may trigger obesity, insulin resistance, and diabetes (10-12). Several prospective studies showed that poor sleep quality patterns such as excessive sleep duration (13), difficulty falling asleep (14), and sleep management (14, 15) increase the risk of impaired glucose tolerance or type 2 diabetes. Pyykkönen et al. (16) indicated that sleeping less than 6 hours or more than 9 hours increases the risk of type 2 diabetes. Even though the mechanisms which are correlated with sleep duration, quality, and the risk of diabetes are not completely clarified, it was suggested that short sleep duration may lead to insulin resistance by increasing sympathetic nervous system activity (17, 18) along with evening cortisol levels (19), and reducing cerebral glucose use (20). Increasing load on the pancreas due to insulin resistance may surpass β-cell function and cause type 2 diabetes in time. In addition, along with sleep disorder, increase in systemic inflammation indicators such as C-reactive protein and interleukin-6 play an important role in the formation of diabetes (21, 22).

Night eating syndrome is regarded as a key mechanism caused by the correlation between poor sleep quality and metabolic diseases such as diabetes. However, any study which examines the relationship between night eating syndrome, sleep quality, and diabetes risk together is not available in literature. This study was planned and carried out to find the correlation between sleep quality and night eating syndrome in addition to diabetes risk and nutritional status.

Method

The study was carried out with 550 volunteers including 330 women and 220 men between the ages of 18-42 years who studied at universities in Ankara, Turkey between May-November 2019. Sample size calculated according to a previous research examining night eating syndrome (23), nutritional habits and sleep quality among university students and considering 95% power and 5% α-error, 392 adolescents had been determined. This study, coded 2019-081, was approved by the Ethics Committee of Gazi University on 30.04.2019 under document no E.55336.

Participants

Individuals who did not meet exclusion criteria were not included in the study. Exclusion Criteria included being under 18, having physical or mental incapacity, undergoing psychiatric drug use in the last 6 months, and type 2 diabetes mellitus diagnosis.

The face to face interview method was applied to collect data from the participants with a questionnaire form consisting of three sections. The first section included questions regarding personal characteristics of the participants. The second was about nutritional habits and physical activities. The last part included anthropometric measurements.

Data Collection

Food Consumption Record

The 24-Hour Dietary Recall Form was recorded to determine their energy and food intake. The average energy and nutrient intake were analyzed by means of the " Nutrition Information System 7.2" (Turkish Version), a computer-aided nutrition program (24).

The Night Eating Syndrome Questionnaire

The Night Eating Questionnaire is used to assess the risk of night eating syndrome. Consisting of 16

questions, the Night Eating Syndrome Questionnaire was developed by Allison et al. (25) and adapted into Turkish by Atasoy et al. (26). The questionnaire consists of questions about morning appetite and the first meal of the day, evening and nocturnal ingestion, ratio of food intake after dinner, food cravings, control over night eating behavior, difficulty in falling asleep, frequency of waking up to eat, awareness and mood during nocturnal ingestions. Items except the 7th are rated between 0-4 with 5 point likert scale and total score ranges between 0-52. Scores not less than 25 are evaluated as "with night eating syndrome", while the scores under 25 are "no night eating syndrome" (26).

The Pittsburg Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) is an effective instrument used to measure the quality and patterns of sleep in the adults. The index was developed by Buysse et al. in 1989 (26) and Ağargün et al. carried out validity and reliability study of the index (27) in Turkey in 1999. It consists of 19 questions each of which has 7 items rated between 0-3. These items are subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disorder, sleeping pill use and daytime dysfunction. PSQI score is obtained by the total score of seven items ranging between 0-21. High scores are associated with poor sleep quality and high level of sleep disorder. More specifically, the scores above 5 mean clinically poor sleep quality (28).

The Finnish Diabetes Risk Score (FINDRISC)

FINDRISC was developed by the Finnish Diabetes Association in order to scan the risk of diabetes within the scope of the Program for the Prevention of Type 2 Diabetes in Finland (29). It is widely used in Turkey and highly recommended by the Turkish Journal of Endocrinology and Metabolism (30). Providing information about the risk of diabetes within 10 years, the FINDRISC consists of 8 questions including (age, BMI, waist circumference, exercise, vegetable and fruit consumption, hypertension, blood sugar level, diabetes history in family). Total FINDRISC score ranges between 0-26 and the individuals whose risk score is above 20 are at diabetes risk and required to be taken in a protection program (30, 31).

Body Composition and Anthropometric Measurements

The anthropometric (height, waist circumference) and body composition measurements of participants were carried out in compliance with applied techniques (32). The "Tanita BC 532" body analysis device was used to measure the body composition (body weight) of participants. In addition, their BMI (kg/m^2) values and waist/height ratios were calculated (33).

Statistical Analyses

The normality of distribution of continuous variables was tested by one-sample Kolmogorov-Smirnov test. Continuous variables with normal distribution were presented as mean (standard deviation [SD]); non-normal variables were reported as median (interquartile range [IQR]). Qualitative variables were expressed with frequency (f) and percentages (%) and Chi-square test was used to compare this data. For the comparison of quantitative variables and the Mann Whitney U test was used in other cases. Pearson correlation coefficient and Spearman correlation coefficient were used in the examination of the correlation among variables (34). All statistical calculations were evaluated within the 95% reliability range and at the $p<0.05$ significance level.

Results

Sleep Quality

The age average of participants was 21.6±2.43 year and the median and interquartile range of their sleep quality scores was 6.61(3.0).The distribution of some characteristics of students by their sleep quality is given in Table 1. 40% of the students were found to have good sleep quality, while 60% were found to have poor sleep quality. The mean age of poor sleeper students was found 21.6±2.39 year and mean age of good sleepers was found 21.7±2.49 year. Gender distribution of students with good sleep quality was 55% women and 45% men. 28.2% of the students with good sleep quality lived with their parents, while the ratio was 18.5% in students with poor sleep quality. 54.1% of the students with good sleep quality stayed in a dormitory, while the ratio was 64.8% in students with poor sleep quality ($p<0.05$). There were significant dif-

Table 1. Distribution of some characteristics of students by their sleep quality

	Sleep Quality				Total (n:550)		χ^2	p
	Good (n:220)		Poor (n:330)					
	f	%	f	%	f	%		
Gender								
Female	121	55.0	201	60.9	322	58.5	1.899	.168
Male	99	45.0	129	39.1	228	41.5		
Residence								
With family	62	28.2[a]	61	18.5[b]	123	22.4	8.67	**.034**
Alone at home	11	5.0	12	3.6	23	4.2		
With flatmates	28	12.7	43	13.1	71	12.9		
Dormitory	119	54.1[a]	214	64.8[b]	333	60.5		
Main meals								
1-2	104	47.3	195	59.1	299	54.4	7.431	**.004**
3	116	52.7	135	40.9	251	45.6		
Snack Meals								
1	103	46.8	118	35.8	221	40.2	6.759	.060
2	96	43.6	172	52.1	268	48.7		
≥3	21	9.5	40	12.1	61	11.1		
Meal skipping								
Yes	179	81.3	287	87.0	466	84.7	12.470	**.002**
No	41	18.7	43	13.0	84	15.3		
Skipped Meals								
Breakfast	76	40.6	130	44.4	206	42.9	0.669	.716
Lunch	103	55.1	152	51.9	255	53.1		
Dinner	8	4.3	11	3.8	19	4.0		
Sleep duration in weekdays (hour/day)								
≤5	3	1.4[a]	56	17.0[b]	59	10.7	35.476	**.000**
6-8	201	91.4[a]	259	78.5[b]	461	83.8		
≥9	16	7.3	15	4.5	30	5.5		
Sleep duration in weekends (hour/day)								
≤5	-	-[a]	11	3.3[b]	11	2.0	11.266	**.010**
6-8	114	51.8	189	57.3	303	55.1		
≥9	106	48.2[a]	130	39.4[b]	236	42.9		
Night eating syndrome								
Available	1	0.5	25	7.6	26	4.7	14.863	**.000**
N/A	219	99.5	305	92.4	524	95.3		
Diabetes risk level								
Low	213	96.8	313	94.8	528	95.6	1.227	.268
Medium/high	7	3.2	17	5.2	24	4.4		
BMI classification								
Underweight	12	5.5	27	8.2	39	7.1	1.526	.466
Normal	156	70.9	225	68.2	381	69.3		
Slightly overweight/overweight	52	23.6	78	23.6	130	23.6		

a-b: These letters denotes a subset of sleep quality categories whose column proportions differ significantly from each other at the .05 level.

ferences in terms of the sleep duration of students with good and poor sleep quality on weekdays and weekends. 1.4% of the students with good sleep quality and 17% of the students with poor sleep quality slept less than 5 hours on weekdays (p<0.001). Additionally, the sleep duration of participants with good sleep quality was a minimum of 6 hours, while 3.3% of the students with poor sleep quality slept a maximum of 6 hours.

There were also significant differences between the number of their main and snack meals. 40.9% of the students with poor sleep quality and 52.7% of the students with good sleep quality had three main meals a day (p<0.05).

The percentage of protein intake (15.5%) of the participants with good sleep quality was higher than in those with poor sleep quality (14.0%). On the contrary, the percentage of carbohydrate intake of participants with good sleep quality was lower (44.0% and 45.0%) (p<0.05) (Table 2).

Correlation between sleep quality score, night eating syndrome and diabetes risk scores and dietary energy, macronutrient intake and some anthropometric measurements was shown Table 3. The sleep quality score had positive correlation with the carbohydrate-based energy intake rate. However, there was a negative correlation with the protein-based energy intake rate and sleep quality score ($r_{CHO(\%)}$:.100, $r_{protein(\%)}$:-.151; p<0.01). The examination of the correlation with subcomponents of sleep quality and nutrition showed that there was a positive correlation between dietary CHO intake and sleep latency, a negative correlation between habitual sleep efficiency and dietary protein intake amount, contribution of protein-based energy to daily energy intake, and protein intake amount per body weight. In addition, even though sleep disorders had negative correlation with protein-based energy intake rates, there was a positive correlation with the CHO rate. There was a negative correlation between daytime dysfunction and the protein-based energy intake rate. There was no correlation between the sleep quality

Table 2. Median and interquartile range values of several anthropometric measurements, daily energy and nutrient intake in addition to scale scores according to sleep quality

	Sleep Quality		
	Good (n:220) Median (IQR)	**Poor (n:330) Median (IQR)**	**p**
Anthropometric measurements			
Body weight (kg)	61.5 (15.0)	60.0 (17.0)	.376
Waist Circumference (cm)	74.5 (12.0)	75.0 (14.0)	.975
Waist/height	0.4 (0.0)	0.4 (0.0)	.573
BMI ($kg/m^{2)}$	22.1 (4.6)	22.1 (4.4)	.756
Energy and nutrients			
Energy (kcal)	1655.2 (721.7)	1645.2 (760.4)	.965
Carbohydrate (g)	170.7 (98.1)	182.0 (92.4)	.177
Carbohydrate (%)	44.0 (11.0)	45.0 (11.0)	**.018***
Protein (g)	60.9 (31.2)	58.4 (31.8)	.148
Protein (%)	15.5 (5.0)	14.0 (5.0)	**.002***
Protein (g/kg)	1.0 (5.0)	0.97 (0.5)	.287
Fat (g)	76.6 (38.8)	74.0 (37.0)	.275
Fat (%)	41.0 (11.0)	40.0 (11.0)	.302
Scale scores			
Sleep Quality	4.0 (2.0)	8.0 (3.0)	**.000****
Night Eating Syndrome	12.0 (5.0)	15.0 (5.0)	**.000****
Diabetes risk	4.0 (4.0)	5.0 (4.0)	**.020****

** Mann-Whitney U is significant at the 0.05 level.** Mann-Whitney U is significant at the 0.001 level.*

score along with the waist circumference, waist/height ratio, or BMI of participants. However, sleep duration, one of the sub-components of sleep quality, was positively correlated with waist circumference and waist/height ratio.

Median values of night eating ($p<0.001$), risk of diabetes ($p<0.05$), and sleep quality scores ($p<0.001$) of participants with good sleep quality were significantly lower than in those with poor sleep quality (Table 2). In addition, a positive correlation was found between the sleep quality score and night eating in addition to diabetes risk scores ($r_{findrisk}$: .111, r_{GYS}:.428). There was also a positive correlation between the risk of diabetes as well as subjective sleep quality, sleep latency, sleep duration, and night eating syndrome ($p<0.05$) (Table 3).

Night Eating Syndrome

The night eating syndrome rates of participants with poor sleep quality (7.6%) were significantly higher than in those with good sleep quality (0.5%) ($p<0.001$) (Table 1). There was a positive correlation between night eating syndrome and all sub-components of sleep quality ($p<0.05$) (Table 3). A positive correlation was observed between night eating syndrome and dietary energy intake, carbohydrates, fat, and dietary fiber amount, while it was negatively correlated with the protein-based energy intake rate ($p<0.05$) (Table 3). Meal skipping habits of participants showed that 61.1% of participants with night eating syndrome skip breakfast, 34.6% lunch, and 3.8% dinner. However, meal skipping rates of individuals not having night eating syndrome were 41.9%, 54.2%, and 4.0% respectively ($\chi 2$: 3.995, $p=.136$) (Table 1). Night eating syndrome was positively correlated with diabetes risk, as well ($r=.225$, $p<0.001$).

In addition, there was another positive correlation between night eating syndrome scores and waist/height, BMI, waist circumference measurements ($r_{w/h}$:131, r_{BMI}: .170, r_w:.125) ($p<0.05$).

Diabetes Risk

3.2% of the participants with good sleep quality and 5.2% of the participants with poor sleep quality had a high risk of diabetes ($p>0.05$) (Table 1). The median value of diabetes risk was significantly high in participants with poor sleep quality (Table-2). There was a significantly positive correlation between diabetes risk and waist/height along with BMI and waist circumference measurements ($p<0.05$; .460; .490; .509 respectively) (Table 3).

Discussion

There is a general opinion that university students have poor sleep quality and inadequate sleep duration (35). In our study, supporting the above-stated opinion, the median value of the sleep quality scores of students was 6.61, 60% of the students (n: 330) had poor sleep quality, and 40% had good sleep quality (n: 220). In another study, similarly, the median value of the sleep quality scores of university students was 6.9±2.4 (36). This study showed that the residence and flatmates of students affected their sleep quality. It was found that the rate of students living with their families was lower and rate of staying dormitory was higher among the students with poor sleep quality than in students with good sleep quality ($p<0.05$). In another study, 75% of the students staying in the dormitory were found to have poor sleep quality (37). These results can be related to the impact of the sleep environment on sleep quality. Additionally, there was a significant difference between weekday and weekend sleep durations of students in terms of their sleep quality ($p<0.05$) (Table 1). 91.4% of students with good sleep quality and 78.5% of students with poor sleep quality sleep for 6-8 hours on weekdays ($p<0.001$) (Table 1). Considering that the ideal sleep duration is a minimum of 7 hours for this age group, (38)nearly all participants with good sleep quality got adequate sleep (38). In this study, the poor sleep quality of students (PSQI>5) can be attributed to various factors such as living away from their families, living alone or with friends, having the freedom to go to bed at any time, increasing anxiety of academic success, difficulty in adapting to the dormitory environment, and increasing time spent on out-of-school social activities.

In this study, a significant positive correlation was found between night eating syndrome and sleep quality scores ($p<0.05$). Also, the rate of night eating syndrome (7.6%) was found to be significantly higher in patients with poor sleep quality than in those with good sleep quality (0.5%) ($p<0.001$) (Table 1). Simi-

Table 3. Correlation between sleep quality score, night eating syndrome and diabetes risk scores and dietary energy, macronutrient intake and some anthropometric measurements

	NES	FINDRISC	BMİ (kg/m²)	Waist (cm)	Waist/ height	Energy (kcal)	Protein (g)	Protein (%)	Protein (g/kg)	Fat (g)	Fat (%)	n-6/n-3	CHO (g)	CHO (%)	Fiber (g)
Sleep Quality (PSQI)	**.428****	**.111****	.004	.012	.042	.051	-.031	**-.151****	-.015	.015	-.022	.009	**.102***	**.100***	.064
Subjective sleep quality	**.112****	**.096***	.041	.043	.058	-.030	.016	.047	.016	-.047	-.024	-.014	-.026	-.015	-.040
Sleep latency	**.367****	**.108***	.042	.055	.070	.065	.035	-.037	.027	.042	.007	.064	**.086***	.032	.066
Sleep duration	**.180****	.073	.063	**.126****	**.129****	.069	.029	-.062	.002	.048	-.035	-.056	.081	.066	.078
Sleep efficiency	**.126****	.028	.059	.070	.077	-.050	**-.102***	**-.114****	**-.104***	-.070	-.033	.035	.000	**.090***	.064
Sleep disturbance	**.291****	.012	-.044	**-.086***	-.050	-.012	-.049	**-.085***	-.018	-.029	-.040	.016	.041	**.092***	.004
Use of sleep medication	**.202****	.039	-.071	-.083	-.055	.057	-.004	-.080	.031	.031	-.015	-.062	.075	.050	.005
Daytime dysfunction	**.347****	.076	-.038	-.064	-.046	.025	-.027	**-.100***	-.001	-.002	-.027	.029	.066	.076	.048
NES	1.000	**.225****	**.170****	**.125****	**.131****	**.170****	.078	**-.104***	.003	**.120****	-.016	.063	**.190****	.079	**.092***
FINDRISC		1.000	**.460****	**.490****	**.509****	.050	.015	-.030	**-.150****	.078	.062	.070	.029	-.052	-.026
BMI (kg/m²)			1.000	**.753****	**.745****	.073	.070	.069	**-.283****	.057	.000	-.044	.055	-.036	.002
Waist circumference (cm)				1.000	**.909****	**.115****	**.130****	.075	**-.215****	**.104***	.001	-.024	.072	-.053	.000
Waist/height					1.000	.054	.073	.059	**-.185****	.061	.010	.014	.027	-.052	-.032
Energy (kcal)						1.000	**.744****	**-.154****	**.650****	**.856****	**.047***	.077	**.873****	.023	**.551****
Protein (g)							1.000	**.487****	**.892****	**.619****	-.016	-.060	**.538****	**-.222****	**.344****
Protein (%)								1.000	**.449****	**-.162****	-.082	**-.214****	**-.299****	**-.367****	**-.212****
Protein (g/kg)									1.000	**.538****	-.022	-.024	**.475****	**-.196****	**.317****
Fat (g)										1.000	**.504****	**.087***	**.545****	**-.395****	**.364****
Fat (%)											1.000	.058	**-.339****	**-.867****	**-.204****
n-6/n-3 fatty acids												1.000	.099	.040	.076
CHO (g)													1.000	**.459****	**.618****
CHO (%)														1.000	**.295***
Dietary fiber (g)															1.000

larly, another study conducted with university students found that those with a higher rate of night eating syndrome symptoms had worse sleep quality (39). In addition, there was a significant positive correlation between night eating syndrome and sub-components of sleep quality ($p<0.05$) (Table 1). Similar to our study, sleep disorders, sleep medication use, and daytime dysfunction were significantly higher in individuals with night eating disorder, according to the Pittsburgh Sleep Quality Index (40). Also, in a study conducted with 144 morbid obese individuals in England, it was found that the total night eating score is weakly correlated with sleep duration and strongly correlated with sleep disorders (41). The correlation between poor sleep quality and night eating syndrome is explained by the decrease in sleep duration due to frequent nocturnal ingestion in individuals with night eating syndrome (9, 42, 43).

On the contrary, night eating syndrome may also occur due to the deterioration of sleep quality. Since the triggering factor is unknown, there is a vicious cycle between poor sleep quality and night eating syndrome (44).

In our study that the number of main meals decreased significantly with the deterioration of sleep quality, whereas the number of intermediate meals increased ($p<0.05$) (Table 1). As sleep duration in people with poor sleep quality is shorter, they constantly need snacks. This may increase the number of intermediate meals and deteriorate their appetite. For this reason, they may skip breakfast. In furtherance, the rate of skipping breakfast was higher in the participants whose sleep durations were shorter (45). Sleep quality is also associated with dietary patterns as well as meal order. It was found that individuals with short sleep durations tend towards high-calorie and high-carbohydrate foods (46). Our study found that the ratio of dietary energy from carbohydrate was higher and had a positive correlation with sleep quality scores in participants with poor sleep quality ($p<0.05$) (Table 3). Another study showed that sleep quality deteriorated with the increase in dietary carbohydrate intake, and those with a higher consumption of confectionery in addition to noodles had worse sleep quality and those with a higher consumption amount of fish along with vegetables had better sleep quality (47). On the contrary, in a study conducted with Chinese adults, the carbohydrate rate in diet was significantly lower in adults with shorter sleep durations than in normal adults (48). Dietary carbohydrates contain a large variety of sugar chains with different metabolisms. Thus, it is not surprising that the amount of any individual carbohydrate has no consistent influence on sleep parameters. In addition to carbohydrates, there is a correlation between the dietary protein ratio and sleep quality. Our study found that the ratio of dietary energy from protein was lower and had a negative correlation with sleep quality scores in participants with poor sleep quality ($p<0.05$) (Table 3). Another study demonstrated that short or long sleep duration in adults decreased the protein-based dietary energy rate compared to normal sleep durations (49). This is explained as tryptophan, a precursor to the neurotransmitter serotonin and the neuro-secretory hormone melatonin, both of which are linked to sleep and alertness.

Dietary patterns were closely correlated with night eating syndrome as well as sleep quality. Our study results showed that night eating syndrome had a positive correlation with the amount of dietary energy, carbohydrates, fat, and dietary fiber intake in addition to a negative correlation with protein-based energy intake ($p<0.05$) (Table 3). However, in a study, adolescents with night eating syndrome were found to have high dietary fat and low carbohydrate intake (50). In addition, there are several studies in literature which find no difference among night eating syndrome, sleep quality, and nutrient intake (51, 52). This may be caused by the difference in dietary carbohydrate content (mono-polysaccharide, low-high glycemic index etc.) and tryptophan amounts, timing of carbohydrate ingestion which impacts serotonin synthesis, and circadian disruption (53). It was considered that the effect of night eating syndrome on increasing energy intake may be correlated with the hormones regulating food intake. In a study examining the effect of sleep duration on hormones regulating food intake, it was found that a 4-hour sleep duration decreased leptin levels by 18% on average and increased ghrelin levels by 28%. Accordingly, the hunger of individuals with inadequate sleep durations increased by 23% and their craving for high-carbohydrate food increased by 30% (54). In addition, orexin A and orexin B peptides released from

the lateral region of the hypothalamus play a role in the neuroendocrine control of appetite in the state of sleep-wake. Orexin-containing neurons is active during wakefulness and quiescent during sleep (55) The short sleep duration in humans has been shown to decrease GLP-1 levels. Sleep restriction can also trigger reward-driven eating behavior, which can lead to excessive eating and cause emotional stress in addition to impulsive behavior. These changes may contribute to the increase in food intake, as well (56).Anthropometric measurements which are indicators of obesity may change with the increase of energy intake as a result of the effects of these mechanisms.

This study found that night eating syndrome and sleep duration were positively correlated with waist circumference and waist/height ratio which are indicators of obesity ($p<0.05$) (Table 3). Additionally, in parallel with the literature, there was a significantly positive correlation between night eating and BMI (57, 58). Another study reported that individuals were at normal weight before having night eating syndrome and they put on weight after getting the syndrome (59). Similarly, another study found that short sleep duration increased obesity in adults by 1.55 times (60). In a study conducted with university students, a positive correlation was found between poor sleep quality and short sleep duration in addition to obesity (23). Systematic review similarly concluded that short sleep duration seems to be independently associated with weight gain, particularly in young age groups (61).

Distortions in sleep duration and quality may significantly affect appetite, nutrition in addition to energy balance, and thus may trigger obesity, insulin resistance, and diabetes (10-12). Poor sleep quality as well as its complaints are associated with alterations in diurnal cortisol levels consistent with alteration of neuroendocrine functioning, in particular the hypothalamic-pituitary-adrenal (HPA). Plasma glucose levels of nocturnal individuals were consistently at a high level between midnight and early morning, whereas insulin secretion was markedly decreased during this time period (i.e., a pronounced mismatch of glucose and insulin levels). In contrast, there was a strong positive correlation between the plasma levels of glucose along with insulin during the daytime and evening in the diurnal individuals. For this reason, night meals cause disruption of insulin response against glucose. Accordingly, obesity and diabetes are higher in patients with night eating syndrome (62, 63). Also systematic review by Irwin confirmed the presence of the association between sleep disturbance and markers of systemic inflammation such as C-reactive protein and interleukin-6 which are also related to obesity. It is suggested that increased inflammation markers play an important role in the development of chronic diseases such as diabetes, and dyslipidemia (3). Night eating syndrome delays meal times along with glucose, and insulin levels. Ghrelin levels change similarly to the deterioration in sleep quality as a result of delayed energy intake. In parallel with this information, our study showed that the risk of diabetes increases, as night eating syndrome increases and sleep quality deteriorates. The correlation between sleep duration and diabetes risk is supported by a number of epidemiological and clinical studies. Epidemiological studies in the United States and around the world have shown that the risk of diabetes and the outcome of diabetes are positively correlated with short (≤6h/24h) and long sleep (≥9h/24h) durations (64).In a meta-analysis of prospective cohort studies, short sleep duration was associated with high risk of diabetes (relative risk=1.37; 95%CI, 1.22-1.53) (65). Gangwisch et al. (61)Q indicated in a meta-analysis of seven studies that diabetes type 2 risk in individuals with inadequate/short sleep duration was 28% higher. Engeda et al. (66) found that individuals who sleep ≤5 hours/day have 2 times the rate of pre-diabetes than those who sleep 9 hours. In summary, repeated bouts of restricted sleep may induce chronic hyperinsulinemia, stimulating downstream pathways like pancreatic beta cell failure and lipogenesis, leading to development of diabetes and obesity (64).

Results and recommendations

In this study conducted on 550 university students with a mean age of 21.6, more than half of the participants were found to have poor sleep quality. It was found that deterioration in sleep quality increased obesity predisposition and night eating syndrome which play a role in the etiology of metabolic diseases

and even increase the risk of diabetes which is also a metabolic disease. University students should improve their sleep quality in order to prevent themselves from getting such diseases. It is recommended to ensure a suitable sleep environment and adequate sleep duration which is one of the most important factors which improve sleep quality.

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