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Determining The Diet Quality, Sleep Quality and Obesity Status of Undergraduate Students: A Cross-Sectional Study

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Summary. *Objectives:* Intake of an adequate and balanced diet and improved nutritional quality are factors that affect and increase sleep quality. Poor diet quality and sleep quality have been associated with chronic diseases such as obesity. This study aimed to evaluate relations among diet quality, sleep quality and obesity in undergraduate students. *Materials and Methods:* The study was conducted with 299 individuals studying at the Department of Nutrition and Dietetics of Near East University between September 2016 and January 2017. A questionnaire was administered to all participants and some anthropometric measurements were obtained to determine obesity status. Diet quality was assessed using the Diet Quality Index-International (DQI-I) tool and 3-day food record, and the Pittsburgh Sleep Quality Index (PSQI) was used to evaluate sleep quality. *Results:* The body mass index (BMI) values showed that 13.7% of the students were underweight, 68.9% were of normal, 12.7% were overweight and 4.7% were obese. Diet quality was poor in 89.3% and sleep quality was poor in 44.1% of the students. 4.9% of the students with good diet quality and 4.5% of the students with poor diet quality were obese, and 4.8% of the students with good sleep quality and 4.5% of the students with poor sleep quality were obese. Total DQI-I scores were negatively correlated and significantly associated with total PSQI scores ($p<0.05$) but BMI was not significantly associated with total DQI-I and PSQI scores ($p>0.05$). *Conclusion:* It was observed that improved diet quality was associated with better sleep quality. The study findings supported the primary hypothesis that improved diet quality will result in better sleep quality. More comprehensive studies in larger samples are warranted to conclusively determine relations among diet quality, sleep quality and obesity status.

Key words: Diet quality, body mass index, obesity, sleep quality

Introduction

Sleep is defined as a temporary, partial, and periodic loss of an organism's interaction with the environment, and a state of physical and mental rest in an inactive state. Sleep plays a critical role in lifelong mental health and psychosocial adjustment. During sleep, the body rests, the cells regenerate, memory functions are regulated and learning process occurs (1,2). Feeling fit and well-rested after waking up has been associated with sleep quality and duration (3). Changes in sleep quality and duration are highly important since they can affect the quality of life and well-being of an individual (2,4). Factors affecting sleep quality and sleep duration include age, sex, alcohol consumption, caffein intake, smoking, use of medication, low socioeconomic status, environmental and psychological factors, foods, nutrition, and diet quality (5,6,7,8).

Foods affect the sleep-wake cycle, metabolic pathways, and sleep quality through micro- and macronutrients they contain. Foods exert their effects via tryptophan, serotonin, and melatonin mechanisms.

Clinical studies have shown a significant association between intake of micro- and macronutrients and sleep and sleep parameters and found that individuals with poor diet quality also had poor sleep quality (4,7,9,10). Insufficient amount of sleep and poor sleep quality may lead to increased energy intake by affecting nutritional habits and diet quality of individuals. High energy intake also increases weight gain and is a risk factor for the development of many chronic diseases (11,12).

The aim of this study was to examine the relations among diet quality, sleep quality and obesity status in undergraduate students. The primary hypothesis is that improved diet quality will result in better sleep quality. The secondary hypothesis is that individuals with good diet quality and sleep quality will have a lower risk of obesity.

Materials and Methods

This cross-sectional study was conducted in a population of 299 individuals studying at the Department of Nutrition and Dietetics, Faculty of Health Sciences, Near East University who agreed to participate in the study between September 2016 and January 2017. All subjects signed written informed consent which clearly indicated that their participation in the study was on a voluntary basis. Approval for the study was obtained from the Ethics and Review Committee for Scientific Research of the Near East University on 22.09.2016 (YDU/2016/39-321).

General Characteristics

A questionnaire consisting of open-ended and multiple-choice questions was used by the study investigators to collect data on the sociodemographic characteristics (e.g., sex, age and place of residence), health status and nutritional habits of the subjects. The questionnaire was administered using the face-to-face interview technique. The "Pittsburgh Sleep Quality Index" was used to determine sleep quality of the subjects and the diet quality was assessed using the "Diet Quality Index-International" and a "3-day food record". Smoking status and alcohol intake of the subjects were evaluated using the "Smoking Index" and "Alcohol Consumption Index", two subscales of the "Lifestyle Index".

Anthropometric Measurements

Anthropometric measurements (body weight and height) were obtained by the study investigators. Before determining the body weight, the subjects were asked to refrain from alcohol consumption and avoid physical activity for a minimum of 24 hours and fast for at least 4 hours. The body weight was measured with the individual wearing light clothes. All body weight measurements were obtained using a portable weighing scale. The height of the subjects was measured using a stadiometer with the subject standing upright, barefoot, arms hanging loosely at the sides, feet together and head positioned in the Frankfort plane. BMI was calculated using the body weight and height values of the subjects. BMI values were obtained by dividing the body weight in kilograms by the square of height in meters. Calculated BMI values were categorized according to the World Health Organization (WHO) classification, where a BMI of <18.50 kg/m^2 was classified as underweight, 18.50-24.99 kg/m^2 as normal, 25.00-29.99 kg/m^2 as overweight and ≥30.00 kg/m^2 as obesity (13).

3-Day Food Record

To determine the nutritional status of the subjects, they were asked to keep food intake records for three consecutive days (two days on weekdays and one day on weekend). The food records were reviewed by the study investigators through face-to-face interviews with the subjects. The fourth edition of the book "A Photo Catalog of Meals and Foods-Servings and Portions" published by Hacettepe University Faculty of Health Sciences, Department of Nutrition and Dietetics was used to review food intake records. Energy and nutrient values of the consumed foods were calculated using the "Computer-based Nutrition Program, Nutrition Information System Software Package, version 7.2" (BEBIS 7.2)", a software specifically developed for Turkey. The adequacy of the calculated energy and nutrient intakes was assessed according to the recommended Dietary Reference Intakes (DRI), appropriate for age and sex (14).

Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index was developed by Buysse et al. in 1989 to determine sleep quality of individuals. It is a 24-item self-report questionnaire that assesses sleep quality and sleep disorders over a 1-month interval. The PSQI consists of seven components including subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleeping medication and daytime dysfunction. Each component is assigned a score ranging from 0 to 3 points. Overall PSQI score is the sum of the scores for seven components, and ranges from 0 to 21. A score of 5 or less denotes "good" sleep quality and a score greater than 5 indicates "poor" sleep quality (15). Validity and reliability of the Turkish version of the PSQI were demonstrated by Ağargün et al. in 1996 (16).

Diet Quality Index-International

The Diet Quality Index was originally developed by Patterson et al. in 1994 (17). Then in 2003, it was transformed into a global scale designated as the Diet Quality Index-International by Kim et al. to determine overall diet quality (18). The DQI-I assesses the variety, adequacy, moderation and balance of a diet. A score is calculated for each of the components and the scores for each component are summed to produce the total DQI-I score. All components are scored separately: variety (0 to 20 points), adequacy (0 to 40 points), moderation (0 to 30 points), balance (0 to 10 points). Total score ranges from 0 to 100 points. An overall score of >60 points indicate "good" diet quality (19).

Smoking Index

The Smoking Index (SMI) is based on both cigarette smoking and the number of cigarettes smoked per day. Individuals are categorized as nonsmokers, former smokers and current smokers. Nonsmokers are assigned the highest score of 10. Current smokers are divided into four subgroups according to the number of cigarettes smoked per day. The scores decrease with increased number of cigarettes smoked (from 5 to 0). Individuals smoking 1-4 cigarettes per day are assigned a score of 5, those who smoke 5-9 cigarettes per day are assigned a score of 3, those smoking 10-19 cigarettes per day are given a score of 1 and those smoking ≥20 cigarettes per day are assigned a score of zero. Since smoking is associated with a significant increase in the risk of chronic illness, the maximum score of 5 points is assigned to current smokers. As quitting smoking has positive health benefits, former smokers are assigned a score of 7 points (20).

Alcohol Consumption Index

The Alcohol Consumption Index (ACI) assesses both the quantity of alcohol consumed and alcohol consumption status. Individuals are classified as nondrinkers, moderate drinkers, above moderate drinkers, and heavy drinkers. Consumption of ≥4 drinks for females and ≥5 drinks for males on one occasion is considered as excessive alcohol consumption and assigned the lowest score of 0 point. Non-drinkers and moderate drinkers (<1-7 drinks/week for females, <1-14 drinks/week for males) are assigned the highest score of 10 points. Above moderate drinkers are assigned a score of 6 points (<7-14 drinks/week for females, <14-21 drinks/week for males), or 3 points (<14-21 drinks/week for females, <21-28 drinks/week for males) or 1 point (<21-28 drinks/week for females, <28-35 drinks/week for males). Heavy drinkers (>28 drinks/week for females and >35 drinks/week for males) get a score of 0 (20).

Statistical Analysis

Descriptive statistics of the study data were presented as number (n) and percentage (%) for qualitative variables, and as arithmetic mean (**μ**), standard deviation (SD), median and minimum-maximum values. The normality of data distribution was checked using the Kolmogorov-Smirnov test. Parametric hypothesis tests were used for statistical analyses. The student's t-test was used to determine the significance of the difference between the means of two independent groups. Multiple groups were compared using the One-way analysis of variance (ANOVA). Post hoc Tukey's test was used for pairwise comparisons when a statistical significance was detected. The Pearson's chi-square (χ2) and Fisher's exact chi-square (χ2) tests were employed for the hypothesis tests of categorical variables. The coefficients of correlation and significance of the relationships among quantitative variables were determined using the Pearson correlation test. The Statistical Package for Social Sciences, version 20.0 (IBM SPSS 20.0) was used for all statistical analyses. A p value less than 0.05 was considered significant.

Results

Of 299 undergraduate students included in the study, 74.6% were female, 25.4% were male and the mean age was 21.16±2.67 years. 31.4% of the students were at their first year, %35.1 at second year, %18.4 at third year and 15.1% at fourth year. 27.8% of the students were living in a student accommodation alone or with roommates, 58.9% in an apartment alone or with housemates, and 13.3% with their family. 68.9% of the students were nonsmokers, 3.7% were former smokers and 27.4% were current smokers. Among smokers, 16.7% reported smoking 1-4 cigarettes/day, 33.3% smoked 5-9 cigarettes/day, 16.7% smoked 10-19 cigarettes/day and 33.3% smoked ≥20 cigarettes per day. Regarding alcohol intake of the students, 68.6% of them were non-drinkers, 19.0% were moderate drinkers and 12.4% were excessive drinkers. The number of drinks consumed on one occasion was ≥5 drinks for males and ≥4 drinks for females among excessive drinkers (35.1%), and <5 drinks for males and <4 drinks for females among moderate drinkers (64.9%) (Table 1).

Table 1. The distribution of sociodemographic characteristics of the study population.

	n	%
Sex		
Female	223	74.6
Male	76	25.4
Academic Year		
First	94	31.4
Second	105	35.1
Third	55	18.4
Fourth	45	15.1
Place of Residence		
Student accommodation (alone or with roommates)	83	27.8
Apartment (alone or with housemates)	176	58.9
Family home	40	13.3
Smoking Status		
Nonsmokers	206	68.9
Former smokers	11	3.7
Current smokers	82	27.4
Number of Cigarettes Smoked Per Day		
1-4	11	13.4
5-9	21	25.6
10-19	31	37.8
≥20	19	23.2
Alcohol Consumption		
Non-drinkers	205	68.6
Moderate drinkers	57	19.0
Heavy drinkers	37	12.4
Number of drinks consumed on one occasion		
Males: ≥5 drinks, Females: ≥4 drinks	33	35.1
Males: <5 drinks, Females: <4 drinks	61	64.9

n: number, %: percentage

According to the BMI values of the students, 13.7% were underweight, 68.9% were of normal, 12.7% were overweight and 4.7% were obese (Table 2). No significant association was found between the academic year and BMI values (p=0.149). Among females, 15.2% were underweight, 71.8% were of normal, 9.0% were overweight and 4.0% were obese; the corresponding figures for males were 9.2%, 60.5%, 23.7% and %6.6, respectively. The students had a mean BMI of 22.2±3.7 kg/m^2, with a mean BMI of 21.7±3.5 kg/m^2 for females and 23.6±3.9 kg/m^2 for males. There was a significant difference between sexes in the mean BMI values (p=0.005) (Table 2).

Overall, the distribution of the DQI-I scores showed that the diet quality was good (score greater than 60) in 10.7% and poor in 89.3% of the students (score less than 60). Good diet quality was found in 10.3% of the female students and 11.8% of the male

Table 2. BMI distribution of the students by academic year and sex

BMI classification	Underweight		Normal		Overweight		Obese		Total		p
	n	%	n	%	n	%	n	%	n	%	
Sex											0.005[1]*
Female	34	15.2	160	71.8	20	9.0	9	4.0	223	100.0	
Male	7	9.2	46	60.5	18	23.7	5	6.6	76	100.0	
Total	41	13.7	206	68.9	38	12.7	14	4.7	299	100.0	
Academic Year											0.149
First	17	18.1	59	62.8	13	13.8	5	5.3	94	100.0	
Second	19	18.1	72	68.6	11	10.4	3	2.9	105	100.0	
Third	4	7.3	42	76.4	7	12.7	2	3.6	55	100.0	
Fourth	1	2.2	33	73.3	7	15.6	4	8.9	45	100.0	
Total	41	13.7	206	68.9	38	12.7	14	4.7	299	100.0	

[1]Pearson's chi-square test (χ2); *p<0.05
n: number, %: percentage, BMI: Body mass index

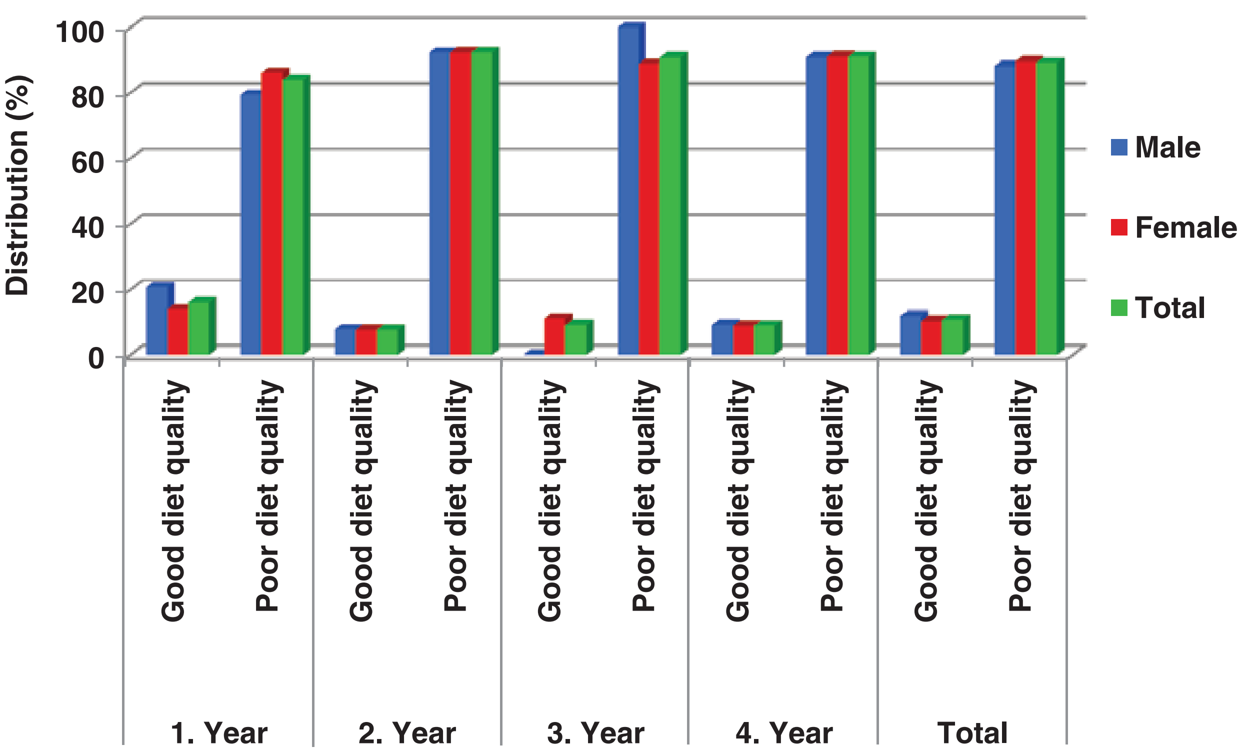

Figure 1. The distribution of DQI-I scores of the students by academic year and sex (%)

students. DQI-I scores did not differ significantly among students at different academic years (p=0.255) or between sexes (p=0.710).

Overall, mean DQI-I scores were 43.5±11.6 for females and 43.9±11.7 for males. The difference between sexes in terms of mean total DQI-I scores was nonsignificant (p=0.824). However, the difference in mean total DQI-I scores was significant between the first-year students and second-year students as well as between the first-year students and fourth year students (p=0.009). The first-year students had a higher mean total DQI-I score compared to second, third- and fourth-year students (Table 3).

Among the DQI-I components, the mean DQI-I variety score of the study population was 13.5±3.8, with a mean score of 13.3±3.8 for females and 14.2±3.9 for males. The difference in the mean DQI-I variety score was statistically nonsignificant among the students at different academic years (p=0.772) and between sexes (p=0.076) (Table 4).

The mean DQI-I adequacy score of the study sample was 12.9±7.5, with a mean score of 12.5±7.4 for females and 14.3±7.6 for males. While the mean DQI-I adequacy scores did not differ significantly between sexes (p=0.066), a significant difference was observed among the students at different academic years (p=0.004). The difference in the mean DQI-I adequacy scores was significant both between the first-year students and second year students and between the second-year students and third year students (p<0.05). Both first year and third year students had higher mean DQI-I adequacy scores than the second-year students (Table 4).

The mean DQI-I moderation score of the study sample was 15.2±5.7, with a mean score of 15.8±5.2 for females and 13.4±6.8 for males. The mean DQI-I moderation scores differed significantly among students at different academic years (p<0.001) and between sexes (p=0.006). Female students had a higher mean DQI-I moderation score than male students. The difference in the mean DQI-I moderation scores was significant between the first- and fourth-year students, between the second- and fourth-year students and between the third- and fourth-year students (p<0.05). The first-year students had higher mean DQI-I moderation score compared to second, third- and fourth-year students (Table 4).

Table 3. The mean (μ) and standard deviation (SD) of total DQI-I scores of the students by academic year and sex

	Females	Males	Total	
DQI-I Score	μ±SD	μ±SD	μ±SD	p
Year 1	45.7±11.0	46.9±12.8	46.0±11.5[b]	0.009[1*]
Year 2	40.9±11.8	44.0±12.5	41.6±12.0[a]	
Year 3	47.1±10.7	37.9±5.1	45.4±10.5[ab]	
Year 4	40.5±11.4	41.0±9.1	40.6±10.8[a]	
Total	43.5±11.6	43.9±11.7	43.6±11.6	
p	0.824[2]			

[1]One-way analysis of variance (ANOVA) [Post hoc Tukey's test, (arithmetic mean ± standard deviation)]; *p<0.05
a-b: The groups with the same letter are not significantly different.
[2]The independent samples t-test (Student's t-test)
DQI-I: Diet Quality Index-International

Table 4. The mean (μ) and standard deviation (SD) of the DQI-I component scores (variety, adequacy, moderation and balance) of the students by academic year and sex

		Females	Males	Total	
		μ±SD	μ±SD	μ±SD	p
DQI-I Variety	**Year 1**	13.5±3.6	13.1±4.1	13.3±3.8	0.772[1]
	Year 2	13.1±3.9	15.4±3.7	13.6±3.9	
	Year 3	14.0±3.8	12.7±4.2	13.8±3.9	
	Year 4	12.3±4.1	15.6±1.5	13.1±3.9	
	Total	13.3±3.8	14.2±3.9	13.5±3.8	
p		0.076[2]			
DQI-I Adequacy	**Year 1**	12.9±6.6	16.2±7.7	13.9±7.1[a]	0.004[1*]
	Year 2	10.2±6.4	12.6±8.2	10.8±7.0[b]	
	Year 3	15.4±8.5	9.5±4.3	14.3±8.2[a]	
	Year 4	13.0±7.9	17.1±5.1	14.2±7.6[ab]	
	Total	12.5±7.4	14.3±7.6	12.9±7.5	
p		0.066[2]			

		Females	Males	Total	p
		μ±SD	μ±SD	μ±SD	
DQI-I Moderation	Year 1	17.1±4.9	15.2±7.2	16.5±5.7[a]	<0.001[1*]
	Year 2	15.6±5.2	14.0±6.5	15.2±5.5[a]	
	Year 3	15.9±5.4	14.1±4.9	15.6±5.3[a]	
	Year 4	13.8±5.0	6.8±4.0	12.1±5.6[b]	
	Total	15.8±5.2	13.4±6.8	15.2±5.7	
p		0.006[2*]			
DQI-I Balance	Year 1	2.1±2.3	2.4±2.5	2.2±2.3[b]	0.048[1*]
	Year 2	1.8±1.8	1.8±2.2	1.8±1.9[ab]	
	Year 3	1.6±2.4	1.6±2.0	1.6±2.4[ab]	
	Year 4	1.2±1.6	0.9±1.3	1.1±1.5[a]	
	Total	1.8±2.1	1.8±2.2	1.8±2.1	
p		0.772[2]			

[1]One-way analysis of variance (ANOVA) [Post hoc Tukey's test, (arithmetic mean ± standard deviation)]; *p<0.05
a-b: The groups with the same letter are not significantly different.
[2]The independent samples t-test (Student's t-test) (arithmetic mean ± standard deviation); *p<0.05
DQI-I: Diet Quality Index-International

Table 5. The mean (μ) and standard deviation (SD) of the PSQI scores of the students by academic year and sex

PSQI Score	Females	Males	Total	p
	μ±SD	μ±SD	μ±SD	
Year 1	6.1±2.5	5.5±3.0	5.9±2.7	0.168[1]
Year 2	5.9±3.3	5.8±2.6	5.9±3.1	
Year 3	5.0±2.8	5.5±3.8	5.1±3.0	
Year 4	5.0±2.5	5.5±3.1	5.1±2.6	
Total	5.6±2.9	5.6±3.0	5.6±2.9	
p	0.907[2]			

[1]One way analysis of variance (ANOVA)
[2]The *independent* samples *t-test* (Student t test)
PSQI: Pittsburgh Sleep Quality Index

The mean DQI-I balance score was 1.8±2.1, with a mean score of 1.8±2.1 for females and 1.8±2.2 for males. The difference between the sexes in the mean DQI-I balance scores was statistically nonsignificant (p=0.772), whereas the difference among the students at different academic years was significant (p=0.048). The first-year students and fourth year students showed a significant difference with regard to mean DQI-I balance scores (p<0.05). The first-year students scored higher on the DQI-I balance component (Table 4).

Among the students with good diet quality, 21.9% were underweight, 62.5% were of normal, 12.5% were overweight and 3.1% were obese, whereas, among the students with poor diet quality, 12.7% were underweight, 69.7% were of normal, 12.7% were overweight and 4.9% were obese. No significant difference was found among the groups (p=0.544).

While 59.4% of the students with good diet quality had good sleep quality, 55.4% of the students with poor diet quality had good sleep quality. The difference between the groups was nonsignificant (p=0.409).

The study sample had a mean PSQI score of 5.6±2.9, indicating poor sleep quality among undergraduate students. The mean PSQI score was 5.6±2.9 for females and 5.6±3.0 for males. A nonsignificant difference was observed between the sexes in the mean PSQI scores (p=0.907). The mean PSQI scores were 5.9±2.7 for first year students, 5.9±3.1 for second year students, 5.1±3.0 for third year students and 5.1±2.6 for fourth year students. The difference among the students at different academic years in the mean PSQI scores was nonsignificant (p=0.168) (Table 5).

Regarding sleep quality of the students, 55.9% had good sleep quality and 44.1% had poor sleep quality. Good sleep quality was found in 55.6% of the females and 56.6% of the males. Sleep quality did not differ significantly between sexes (p=0.710). Examination of sleep quality among all students by academic year revealed that 50.0% of the first year students, 57.1% of the second year students, 60.0% of the third year students and 60.0% of the fourth year students had good sleep quality. There was no significant difference in sleep quality among the students at different academic years (p=0.255).

Of the students with good sleep quality, 14.9% were underweight, 67.7% were of normal, 12.6% were overweight and 4.8% were obese. Among the students with poor sleep quality, 12.1% were underweight, 70.5% were of normal, 12.9% were overweight and 4.5% were obese. The difference between the groups was nonsignificant (p=0.910).

When the scores for the PSQI subscales are examined, the mean subjective sleep quality scores of the study sample was 2.1 ± 0.8. The scores were 2.2 ± 1.0 for sleep latency, 1.5 ± 0.5 for sleep duration, 1.1 ± 0.5 for sleep efficiency, 2.2 ± 0.5 for sleep disturbances, 1.0 ± 0.3 for the use of sleeping medication, and 2.1 ± 1.0 for daytime dysfunction. The mean PSQI subscale scores did not show significant difference among the students at different academic years and between sexes (p>0.05).

Relationships among the body mass index values and total mean scores for diet quality, alcohol consumption, smoking and sleep quality of the students are presented in Table 6. No significant association was found between BMI and total mean DQI-I, PSQI, SMI or ACI scores, whereas DQI-I was negatively correlated and significantly associated with mean PSQI and ACI scores. Based on the latter relationship, as the DQI-I scores of the students increase, their PSQI scores decrease. Higher DQI-I scores indicate a good diet quality and lower PSQI scores denote good sleep quality. Thus, the students with a good diet quality also had good sleep quality. Moreover, reduced alcohol consumption was associated with better diet quality. On the other hand, mean total SMI, PSQI and ACI scores were positively correlated and significantly associated; therefore, higher PSQI scores were found with increased smoking and alcohol consumption. Higher PSQI scores indicate poor sleep quality and smoking lowers the sleep quality (Table 6).

Total PSQI score was negatively correlated and significantly associated with DQI-I variety scores (r=-0.127, p=0.028) and DQI-I balance scores (r=-0.140, p=0.016). However, total PSQI score was not significantly associated with DQI-I adequacy scores and DQI-I moderation scores (p>0.05). A negative correlation and a significant association were found between BMI and DQI-I balance scores (r=-0.116, p=0.045) but BMI was not significantly associated with DQI-I adequacy, moderation and variety scores (p>0.05). PSQI subscale scores showed a nonsignificant association with BMI and total DQI-I scores (p>0.05). The SMI total score was positively correlated and significantly associated with the PSQI subscales of subjective sleep quality (r=0.171, p=0.003), sleep latency (r=0.173, p=0.003), sleep duration (r=0.132, p=0.022) and use of sleeping medication (r=0.152, p=0.008) but not significantly associated with DQI-I subscales (p>0.05). Among the PSQI subscales, total ACI score showed

Table 6. Relationships among body mass index, diet quality, sleep quality, smoking and alcohol consumption scores of the study sample

	BMI		**DQI-I**		**PSQI**		**SMI**		**ACI**	
	r	**p**	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**
BMI	1									
DQI-I	-0.002	0.977	1							
PSQI	0.024	0.676	-0.138	0.017[1]*	1					
SMI	0.065	0.263	-0.062	0.286	0.187	0.001[1]*	1			
ACI	0.071	0.218	-0.133	0.022[1]*	-0.011	0.848	0.269	0.000[1]*	1	

[1]Pearson correlation test; *p<0.05

BMI: Body mass index, DQI-I: Diet Quality Index-International, PSQI: Pittsburgh Sleep Quality Index, SMI: Smoking Index, ACI: Alcohol Consumption Index a negative correlation only with daytime dysfunction scores (r=-0.118, p=0.041) and with the DQI-I subscales of DQI-I moderation score (r=-0.135, p=0.019) and DQI-I (r=-0.114, p=0.049) balance score.

Regarding the relationships with sex, no significant association was observed between mean DQI-I score and PSQI and SMI scores or BMI (p>0.05). However, mean DQI-I score was negatively correlated and significantly associated with mean ACI score in male students (r=-0.238, p=0.039). When the association was examined in terms of the academic year, a positive correlation and a significant association between mean DQI-I score and mean PSQI score were found for first year students only (r=-0.339, p=0.001) (Table 7).

Discussion

It is known that university students experience both poor sleep quality and diet quality due to a number of reasons including being away from their family home, adaptation to a new place and environment, eating an inadequate and unbalanced diet, skipping meals and irregular sleep hours. Determining sleep quality and diet quality of individuals is crucial to achieve improvement in sleep quality and for regulation of eating habits over the long-term. This may prevent diseases such as obesity caused by inadequate and unbalanced diet and sleep disorders associated with inadequate and poor-quality sleep. Therefore, this study is important since it provides valuable data on the sleep quality and diet quality of the university students.

Individuals with a total DQI-I score above 60 are considered to have a good diet quality (20). In the current study, the mean diet quality score of the students was 43.6±11.6, with a score of 43.5±11.6 for females and a score of 43.9±11.7 for males. The difference in the diet quality scores between sexes was nonsignificant. These findings indicate that the study subjects have a poor diet quality. In a study by Williams et al., overall DQI-I scores were 51.5±11.9 in females and 53.6±12.1 in males. The authors found a significant difference between sexes, with better diet quality among males compared to females (21). The EVASYON study showed a mean diet quality score of 49.2±12.6 in the study subjects, with a significant difference between sexes. Female subjects were found to have a better diet quality in comparison to males (22). In a study in 288 young individuals from Southern Spain, mean diet quality score was 56.3±9.4, indicating poor diet quality (23). Consistent with other studies reporting poor diet quality among younger populations, a study from the Balearic Islands involving more than 1,200 adolescents found a mean diet quality score of 42.8±10.0 (24). Poor diet quality found among the students in the current study can be explained by several factors including skipping breakfast, which is the most important meal of the day, insufficient intake of energy

Table 7. Relationships of DQI-I scores with PSQI, ACI, SMI scores and BMI by academic year and sex

		PSQI		ACI		SMI		BMI	
		r	p	r	p	r	p	r	p
DQI-I Score	**Sex**								
	Female	-0.109	0.106	-0.100	0.137	-0.089	0.187	-0.003	0.966
	Male	-0.222	0.054	-0.238	0.039[1]*	-0.035	0.765	-0.012	0.921
	Academic Year								
	Year 1	0.339	0.001[1]*	-0.132	0.205	0.085	0.361	0.006	0.951
	Year 2	-0.073	0.461	0.139	0.159	-0.078	0.429	0.042	0.673
	Year 3	0.003	0.985	-0.230	0.092	-0.266	0.050	0.014	0.922
	Year 4	-0.138	0.365	-0.103	0.500	-0.155	0.309	-0.123	0.421

[1]Pearson correlation test; *p<0.05
BMI: Body mass index, DQI-I: Diet Quality Index-International, PSQI: PSQI: Pittsburgh Sleep Quality Index, SMI: Smoking Index, ACI: Alcohol Consumption Index

and macro- and micronutrients, below recommended intake of four main food groups, and the conduct of the study in autumn and winter months. Improvement of the diet quality is required to prevent the development of chronic illnesses and to increase quality of life.

As a result of the study, a negative correlation was found between mean DQI-I score and mean PSQI score, demonstrating improved sleep quality with better diet quality (Table 6). Similarly, a significant association between diet quality and sleep quality was also reported by Bel et al. in the cross-sectional HELENA study in 1522 subjects ($p<0.001$) (25). A separate study involving 202 university students also found a significant association between mean DQI-I score and mean PSQI score ($p<0.05$); thus, the poorer the diet quality the lower the sleep quality (26). In a cross-sectional study by Momemi et al., greater intake of energy, carbohydrates and fat was found among individuals with poor sleep quality compared to those with good sleep quality (12). Contrastingly, Beebe et al. did not observe a significant association between diet quality and sleep quality in nurses ($p>0.05$) (27). Likewise, a study conducted in the Turkish Republic of Northern Cyprus did not find a significant association between sleep quality and diet quality (28). Adequate intake of micro- and macronutrients is of paramount importance to maintain the sleep-wake cycle. Inadequate intake of nutrients causes impaired secretion of the melatonin hormone that regulates sleep and disrupts the release of serotonin neurotransmitter, which is involved in the production of melatonin, resulting in sleep disorders with reduced sleep duration and poor sleep quality. A sufficient intake of essential nutrients requires eating a balanced and adequate diet as well as a wider variety of foods and improving the diet quality. A marked relationship between diet quality and sleep quality has been reported by many studies. Improved diet quality has been associated with better sleep quality and reduced risk for developing a number of chronic diseases such as obesity (4,7).

In the present study, body mass index (BMI) was not significantly associated with diet quality (Table 6). In one study, diet quality was reported to be significantly associated with body mass index measurements and physical activity levels among university students ($p<0.05$) (26). In a study by Lee et al. improved diet quality was shown to be correlated with reduced BMI (29). A cross-sectional study in 658 subjects showed that lower overall DQI-I scores were correlated with increased prevalence of obesity and higher body fat percentage (30). The lack of a link between BMI and diet quality among the students in this study may be explained by intake of diets restricted in energy and micro- and macronutrients and engaging in vigorous physical activity to achieve rapid weight loss in a short time without considering their effects on health.

It is considered that individuals with a PSQI score of greater than 5 have poor sleep quality (15). Overall mean PSQI scores were 5.6±2.9 for both the study sample and females and 5.6±3.0 for males. Therefore, our subjects have poor quality (Table 3). The results of our study are consistent with those reported in the literature. Spira et al. examined sleep quality among male subjects and found poor sleep quality with a mean PSQI score of 5.6±3.2 (31). While similar findings were reported by three studies that assessed sleep quality (2,32,33), a study in nurses found lower sleep quality with a mean PSQI score of 7.1±2.9 (34). The authors of that study suggested that working long hours and in shifts caused impairment of sleep quality among the nurses.

The findings of the current study showed that 55.9% of the participants had good sleep quality. 55.6% of the females and 56.6% of the males were found to have good sleep quality. In a study in university students, mean sleep quality score was 6.6±2.7 and 39.6% of the students had good sleep quality (35). A separate study in students showed a mean sleep quality score of 4.9±2.6, with 60.9% of the females and 63.5% having good sleep quality (36). In a study in medical students, only 3.7% were found to have good sleep quality (37). The authors suggested that the demanding curriculum accounted for the lower sleep quality among medical students in comparison to other university students.

Our results did not demonstrate a significant difference between sexes in terms of sleep quality (Table 5). Similarly, Xu et al. reported no difference in sleep quality between sexes in Chinese adolescents ($p>0.05$) (38). Several studies that compared sleep quality between men and women failed to demonstrate a significant difference (33,39). However, in a study by Grandner et al., a significant difference was found between sexes, with females having lower sleep quality ($p<0.05$) (40). In general, women are exposed to a heavier workload during the day compared to men, leading to an increase in the levels of anxiety, sleep disturbances and greater need for slow-wave sleep.

Body mass index is an important factor that affects sleep quality of individuals. In the present study, BMI was not significantly associated with sleep quality (Table 6). Similarly, a study in 350 university students did not observe a strong correlation between PSQI scores and BMI. In the study, it was found that 79.6% of the individuals were underweight, %16.8 had normal body weight and 3.7% were overweight/obese (37). Other studies in literature also reported a nonsignificant relation between BMI and sleep quality (39,41). These data support our findings. Contrastingly, a negative correlation and a significant association were found between BMI and sleep quality among Greek women in one study ($p<0.05$) (42). A cross-sectional study by Tepe et al. in 132 subjects reported increased body mass index values with lower sleep quality (43). A study conducted in China found a significant correlation between sleep quality and body mass index in women ($p <0.001$). 72.6% of women had normal body mass index, 23.0% were underweight, 3.4% were overweight and 1.0% were obese (36). In another cross-sectional study in 260 university students, those with poor sleep quality were found to have higher BMI values (12). In a meta-analysis of 18 studies, it was reported that for each additional hour of sleep BMI decreased by 0.35 kg/m^2 in individuals with poor sleep quality (44). A study in adolescents found higher body fat percentage and BMI values in adolescents sleeping less than 8 hours a day compared to those who had an adequate amount sleep ($p<0.05$) (25). Insufficient sleep affects hunger and satiety hormones by increasing the activity of the sympathetic nervous system. Inadequate sleep increases food intake by increasing ghrelin levels and decreasing leptin levels. It also has a potential effect that triggers obesity by increasing tiredness and reducing energy expenditure (45). Recommended duration of sleep is 7-9 hours daily for adults (46). Meeting the recommended sleep duration and having good quality sleep may lower the risk of obesity.

Smoking and alcohol consumption are other important factors that affect sleep quality. In the current study, increased number of cigarettes smoked per day was associated with lower sleep quality (Table 6). In a study by Arber et al., current smokers were found to experience 22% more sleep problems than non-smokers and 15% more sleep problems than former smokers (47). Another study reported significantly reduced sleep quality with increased smoking ($p<0.05$) (48). However, a study in 2,000 subjects from 20 to 59 years of age found no significant relation between smoking and sleep over a period of 6 years (49). In a study examining sleep quality in nurses, smoking was not significantly associated with sleep quality ($r=0.490$ $p=0.429$) (2). It is known that nicotine found in cigarettes has a stimulatory effect and smoking especially before sleep makes it difficult to fall asleep and affects sleep quality adversely (48).

Alcohol consumption was found to have no effect on sleep quality in the present study (Table 6), which is consistent with the findings of published studies in the literature. In a study in 30 Greek women from 30 to 60 years of age, sleep was not significantly affected by alcohol consumption ($p>0.05$) (50). In a separate study in 2,000 subjects from 20 to 59 years of age, alcohol consumption was not found to have a significant effect on sleep over a period of 6 years (49). Contrastingly, one study reported a significant relation between alcohol consumption and sleep quality ($p<0.01$) (40). In the study by Arber et al., sleep problems were reported in 23% of non-drinkers and in 15% of individuals who consume 2-3 drinks per week (47). Ethanol found in alcoholic beverages reduces the transport of tryptophan across the blood-brain barrier. Reduced amount of tryptophan causes decreased production of serotonin and melatonin and reduces both the quality and duration of sleep. This effect of alcohol is more pronounced after a long night of drinking (51,52). The nonsignificant association between alcohol consumption and sleep quality among the students in the current sudy can be explained by the fact that 68.6% were non-drinkers, and 64.9% of the students who consumed alcohol reported a moderate intake of alcohol (less than 5 drinks for males and less than 4 drinks for females), and the timing and duration of alcohol consumption might have had an effect.

Conclusion

Our findings showed that overall, the undergraduate students participating in the study had poor sleep quality and diet quality. The students with poor sleep quality also had poor diet quality and those with good sleep quality also had good diet quality. Obesity was not significantly associated with diet quality and sleep quality. Efforts should be made to improve diet and sleep quality by ensuring intake of an adequate and balanced diet, and strategies should be implemented to avoid the risk of developing chronic diseases. The study provides important data on both diet quality and sleep quality and obesity status of the university students and therefore, may provoke further research into these areas.

More comprehensive studies in larger samples are warranted to corroborate the findings of this study which demonstrated the relation between diet quality and sleep quality in university students.

Study Limitations: Several limitations should be noted for the study. First, only the students from the department of nutrition and dietetics were included in the study. Secondly, food consumption frequency was not captured while collecting the 3-day food record for the participants. Thirdly, the assessment of food intake and sleep status were based on self-reports of the students. Despite these limitations, our findings are in line with previous reports in the literature.

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