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The Association of Sleep Quality with Dietary Intake and Rate of General and Central Obesity among Young Female Students in Qazvin City, Iran

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ABSTRACT

Background: Insufficient sleep duration and unhealthy diet are associated with weight gain. However, little is known about the association of sleep quality with dietary intake and obesity. The aim of the present study was to compare dietary intake and anthropometric indices between good and poor sleepers. **Methods:** In this cross-sectional study, a total of 260 females youth aged 18-30 years were recruited among the students of Qazvin University of Medical Sciences. The evaluated variables consisted of sleep quality, dietary intake, and anthropometric indices. Statistical analysis was performed using SPSS version 21.0. **Results:** Participants in the poor quality sleep group had higher intakes of calorie ($P < 0.001$) and carbohydrate ($P < 0.001$), and lower protein intake ($P < 0.01$) in comparison with good sleepers. Regarding food groups, poor sleepers had higher intake of bread-grains ($P = 0.02$) group, but lower intake of meat-alternatives ($P < 0.001$), vegetables ($P < 0.001$), and fruits ($P < 0.001$) in comparison with the good sleepers. Participants in the poor quality sleep group had higher weight ($P < 0.001$), body mass index ($P < 0.001$), waist circumference ($P < 0.001$), and fat mass ($P < 0.001$) in comparison with good sleepers. **Conclusion:** Our findings emphasize the relationship of poor quality sleep with unhealthy dietary intake and obesity in young female women.

Keywords: *Sleep quality; Dietary intake; Body weight; Central obesity; Young female*

Introduction

Obesity, a major public health problem worldwide, is sometimes a true epidemic (Katagiri *et al.*, 2014). The high morbidity related to obesity highlights the importance of recognizing various factors that may increase its high prevalence in the population. Expressed phenotype of obesity is affected by non-genetic determinants including environmental and behavioral factors (Bouchard, 2007, Friedman, 2004, Hill *et al.*, 2003). Physical activity and dietary patterns have obtained much attention as effective factors of obesity over

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the past decades; however, many other determinants have been recognized to influence the obesity epidemic (Keith *et al.*, 2006). In this regard, sleep deprivation has received much attention (Schoenborn *et al.,* 2004). The literature showed that sleep quality in short sleepers might be poorer (Hayashino *et al.*, 2007).

Based on cross-sectional and case-control studies, insufficient sleep and poor quality sleep are related to obesity (Gupta *et al.*, 2002, Sekine *et al.*, 2002, Vioque *et al.*, 2000, Von Kries *et al.*, 2002). The possible mechanisms proposed for this association include irregular food intake and lower vegetable consumption (Ohida *et al.*, 2001), lower physical activity due to daytime sleepiness alterations in the balance of energy intake and energy expenditure (Shi *et al.*, 2008), altered levels of orexigenic and anorexigenic hormones (Spiegel *et al.*, 2004, Taheri *et al.*, 2004), and diet quality (Azadbakht and Esmaillzadeh, 2011).

Some investigations demonstrated that acute sleep restriction elevates calorie intake in adults due to elevated consumption of carbohydrates and fats (Bosy-Westphal *et al.*, 2008, Brondel *et al.*, 2010). The results of a study over men sleeping 4 hours for two successive nights reported an elevated appetite particularly for energy dense foods with a high level of carbohydrate (Spiegel *et al.*, 2004).

Although many studies evaluated the relationship of sleep quality and/or duration with weight status and dietary intakes, no study has ever evaluated these associations among Iranian young female students. Thus, the aim of this study was to elucidate the possible negative impacts of poor-quality sleep on the dietary intakes and anthropometric variables among the female students in Qazvin University of Medical Sciences, Iran.

Materials and Methods

Participants and design: This cross-sectional study was carried out among young female students aged 18-30 years. The participants were selected from Qazvin University of Medical Sciences, Qazvin, Iran from February to March 2018. A random sample of 260 healthy female students was selected using a multistage sampling method from schools and departments of Qazvin University of Medical Sciences. Volunteers could participate in this study if they were native single female; aged 18-30 years; had body mass index (BMI) of 18.5 to 35 kg/m^2; were under no medication and/or dietary supplements; and were not suffering from mental disability. Shift workers were excluded from the study.

Sleep quality assessment: Sleep quality was investigated using the validated Iranian version of Pittsburg Sleep Quality Index (PSQI) (Naderi *et al.*, 2017). The PSQI is a validated self-report measure of subjective sleep quality and sleep disturbances during the past month period. Briefly, each participant answered nine questions, which generated a score (range 0-3, 0 = no difficulty and 3 = sever difficulty) for seven components of sleep quality, sleep latency, sleep duration, sleep efficacy, sleep disturbances, use of sleeping medication, and day time dysfunction. Sum of these seven scores indicated a global score for sleep quality (range 0-21). A total score of > 5 showed "poor" quality sleep, while participants with total score of ≤5 were categorized as "good" sleepers.

Anthropometric, dietary intake and physical activity measurements: Anthropometric measurements including height, weight, waist circumference, and body fat percentage were conducted for all participants. Height was measured by a non-stretched tape, while the participant was in a standing position and without shoes. Weight was measured using a calibrated digital scale with minimal clothing and without shoes. The participants' BMI was calculated as body weight (kg) divided by height squared (m^2). Waist circumference was evaluated at the narrowest region between the lowest rib and the iliac crest over light clothing by a non-stretched tape (Wang *et al.*, 2003). Body fat mass percentage (FM%) was measured by Bioelectrical Impedance Analyzer (Quad scan 4000; Body stat).

Dietary intakes were investigated through a validated 168-item semi-quantitative food frequency questionnaire (FFQ) (Haghighatdoost *et al.*, 2012, Mirmiran *et al.*, 2010), which asked about the portion size and frequency of food and beverage consumption over the past year on a daily, weekly, or monthly basis. The reported frequency for each food item was converted to daily intake. The participants were provided with the potion size images to evaluate the reporting accuracy. Household measures were used to alter all portion sizes of the consumed foods to grams. FFQ was completed by a trained interviewer in 30-36 minutes. Nutrient analysis of diets was conducted by nutritionist 4 software. We evaluated calorie (kcal/day), macronutrients (g/day), and food groups (serving/day) intakes from FFQ. Basically, all food items were classified under five food groups, provided by U.S. Department of Agriculture’s Food Guide Pyramid (bread-grains, vegetables, fruits, meats, and dairy).

Physical activity level was investigated by Persian short form of the International Physical Activity Questionnaire (IPAQ) and reported in Met-Min/week (Craig *et al.*, 2003). A questionnaire was used for socioeconomic status information.

Data analysis: Statistical analysis was performed by SPSS version 21.0 (SPSS Inc, Chicago, Illinois) software. The normal distribution of date was examined by Kolmogorov-Smirnov test. Furthermore, Mean ± SD was used to describe normal distributed data. Non-normally distributed data was described as Median (interquartile). The mean values of the dietary intakes, anthropometric indices, and physical activity were compared between good and poor sleepers using independent *t*-test for normal distributed variables and Mann-Whitney *U* test for non-normal distributed data. Spearman correlation was used to detect possible bivariate associations. P-value < 0.05 was considered significant.

Ethical considerations: The 260 female students, who met the inclusion criteria, were informed about the aims and protocol of the study, wrote informed consent forms, and signed them. This study was approved by the Ethics Committee of Qazvin University of Medical Sciences, Qazvin, Iran (code: IR.QUMS.REC.1396.413).

Results

Two hundred sixty female students, who were studying in Qazvin University of Medical Sciences, Iran, participated in the current study. The participants' mean age was 21.95 ± 2.11 years. Of 260 female students who participated in the study, 111 (42.7%) were poor sleeper (PSQI > 5) and 149 (57.3%) were good sleeper (PSQI ≤ 5). **Table 1** demonstrates anthropometric indices and dietary intakes of the participants. A questionnaire was administered for socioeconomic status information and no significant difference was found between participants in this regard.

Table 2 compares dietary intakes between good and poor sleeper groups. As demonstrated in this table, those in the poor sleep quality group (PSQI > 5) had higher intakes of calorie 2460 versus 2175; *P* < 0.001) kcal/d and carbohydrate 352 versus 290 g/d; *P* < 0.001) in comparison with good sleepers (PSQI ≤ 5) and lower protein intake 88 versus 99 g/d; *P* < 0.01). Moreover, regarding five food groups, poor sleepers had higher intake of bread-grains 9 ± 2 versus 8 ± 2 serving/d; *P* = 0.02) group, but lower intake of meat-alternatives 5 ± 2 versus 5 ± 1 serving/d; *P* < 0.001), vegetables 2 ± 1 versus 2 ± 1 serving/d; *P* < 0.001) and fruits (2 ± 1 versus 3 ± 1; *P* < 0.001) in comparison to good sleepers (**Table 2**).

No significant difference was observed between the two groups regarding the frequency of main meals (breakfast, lunch, and dinner) and between meals per day (*P* > 0.05) (data not shown).

Participants in the poor quality sleep group (PSQI > 5) had higher weight (65.52 ± 9.64 versus 57.46 ± 7.33 kg; *P* < 0.001), BMI (25.06 ± 3.30 versus 21.87 ± 2.38 kg/m^2; P < 0.001), waist circumference (78.63 ± 7.31 versus 70.70 ± 5.95 cm; *P* < 0.001), and body FM% (36.08 ± 5.42 versus 29.66 ± 5.19 percent; *P* < 0.001) in comparison with those in the good sleep quality group (PSQI ≤ 5) (**Table 3**). Moreover, a significant difference was observed between good sleepers (1157 Met-Min/week) with poor sleepers (820 Met-Min/week) in relation to physical activity (*P* < 0.01).

Table 4 and 5 show the correlation between some sleep habits with anthropometric indices,

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food groups and food intakes in the participants. As these tables demonstrates, total night sleep had a positive and significant correlation with intake of vegetables per day (r = 0.01, P < 0.01), and total sleep time and intake of vegetables per day (r = 0.12, P = 0.04). Furthermore, the sleep onset latency had a significant association with weight (r = 0.26, P < 0.001), body fat mass percentage (r = 0.30, P < 0.001), waist circumference (r = 0.28, P < 0.001), calorie intake (r = 0.15, P = 0.01), protein intake (r = 0.17, P < 0.01), carbohydrate intake (r = 0.16, P < 0.01), bread-grain group intake (r = 0.13, P = 0.03), and the number of meat serving intake per day (r = 0.25, P < 0.001). In addition, sleep onset latency had a negative and significant correlation with intake of vegetable (r = -0.35, P < 0.001) and fruits (r = -0.34, P < 0.001) per day. No significant correlation was observed between other variables ($P \geq 0.05$).

Table 1. Anthropometric measurements and dietary intakes of the female students (n=260).

Variables	**Mean** ± SD	**Min**	**Max**
Age (year)	21.95 ± 2.12	19.00	30.00
Height (cm)	161.84 ± 5.84	147.00	179.00
Weight (kg)[a]	60.90 ± 9.28	44.20	107.00
Body mass index (kg/m^2)	23.23 ± 3.22	18.50	34.99
Waist circumference (cm)	74.09 ± 7.62	59.50	110.00
Body fat mass (%)	32.40 ± 6.17	20.50	55.00
Food intakes			
Calorie (kcal/d)	2309.17 (869.95)[a]	1278.00	2999.00
Protein (g/d)	96.26 (43.83) [a]	13.88	148.00
Carbohydrate (g/d)	317.32 (122.24) [a]	110.00	499.00
Total fat (g/d)	90.00 (33.16) [a]	27.04	192
Food groups, serving/d			
Bread-grains	8.65 ± 2.46	2.40	16.73
Vegetables	2.58 ± 1.33	0.5	7.72
Fruits	9.92 ± 1.61	0.29	9.61
Meats-alternatives	5.46 ± 1.92	1.99	10.38
Dairy	2.50 ± 1.23	0.31	8.13

[a]: Values are shown as median (Inter Quartiles)

Table 2. Comparing the dietary intakes between good and poor sleeper groups

Variables	**Good sleeper (n=149)**	**Poor sleeper (n=111)**	**P-value**
Calorie intake, kcal/d[a]	2175.26 (830.49)	2460.93 (676.55)	< 0.001
Protein intake, g/d[a]	99.22 (48.21)	88.00 (39.09)	< 0.01
Carbohydrate intake, g/d[a]	290.39 (143.14)	352.59 (103.55)	< 0.001
Total fat intake, g/d[a]	89.12 (39.34)	92.00 (36.16)	0.09
Food groups, serving/d			
Bread-grains[b]	8.35 ± 2.41	9.06 ± 2.48	0.02
Vegetables[b]	2.94 ± 1.41	2.10 ± 1.05	< 0.001
Fruits[b]	3.38 ± 1.61	2.31 ± 1.40	< 0.001
Meats-alternatives[b]	5.75 ± 1.62	5.24 ± 2.09	0.03
Dairy[b]	2.53 ± 1.27	2.45 ± 1.17	0.59

[a]: Values are shown as median (Inter Quartiles), and P-values according to Mann Whitney *U* test; [b]: Values are shown as mean±SD, and P-values according to independent t-test.

Table 3. Comparing mean (±SD) of the anthropometric measurements between good and poor sleeper groups

Variables	Good sleeper (n=149)	Poor sleeper (n=111)	P-value[a]
Weight (kg)	57.46 ± 7.33	65.52 ± 9.64	< 0.001
Height (cm)	161.98 ± 5.68	161.64 ± 6.07	0.64
Body mass index (kg/m^2)	21.87 ± 2.38	25.06 ± 3.30	< 0.001
Waist circumference (cm)	70.70 ± 5.91	78.63 ± 7.31	< 0.001
Body fat mass (%)	29.66 ± 5.19	36.08 ± 5.42	< 0.001

[a]: independent *t*-test.

Table 4. Correlation (r) between total sleep time (TST), total night sleep (TNS) and sleep onset latency (SOL) with anthropometric measurements.

Variables	Weight (kg)	Body mass index (kg/m^2)	Fat mass (%)	Waist circumference (cm)
TNS (h)				
r	-0.02	-0.02	-0.08	-0.09
P-value	0.74	0.68	0.16	0.11
TST (h)				
r	-0.02	-0.00	-0.03	-0.10
P-value	0.66	0.90	0.57	0.09
SOL (min)				
r	0.26	0.28	0.30	0.28
P-value	<0.001	<0.001	<0.001	<0.001

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Table 5. Correlations (r) between total sleep time (TST), total night sleep (TNS), sleep onset latency (SOL) with dietary intakes (n=260).

Variables	A	B	C	D	E	F	G	H	I
TNS (h)									
r	-0.05	-0.02	-0.07	0.01	-0.14	0.01	0.07	-0.08	-0.12
P-value	0.36	0.74	0.22	0.86	0.82	<0.01	0.22	0.16	0.04
TST (h)									
r	-0.07	-0.02	-0.08	0.01	-0.00	0.12	0.02	-0.02	-0.08
P-value	0.21	0.68	0.16	0.75	0.92	0.04	0.70	0.71	0.17
SOL (min)									
r	0.15	0.17	0.16	0.07	0.13	-0.35	-0.34	0.25	0.06
P-value	<0.01	<0.01	<0.01	0.25	0.03	<0.001	<0.001	<0.001	0.32

A: Calorie (kcal/d), B: Protein (g/d), C: Carbohydrate (g/d), D: Fat (g/d), E: Bread-grain (serving/d), F: Vegetables (serving/d), G: Fruits (serving/d), H: Meats (serving/d), I: Dairy (serving/d)

Discussion

In this cross-sectional study, poor sleepers had significantly higher intakes of calorie, carbohydrates, and bread-grains group, lower intakes of protein, fruits, vegetables, and meat-alternatives, as well as a higher rate of general and central obesity compared to good sleepers. No significant difference was observed in the frequency of main meals and between meals per day.

Dietary intake and sleep quality, two important factors of lifestyle, are independent determinants of weight and obesity. Our hypothesis was that dietary intakes are different between good and

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poor sleepers, which may subsequently associate obesity with sleep quality.

Unhealthy food intake among individuals with insufficient sleep was demonstrated by some studies (Kim *et al.*, 2011, Ohida *et al.*, 2001). These studies compared the intake of different food groups between short and longer sleepers. Although the relationship between sleep insufficiency and anthropometric indices has been widely assessed (Cappuccio *et al.*, 2008, Knutson and Van Cauter, 2008, Patel and Hu, 2008, Sivak, 2006, Taheri *et al.*, 2004), some limitations are observed in the Middle Eastern countries, such as Iran. Since different countries have different dietary patterns, it is useful to investigate such relationships for each country. We also found that poor sleepers had significantly higher intakes of calorie and carbohydrate, which is in line with some previous studies on dietary intakes and sleep duration (Brondel *et al.*, 2010, Haghighatdoost *et al.*, 2012, Nedeltcheva *et al.*, 2008, Spiegel *et al.*, 2004), but not all (Schmid *et al.*, 2009). The findings showed that poor sleepers had lower intake of protein, meat-alternatives, vegetables, and fruits. The results of a study (Nedeltcheva *et al.*, 2008) suggest that inadequate sleep itself may have an impact on individual energy intake. Increased carbohydrate intake and preference for sweets have been indicated in physiologically demanding states (Nedeltcheva *et al.*, 2008). The adult experimental evidence similarly demonstrates a causal relationship between insufficient sleep and an unhealthy diet. Some researchers indicated that higher intakes of carbohydrate- rich foods (Bosy-Westphal *et al.*, 2008, Nedeltcheva *et al.*, 2008) have affirmed alterations in dietary fat (Brondel *et al.*, 2010, St-Onge *et al.*, 2011). These differences may be resulted from circadian clock disturbances. In fact, the circadian system has a major and direct impact on the regulation of sleep, metabolism of energy, and eating (Laposky *et al.*, 2008, Turek *et al.*, 2005). For example, leptin that is regulated by circadian rhythms, reduces appetite, elevates energy expenditure, and affects the sleep efficiency. Circadian clock disturbance decreases serum concentrations of leptin (Haghighatdoost *et al.*, 2012).

Regarding anthropometric measurements, our findings demonstrated that weight, BMI, body fat percentage, and waist circumference are significantly higher in poor sleepers compared to good sleepers. The findings are in agreement with some previous studies that reported the significant relationship of obesity with insufficient sleep and poor quality sleep (Gupta *et al.*, 2002, Haghighatdoost *et al.*, 2012, Sekine *et al.*, 2002, Vioque *et al.*, 2000, Von Kries *et al.*, 2002). It was reported that sleep quality was poorer in short sleepers (Hayashino *et al.*, 2007). Several mechanisms have been proposed to explain the relationship of insufficient sleep with higher BMI values. It has been well proven that insufficient sleep is related to lower levels of anorexigenic hormones such as leptin in contrast with elevated serum concentrations of orexigenic hormones such as ghrelin (Spiegel *et al.*, 2004, Taheri *et al.*, 2004). Serum levels of cortisol also elevate toward the evening in individuals with total and partial sleep insufficiency. Cortisol has a lipogenic effect, which may lead to weight gain in chronic sleep insufficiency (Spiegel *et al.*, 1999). Moreover, lower physical activity might result in weight gain in people with insufficient sleep (Shi *et al.*, 2008). Our findings demonstrated a significant difference in physical activity levels between good and poor sleepers. However, sleep insufficiency can contribute to weight gain through other mechanisms. The results of a study suggested that the relationship between sleep insufficiency and obesity may be due to alterations in neuronal activity after exposure to food stimuli. These alterations related to sleep insufficiency influence brain parts connected to motivation and desire, which contribute to an elevated tendency to eat food in those who are not getting sufficient sleep (St-Onge *et al.*, 2012). In a world where food is easily available, these effects would elevate weight gain.

The present study has several limitations. First, causality relationship could not be determined by cross-sectional design. We were

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not capable of recognizing whether unhealthy diet and obesity were resulted from poor sleep quality or poor sleep quality was resulted from unhealthy diet and weight gain. Second, we investigated sleep quality and dietary intakes by administrating self-reported questionnaires. Self-reported data may lead to over- or under-estimation because they depend on the individual's memory. Third, serum levels of leptin and ghrelin were not measured.

Conclusion

Data from the present study propose that young females with good sleep quality had a healthy diet and better anthropometric indices. Therefore, unhealthy diet in poor sleepers may lead to overweight and abdominal obesity in young women. This association needs further investigation in both genders and other age groups. Educations on optimizing sleep quality and duration is recommended according to the educational models to ameliorate the quality of life.

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Conflict of interest

None

Authors' contributions

Momeni F carried out the data collection process conducted the research work and Also wrote the manuscript. Javadi M and Vafa M were involved with conception and design of the study. Sarbakhsh P conducted statistical analysis and interpretation of data. Abiri B and Mohammadi I revised the manuscript, and provided guidance to improve the quality of final manuscript. All authors read and approved the final manuscript.

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