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Associations between Dietary Patterns and Sleep Problems in Adolescent Girls: A Descriptive Cross-Sectional Study

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ABSTRACT

Background: Adolescence may be accompanied by abnormalities in menstrual cycles that result in a higher incidence of sleep problems and related psychological disorders. Dietary factors can intensify or improve sleep problems. This study aimed to evaluate the association between sleep problems and habitual dietary patterns among Iranian adolescent girls. **Methods:** This study was conducted in cities of Mashhad and Sabzevar, northeastern Iran. A total of 752 adolescent girls aged 12-18 years were recruited from several schools by using a random cluster sampling method. A valid and reliable food frequency questionnaire (FFQ) was used to obtain the dietary intakes of the girls. Validated Iranian versions of the questionnaires were used to assess insomnia and daytime sleepiness prevalences. **Results:** Three major dietary patterns were identified based on the principal component analysis (PCA), including healthy, western, and traditional dietary patterns. No significant associations were found between the quartiles of healthy (OR: 1; 95% CI 0.62-1.59, P trend = 0.75), western (OR: 1.3; 95% CI 0.8-2.10, P_{trend} = 0.16) or traditional (OR: 0.62; 95% CI 0.69-1.82, P_{trend} = 0.64) dietary patterns and sleep insomnia. In addition, there were no significant relationships between the quartiles of healthy (OR: 0.85; 95% CI 0.54-1.69, P trend = 0.84), western (OR: 0.81; 95% CI 0.49-1.32, P_{trend} = 0.55) or traditional (OR: 1.07; 95% CI 0.66-1.74, P_{trend} = 0.9) dietary patterns and daytime sleepiness. **Conclusions:** No significant association was observed between dietary patterns and insomnia or daytime sleepiness among adolescent girl participants.

Keywords: *Dietary Patterns; Insomnia; Daytime sleepiness; Adolescents*

Introduction

Sleep-related disorders are prevalent problems in adolescents and are related to mood disorders, including depression, anxiety, suicidal thoughts and attempts, impaired academic performance, fatigue, pain, and overall reduced quality of life (Roberts *et al.*, 2008). Sleep difficulties are one important risk

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factor for serious metabolic disorders, including obesity, metabolic syndrome, and type 2 diabetes (Matthews and Pantesco, 2016). Adolescence is a critical period, especially for girls, which may be accompanied by menstrual cycles abnormalities that result in a higher incidence of sleep problems and related psychological disturbances (Roberts *et al.*, 2008). Insomnia has been defined as difficulty with the initiation, maintenance, duration, or quality of sleep which has a negative influence on the day time functioning (Manjavong *et al.*, 2016). The prevalence of insomnia in adolescents is reported to be approximately 23.8% (Hysing *et al.*, 2013), so it seems to be the most common sleep disorder in this age group (Donskoy and Loghmanee, 2018). In addition, excessive daytime sleepiness (EDS) is a public health challenge among the adolescents, with a prevalence ranging from 7.8% to 55.8% (Pereira *et al.*, 2010).

Dietary factors appear to be a modifiable etiologic factor, which can intensify or improve sleep problems and act as a bridge between sleep-related disorders and poor health outcomes. Recently, the role of diet in the pathogenesis of sleep problems have received more attention and their results are inconsistent (Kurotani *et al.*, 2015). While, some findings from epidemiological studies indicated that individuals with higher intakes of refined carbohydrates (Yoneyama *et al.*, 2014) and saturated fatty acids (Grandner *et al.*, 2010, Shi *et al.*, 2008) experience more sleep problems; others suggested that calcium, fiber and B-vitamins may prevent poor sleep symptoms (Peuhkuri *et al.*, 2012). Although, it was reported that the subjects with more difficulty maintaining sleep (DMS) consumed lower carbohydrates (Tanaka *et al.*, 2013), some other studies affirmed that carbohydrate-rich meals increased levels of day-time sleepiness, and this may occur due to serotonin production (Dye *et al.*, 2000, Linder, 1991, Lowden *et al.*, 2004). Moreover, direct associations were reported between low and high protein intakes with insomnia symptoms among middle-aged Japanese workers (Tanaka *et al.*, 2013).

Given that foods are consumed in combination, it is difficult to distinguish the specific effects of each food or nutrient. Recently, nutritional epidemiology attentions have focused on the dietary pattern approach, which mainly corrects some possible interactions between foods and nutrients (Kurotani *et al.*, 2015, Yu *et al.*, 2017).

Although there is increasing evidence showing the relationship between diet and insomnia (Kurotani *et al.*, 2015, Yu *et al.*, 2017), to the best of the authors' knowledge, no previous study has focused on the relationship between habitual dietary patterns and chronic insomnia in adolescents. In the present cross-sectional study, it was hypothesized that some major dietary patterns may be related to insomnia problems among Iranian female adolescents.

Materials and Methods

Study population and design: This cross-sectional study was conducted in cities of Mashhad and Sabzevar, northeastern Iran in 2015-2016. A total of 752 adolescent girls aged 12-18 years were participated using a random cluster sampling method from several schools. The participants with a history of chronic diseases (colitis, diabetes, cardiovascular diseases, cancer, and hepatitis) and current medication for the psychological disease were excluded. All of the participants and their parents were asked to complete the written informed consent before the beginning of the study. The study was approved by the ethics committee of Mashhad University of Medical Sciences.

Mesurements: General demographic information was obtained by face-to-face interviews, using a standard questionnaire. Physical activity was assessed through the validated modifiable activity questionnaire (Delshad *et al.*, 2015) and was provided as metabolic equivalents (METs) in hours per day. To estimate energy intake, the reported portion size in FFQ was converted to grams using household measures and then were entered into the Nutritionist IV software. A trained technician using standard protocols measured body weight and height. Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared.

To assess the prevalence of insomnia, a validated Iranian version of the Insomnia Severity Index (ISI) questionnaire was used (Yazdi *et al.,* 2012). The ISI questionnaire has seven questions. Each question has a score range between 0 and 4 stratified into four categories, including 0 (None), 1 (Mild), 2 (Moderate), 3 (Severe), and 4 (Very severe). The total score of ISI ranges from 0 to 28 points. If the ISI score is >7, an individual is considered to have Insomnia.

Daytime sleepiness was assessed through a validated Persian translation of the Epworth Sleepiness Scale (ESS) (Johns, 1991, Sadeghniiat Haghighi *et al.*, 2013). This questionnaire explore the sleepiness rate by assessing eight daily situations, each situation has a score range between 0 and 3. The total score of ESS ranges from 0 (no daytime sleepiness) to 24 (the most excessive daytime sleepiness). EDS was defined as ESS ≥10 (Hayley *et al.*, 2014).

Aggression score was assessed using a validated Persian translation of the Buss-Perry questionnaire (Zivari-Rahman *et al.*, 2012). This questionnaire includes 29 questions with multiple-choice responses. A median cut-point for the definition of aggression was used; therefore, the individuals were categorized as aggressive if their score was >64.

A Persian version of the Beck Depression Inventory (BDI) was used to determine depression score (Bonnet *et al.*, 2005, Ghassemzadeh *et al.*, 2005, Norrby, 2002). BDI is a self-administered questionnaire, including 21 items with various options. The total score for the BDI ranges from 0 to 63 points. If the BDI score was < 13, the person was not considered as depressed, and if the subject's score was > 13, they were categorized as depressed.

A valid and reliable semi-quantitative food frequency questionnaire (FFQ) contained 147 food items used to obtain the dietary intakes of the study participants (Hosseini Esfahani *et al.,* 2010). Experienced dietitians asked participants to designate their consumption frequency for each food item consumed during the previous year on a daily, weekly, or monthly basis during face-to-face interviews. Portion sizes of the consumed foods that were reported in household measures were then converted to grams. The energy and nutrient content of foods were then calculated with the USDA food composition table included in the Nutritionist IV software (First Databank; Hearst, San Bruno, CA, USA). For some traditional Iranian food items that are not included in Nutritionist IV (e.g., traditional bread and some dairy products such as Kashk), Iranian food composition table was used. The dietary intakes of the participants were adjusted for energy intake. To identify dietary patterns, 40 predefined food groups were evaluated (**Table 1**). Certain food groups were created based on the similarity of nutrients and their association with insomnia.

Ethical cosiderations: This study was approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran (Ethic code: 931188). All methods of the current study were performed in accordance with the Declaration of Helsinki, and all students and their parents completed the informed written consent.

Data analysis: The major dietary patterns were identified using principal component analysis (PCA) based on the 40 food groups, and factors were rotated by varimax rotation. Three factors with eigenvalues > 2 and interpretation of a scree plot were determined. Therefore, three major dietary patterns were identified and then labeled by the interpretation of previous reports. For all the participants, the factor scores of each derived pattern were obtained by summing the intakes of foods weighted by their factor loading. The individuals categorized according to quartiles of dietary pattern scores. To assess the differences in continuous variables across quartiles of three dietary pattern scores one-way analysis of variance was performed.

Data analysis: For all statistical analyses, SPSS software version 15.0 (SPSS Inc, Chicago, IL, USA) was used. A chi-squared test was used to compare categorical variables across quartiles of dietary pattern. To explore the relationship between dietary patterns and insomnia, logistic regression was used in several models. In model I, age, energy intake, passive smoking, physical activity, and menstruation status were controlled. In model II, a further adjustment was used for BMI percentile. A P-value < 0.05 was considered statistical significant level.

Results

Three major dietary patterns were identified and are shown in **Table 1**. The first pattern was characterized by higher consumption of low and high-fat dairy, fish, eggs, yogurt drink,legumes, fruits, garlic, olives, mayonnaise, tomatoes, cruciferous, green leafy, and other vegetables, which was named as a *healthy dietary pattern*. The second pattern was labeled as the *western dietary pattern*, characterized by higher intakes of refined grains, red meats, poultry, processed meats, pizza, fruits, fruit juice, industrial juice and compote, mayonnaise, nuts, soft drinks, sweets, and desserts, coffee, and pickles. The third pattern was a *traditional dietary pattern* with the highest loading factors for potatoes, snacks, hydrogenated fats, vegetable oil, sugars, soft drinks, sweets and desserts, tea, and spices.

General and clinical characteristics of the study participants across quartiles of major dietary patterns are shown in **Table 2**. There were no significant differences in age and mensuration status between the quartiles of dietary pattern scores. However, BMI percentiles of the participants were significantly different across quartiles of traditional dietary patterns. In addition, individuals with higher healthy dietary pattern scores were more likely to be physically active compared to those in the lowest quartiles (P = 0.006). Moreover, the depression score was higher in the first quartile of the healthy dietary pattern than in the fourth quartile (P = 0.003). Additionally, the participants in the lowest quartile of the healthy pattern tended to be exposed to smoking compared to those in the highest quartile (P = 0.01).

Table 3 reveals that the participants with the greatest adherence to any of these dietary patterns had significantly higher intakes of total energy and vitamin C, but lower intake of dietary fiber. Also, dietary intakes of red meat, high-fat dairy, coffee, and calcium increased by increasing adherence to the healthy or western dietary pattern, but decreased by increasing scores of traditional dietary pattern. The intakes of whole grains and magnesium were higher among individuals in the first quartile of the traditional or western dietary pattern, but were lower among those in the first quartile of healthy dietary pattern. The intakes of refined grains, total carbohydrate, folic acid, and vitamin B3 decreased by increasing scores of healthy or traditional dietary pattern.

By an increasing western dietary pattern score, dietary intake of processed meat and nuts increased, but the intakes of low-fat dairy, legumes, monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA), vitamin E, and caffeine decreased.

Moreover, individuals in the last quartile of traditional dietary pattern tended to consume higher amounts of vegetable oil, spices, total fat, MUFA, PUFA, vitamin E, and caffeine, but the intakes of processed meats, total protein, vitamin B6, B12, D, and A were higher among those in the first quartile.

The participants with the greatest adherence to healthy dietary pattern had significantly higher intakes of low-fat dairy products, fruits and legumes as well as protein, total fat, MUFA, vitamin A, B6, B12, and D. However, these individuals consumed lower amounts of spices and caffeine.

Multivariable-adjusted odds ratios for insomnia and daytime sleepiness across categories of dietary pattern are indicated in **Tables 4**, respectively. No significant associations were found between the healthy (OR: 1; 95% CI 0.62-1.59, P_{trend} = 0.75), western (OR: 1.3; 95% CI 0.8-2.10, P_{trend} = 0.16) or traditional (OR: 0.62; 95% CI 0.69-1.82, P_{trend} = 0.64) dietary patterns and sleep insomnia. There were no relations between the healthy (OR: 0.85; 95% CI 0.54-1.69, P_{trend} = 0.84), western (OR: 0.81; 95% CI 0.49-1.32, P_{trend} = 0.55) or traditional (OR: 1.07; 95% CI 0.66-1.74, P_{trend} = 0.9) dietary patterns and daytime sleepiness. These findings remained non-significant after adjustment for confounding variables in different models.

Discussion

There is increasing evidence showing an association between dietary patterns and insomnia symptoms. In the current cross-sectional study, three major dietary patterns were explored, including healthy, western, and traditional dietary patterns. The healthy dietary pattern was characterized by a high intake of legumes, fish, eggs, low- and high-fat dairy products, yogurt drink, fruits, garlic, olives, mayonnaise, tomatoes, cruciferous, green leafy, and other vegetables. A western dietary pattern was characterized by a high intake of red meats, poultry, processed meats, refined grains, pizza, fruits, fruit juice, industrial juice and compote, nuts, mayonnaise, soft drinks, sweets and desserts, coffee, and pickles. The third pattern was the traditional dietary pattern with the highest loading factors for potatoes, sugars, soft drinks, hydrogenated fats, vegetable oil, snacks, sweets and desserts, tea, and spices. No significant association was found between adherence to any of these dietary patterns and insomnia or daytime sleepiness in crude or adjusted models.

The results of the current study were in line with a recent cross-sectional descriptive study (Gonzalez-Sanchez *et al.*, 2019) showing no association between diet quality and presence of insomnia; however, some other studies indicated significant associations between dietary patterns and insomnia symptoms or day-time sleepiness (Campanini *et al.*, 2017, Castro-Diehl *et al.*, 2018, Godos *et al.*, 2019, Kurotani *et al.*, 2015, Martins *et al.*, 2019, Rostami *et al.*, 2019, Yoneyama *et al.*, 2014, Yu *et al.*, 2017).

Yu et al. found that both traditional northern and modern dietary patterns are associated with a decreased prevalence of insomnia symptoms (Yu *et al.*, 2017). However, this study suffer from some limitations; first, an invalid FFQ was applied to obtain dietary intakes; second; only 12 commonly consumed food groups in the Chinese diet were reported and other food groups that may be related to sleep problemswere not addressed. Moreover, this study was conducted in an adult population which is different from the study population.

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Similarly, Kurotani et al. observed that higher adherence to the healthy dietary pattern (characterized by high intakes of vegetables, potatoes, mushrooms, seaweeds, soy products, and eggs) was related to low prevalence of difficulty initiating sleep once or several times in a week (Kurotani *et al.*, 2015). However, they found no significant association between healthy dietary pattern and difficulty initiating sleep at least three times a week. They suggested that diet might have an effect on only mild insomnia symptoms, but it does not affect more sever sleep disorders, which may be affected by factors other than diet. Moreover, they used a not validated and reliable sleep symptom questionnaire (Kurotani *et al.*, 2015).

Table 1. Food groups used in the factor analysis and food loading matrix for major dietary patterns[a]

Food groups	Food items	Dietary patterns		
		Healthy	Wester	Traditional
Refined grains	White breads (lavash, baguettes), rice, Macaroni, noodles	-	0.23	-
Whole grains	Dark breads (Iranian), corn, Barley, bulgur	-	-	-
Potatoes	Potatoes	-	-	0.26
Snacks	French fries, chips, crackers	-	0.51	0.21
Legumes	Beans, peas, lentils, soy, mung, split peas	0.24	-	-
Other vegetables	broad beans, Cucumber, mixed vegetables, eggplant, celery, green peas, green beans, Sweet pepper, turnip, squash, mushrooms, carrots, onions	0.71	-	-
Red meats	Beef, hamburger, lamb, minced meat	-	0.34	-
Poultry	Chicken	-	0.36	-
Fish	Canned tuna fish, other fish	0.23	0.31	-
Organ meats	Heart, liver and kidney, intestine and viscera	-	-	-
Processed meats	Sausages	-	0.44	-
Eggs	Eggs	0.32	-	-
Pizza	Pizza	-	0.32	-
Low fat dairy	Skim or low-fat milk, low-fat yogurt	0.39	-	-
High fat dairy	High-fat milk, whole milk, chocolate milk, cream, high fat yogurt, cream yogurt, cream cheese, other cheeses, ice cream	0.35	-	-
Yoghurt drink	Doogh	0.40	-	-
Butter	Butter	-	-	-
Margarine	Margarine	-	-	-
Cruciferous vegetables	Cabbage, cauliflower, brussels sprouts, Kale	0.44	-	-
Tomatoes	Tomatoes, red sauce	0.61	-	-
Green leafy vegetables	Spinach, lettuce	0.61	-	-
Garlic	Garlic	0.33	-	-
Fruits	Orange, tangerine, lemon, lime, grapefruit, banana, apple, pear, strawberry and other berries, peach, cherries, fig, melon, watermelon and Persian melon, cantaloupe, raisins or grapes, kiwi, apricots, nectarine, mulberry, plums, persimmons, pomegranates, date	0.33	0.27	-
Dried fruits	Raisins, dried berries, other dried fruits	-	-	-
Fruit juice	Lemon juice, all types of juice	-	0.29	-
Industrial juice and compote	industrial Juice, fruit compote	-	0.48	-
Olives	Olives, olive oils	0.27	-	-

Table 1. Food groups used in the factor analysis and food loading matrix for major dietary patterns[a]

Food groups	Food items	Dietary patterns		
		Healthy	Wester	Traditional
Hydrogenated fats	Hydrogenated vegetable oils, animal oils	-	-	0.40
Vegetables oil	Vegetable oils (except for olive oil)	-	-	0.25
Mayonnaise	Mayonnaise	0.23	0.26	-
Nuts	Walnut, all types of nuts	-	0.27	-
Sugars	Sugar, candy	-	-	0.67
Soft drinks	Soft drinks	-	0.45	0.30
Sweets and desserts	Jam, Iranian confectioneries (gaz, sohan), chocolates, biscuits, Cakes, confections	-	0.42	0.27
Honey	Honey	-	-	-
Tea	Tea	-	-	0.68
Coffee	Coffee	-	0.27	-
Pickle	Pickle	-	0.23	-
Spices	Spices, green pepper	-	-	0.58

[a]*: Factor loadings of < 0.2 have been removed to simplify the table.*

Table 2. General characteristics, anthropometrics and clinical parameters of the study participants by quartiles (Q) categories of dietary pattern score

Variables	Healthy dietary pattern			Western dietary pattern			Traditional dietary pattern		
	Q1	Q4	P-value[a]	Q1	Q4	P-value	Q1	Q4	P-value
Age (y)	14.5 ± 1.5[b]	14.6 ± 1.5	0.4	14.4 ± 1.4	14.5 ± 1.5	0.4	14.3 ± 1.6	14.6 ± 1.4	0.2
Body mass index percentile (%)									
<25	35 (29.2)	25 (17.1)	0.08	36 (30.0)	37 (25.3)	0.4	30 (25.0)	50 (34.2)	0.01
25-50	33 (27.5)	36 (24.7)		25 (20.8)	37 (25.3)		30 (25.0)	37 (25.3)	
50-85	25 (20.8)	38 (26.0)		34 (28.3)	28 (19.2)		30 (25.0)	33 (22.6)	
≥85	27 (22.5)	47 (32.2)		25 (20.8)	44 (30.1)		30 (25.0)	26 (17.8)	
Physical activity (MET.h/day)	6.37 ± 0.38	6.54 ± 0.50	0.006	6.39 ± 0.35	6.51 ± 0.57	0.06	6.46 ± 0.49	6.44 ± 0.52	0.11
Menstruation (%)	172 (91.5)	171 (91.0)	0.3	167 (88.8)	173 (92.0)	0.4	169 (89.9)	165 (87.8)	0.6
Depression score	11.5 ± 9.8	8.8 ± 7.6	0.003	10.4 ± 9.0	11.5 ± 9.5	0.6	11.00 ± 9.6	10.6 ± 8.4	0.9
Aggression score	78.6 ± 20.9	74.9 ± 19.5	0.08	75.4 ± 20.6	82.0 ± 20.0	0.005	78.4 ± 20.7	79.7 ± 20.5	0.1
Passive smoker (%)	67 (35.6)	61 (32.4)	0.006	66 (35.1)	61 (34.0)	0.8	57 (30.3)	69 (36.7)	0.2

a:*ANOVA for continuous variables and chi-squared test for categorical variables;*[b]*:Mean ± SD.*

Table 3. Dietary intakes of the participants by quartiles (Q) categories of dietary pattern scores

Variables	Healthy dietary pattern			Western dietary pattern			Traditional dietary pattern		
	Q1	Q4	P-value [a]	Q1	Q4	P-value	Q1	Q4	P-value
Red meat	4.67 ± 5.06[b]	5.16 ± 4.60	0.004	3.48 ± 3.43	6.77 ± 6.92	<0.001	5.63 ± 4.59	4.17 ± 3.89	0.01
processed meat	1.88 ± 2.53	1.84 ± 2.86	0.1	0.86 ± 1.17	3.19 ± 3.63	<0.001	2.30 ± 3.41	1.37 ± 1.68	0.005
Low fat dairy	53.5 ± 54.2	102.9 ± 76.1	<0.001	86.7 ± 73.1	65.5 ± 54.1	0.002	89.3 ± 73.1	72.7 ± 70.4	0.1
High fat dairy	40.9 ± 41.1	81.3 ± 70.3	<0.001	53.6 ± 48.7	60.5 ± 46.7	0.02	73.8 ± 66.6	50.7 ± 43.6	<0.001
Fruits	61.9 ± 58.0	97.8 ± 68.6	<0.001	70.9 ± 51.2	81.4 ± 66.5	0.3	80.6 ± 55.5	75.5 ± 65.2	0.8
Vegetables oil	1.95 ± 2.84	1.91 ± 2.48	0.1	2.33 ± 3.29	1.68 ± 1.92	0.1	1.36 ± 1.73	2.27 ± 2.86	0.002
Legumes	65.6 ± 58.3	108.9 ± 85.4	<0.001	34.4 ± 26.4	28.0 ± 20.5	0.02	33.2 ± 26.1	29.8 ± 22.8	0.2
Coffee	2.44 ± 8.58	4.02 ±11.00	0.02	1.57 ± 5.08	5.21 ± 12.26	0.001	4.91 ± 14.11	2.51 ± 8.29	0.01
Whole grains	78.7 ± 63.1	62.1 ± 45.4	0.4	89.5 ± 67.7	72.8 ± 55.8	<0.001	76.1 ± 60.4	62.0 ± 48.4	0.01
Refined grains	139.9 ± 80.4	82.8 ± 40.4	0.001	105.4 ± 59.6	105.7 ± 67.0	0.1	130.5 ± 77.7	91.5 ± 49.7	<0.001
Spices	1.08 ± 1.18	1.02 ± 1.15	0.05	1.15 ± 1.26	0.93 ± 0.90	0.2	0.56 ± 0.59	1.58 ± 1.67	<0.001
Nuts	5.08 ± 9.36	6.09 ± 7.49	0.09	4.27 ± 7.28	7.60 ± 10.84	0.001	4.97 ± 8.73	6.31 ± 10.08	0.4
Nutrients									
Total energy (kcal)	2351± 825	3181 ± 705	<0.001	2186 ± 786	3377 ± 639	<0.001	2292 ± 829	3127 ± 756	<0.001
Protein (% of energy)	12.7 ± 2.1	14.2 ± 2.3	<0.001	13.6 ± 2.4	13.4 ± 2.3	0.2	14.9 ± 2.2	12.0 ± 2.1	<0.001
Carbohydrate (% of energy)	57.4 ± 7.7	52.6 ± 6.7	<0.001	54.1 ± 8.8	54.8 ± 6.7	0.5	56.4 ± 7.3	52.5 ± 8.1	<0.001
Total fat (% of energy)	31.8 ± 8.3	35.5 ± 7.2	<0.001	34.6 ± 9.7	33.5 ± 6.7	0.2	30.7 ± 7.2	37.7 ± 8.5	<0.001
Dietary fiber (g/1000 kcal)	47.4 ± 19.1	43.3 ± 15.8	0.02	47.6 ± 13.5	42.3 ± 18.5	0.004	47.4 ± 17.7	42.3 ± 16.7	0.02
MUFAs (g/1000 kcal)	31.8 ± 9.05	33.9 ± 10.8	0.01	36.04 ± 11.5	31.2 ± 9.3	<0.001	30.3 ± 7.6	37.9 ± 13.1	<0.001
PUFAs (g/1000 kcal)	23.2 ± 8.2	21.2 ± 9.8	0.1	10.8 ± 0.7	8.8 ± 0.6	<0.001	19.0 ± 5.9	27.7 ± 12.6	<0.001
Folic acid (µg/day)	680 ± 192	636 ± 180	0.02	636 ± 128	661 ± 214	0.3	679 ± 180	618 ± 181	0.007
Vitamin B3 (mg/day)	9.43 ± 2.09	8.58 ± 2.00	<0.001	8.99 ± 2.12	9.13 ± 2.13	0.89	10.00 ± 2.05	7.85 ± 1.77	<0.001
Vitamin B6 (mg/day)	0.67 ± 0.12	0.75 ± 0.12	<0.001	0.70 ± 0.14	0.70 ± 0.12	0.82	0.76 ± 0.12	0.65 ± 0.12	<0.001
Vitamin B12 (µg/day)	1.12 ± 0.57	<0.001	<0.001	0.74 ± 0.05	4.38 ± 0.31	0.22	2.05 ± 4.39	1.30 ± 0.67	0.01
Magnesium (mg/day)	175.3 ± 43.8	190.0 ± 36.1	<0.001	46.7 ± 3.40	36.7 ± 2.67	<0.001	190.9 ± 41.1	172.0 ± 40.6	<0.001
Vitamin D (µg/day)	2.40 ± 0.99	4.08 ± 2.62	<0.001	3.03 ± 1.46	3.17 ± 1.89	0.4	3.53 ± 2.08	2.90 ± 1.74	0.007
Vitamin C (mg/day)	156.2 ± 42.7	244.6 ± 70.1	<0.001	166.8 ± 56.5	226.0 ± 69.8	<0.001	179.3 ± 61.0	202.9 ± 63.2	0.001
Vitamin E (mg/day)	13.9 ± 5.1	14.4 ± 6.2	0.2	16.0 ± 6.8	12.7 ± 4.9	<0.001	11.9 ± 3.4	17.0 ± 7.6	<0.001
Vitamin A (µg/day)	377 ± 180	842 ± 386	<0.001	577 ± 283	653 ± 943	0.3	677 ± 932	554 ± 330	0.09
Calcium (mg/day)	935 ± 273	1363± 466	<0.001	166 ± 56	226 ± 69	0.001	1236 ± 350	1041 ± 418	<0.001
Caffeine (mg/day)	101.3 ± 84.3	77.4 ± 68.7	0.001	95.7 ± 79.1	77.7 ± 72.2	0.02	36.7 ± 32.0	149.0 ± 90.2	<0.001

[a]: Obtained from one-way ANOVA; [b]:Mean ± SD; SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acid.

Table 4. Multivariate adjusted odds ratios (95% CIs) for insomnia (Q) and day time sleepiness across quartiles of dietary pattern scores

Paterns	Crude	Model 1 [a]	Model 2 [b]
Insomnia			
Healthy pattern			
Q1 (Ref)	1	1	1
Q2	0.91 (0.57-1.47)	0.87 (0.53-1.40)	0.82 (0.49-1.36)
Q3	0.71 (0.43-1.16)	0.70 (0.42-1.16)	0.72 (0.42-1.22)
Q4	1 (0.62-1.59)	0.92 (0.55-1.53)	1.11 (0.64-1.92)
P-trend [c]	0.75	0.58	0.85
Western pattern			
Q1 (Ref)	1	1	1
Q2	0.93 (0.56-1.54)	0.88 (0.53-1.48)	0.83 (0.49-1.42)
Q3	1.23 (0.76-1.99)	1.20 (0.72-2.00)	1.10 (0.65-1.88)
Q4	1.30 (0.80-2.10)	1.28 (0.73-2.26)	1.13 (0.63-2.03)
P-trend	0.16	0.25	0.51
Traditional pattern			
Q1 (Ref)	1	1	1
Q2	0.71 (0.67-1.77)	1.06 (0.65-1.73)	1.22 (0.73-2.06)
Q3	0.71 (0.67-1.77)	0.96 (0.58-1.60)	1.10 (0.64-1.88)
Q4	0.62 (0.69-1.82)	1.02 (0.61-1.73)	1.10 (0.63-1.92)
P-trend	0.64	0.98	0.95
Day time sleepness			
Healthy pattern			
Q1	1	1	1
Q2	0.68 (0.55-1.47)	0.87 (0.53-1.44)	0.42 (0.48-1.35)
Q3	0.73 (0.56-1.49)	0.93 (0.56-1.54)	0.80 (0.55-1.57)
Q4	0.85 (0.54-1.69)	1.08 (0.64-1.82)	0.70 (0.64-1.92)
P-trend	0.84	0.74	0.57
Western pattern			
Q1	1	1	1
Q2	1.12 (0.70-1.80)	0.77 (0.46-1.26)	0.73 (0.44-1.23)
Q3	0.89 (0.54-1.45)	0.71 (0.42-1.19)	0.64 (0.38-1.10)
Q4	0.81 (0.49-1.32)	0.90 (0.51-1.57)	0.75 (0.42-1.34)
P-trend	0.55	0.61	0.27
Traditional pattern			
Q1	1	1	1
Q2	1.02 (0.62-1.67)	0.76 (0.65-1.77)	1.11 (0.66-1.86)
Q3	1.10 (0.68-1.79)	0.88 (0.57-1.60)	1.03 (0.61-1.76)
Q4	1.07 (0.66-1.74)	0.89 (0.56-1.64)	1.03 (0.59-1.79)
P-trend [*]	0.90	0.97	0.97

[a]: Adjusted for age, energy intake, passive smoking, physical activity, and menstruation; [b]: Additionally adjusted for BMI percentile, depression, and aggression scores;[c]: P=value for trend based on multiple regression analysis, with ordinal numbers 0 to 4 assigned to quintile categories of each dietary pattern.

The mechanisms underlying this inverse association are unclear, but it was hypothesized that dietary protein intake might be inversely associated with insomnia (Zadeh *et al.*, 2011), the mechanism of this association may be related to Tryptophan (TRP). Brain TRP is a precursor to serotonin and melatonin controling sleep cycle (España and Scammell, 2011). However, TRP enters the brain in competition to large-chain neutral amino acids (LCAANs), and the ratio of plasma TRP to LCAANs is a determining factor in this competition. Recently, it has been proposed that this ratio is affected by both dietary carbohydrates and proteins (Wurtman *et al.*, 2003). In animal models, it was shown that high-carbohydrate low-protein diets elevate brain TRP concentration compared to high-protein diets (Fernstrom and Wurtman, 1972).

Moreover, vitamin B3 and B6 may enhance TRP availability for the serotonin and melatonin synthesis (Peuhkuri *et al.*, 2012); in addition, vitamin B12 (Hashimoto *et al.*, 1996) and Magnesium (Meoli *et al.*, 2005) can enhance the melatonin secretion.

In the present study, the participants with the greatest adherence to healthy dietary pattern had significantly higher intakes of animal protein resources, such as dairy products and red meat, as well as total protein (% energy), vitamin B6 and B12, and magnesium. However, they tended to intake lower amount of total carbohydrate (% energy) and vitamin B3. The lower intake of carbohydrate may attenuate the higher animal protein intake effects, and consequently the ratio of plasma TRP to LCAANs. It may be an explanation for the null associations between this healthy dietary pattern and insomnia.

This study hadseveral strengths; first, to the best of the authors' knowledge, this was the first study focusing on the relationship between habitual dietary patterns and chronic insomnia in adolescents. Second, the dietary intake of the participants was assessed using a validated and reliable FFQ. Third, the data were collected with a high degree of quality control.

This study also had some limitations. First, the PCA required a subjective choice in determining the number of factors, the rotation method of initial factors, and the name of dietary patterns. Second, the causality or the direction of the relation cannot result from the cross-sectional studies. Third, the study population might not be representative of the general population. To assess dietary intake, the FFQ was used, which is prone to measurement error and misclassification. Finally, like other observational studies, several unmeasured confounders were in this study, which could not be controlled.

The present study indicated no significant association between dietary patterns and insomnia or daytime sleepiness among adolescent girl participants. Furthermore, well-designed and longitudinal studies are required to clarify the role of dietary patterns on the management of sleep problems.

Conclusion

The results indicated no significant association between adherence to either the healthy, Western or Traditional dietary patterns and sleep problems among adolescent girl participants. Moreover, well-designed and longitudinal studies are required to clarify the role of dietary patterns on the management of sleep problems.

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Authors' contributions

Ghayour-Mobarhan M and Khayyatzadeh SS designed the research; Khayyatzadeh SS, Salehi-Abargouei A, and Ghayour-Mobarhan M managed the whole project and contributed in all steps; Rajaie H performed statistical analysis and interpretation of the data; Rajaie H wrote the first draft of the manuscript; Salehi-Abargouei A and A.Ferns G facilitated the preparation of the manuscript and its finalization; Khayyatzadeh SS had primary responsibility for final content. All the authors read and approved the final manuscript.

Confilict of interests

The authors declare that there is no competing interest.

References

Bonnet F, et al. 2005. Anxiety and depression are associated with unhealthy lifestyle in patients at risk of cardiovascular disease. *Atherosclerosis.* **178 (2)**: 339-344.

Campanini MZ, Guallar-Castillón P, Rodríguez-Artalejo F & Lopez-Garcia E 2017.

Mediterranean diet and changes in sleep duration and indicators of sleep quality in older adults. *Sleep.* **40 (3)**.

Castro-Diehl C, et al. 2018. Mediterranean diet pattern and sleep duration and insomnia symptoms in the Multi-Ethnic Study of Atherosclerosis. *Sleep.* **41 (11)**: zsy158.

Delshad M, et al. 2015. Reliability and validity of the modifiable activity questionnaire for an Iranian urban adolescent population. *International journal of preventive medicine.* **6 (1)**: 3.

Donskoy I & Loghmanee D 2018. Insomnia in Adolescence. *Journal of medical sciences.* **6 (3)**: 72.

Dye L, Lluch A & Blundell JE 2000. Macronutrients and mental performance. *Journal of nutrition.* **16 (10)**: 1021-1034.

España RA & Scammell TE 2011. Sleep neurobiology from a clinical perspective. *Sleep.* **34 (7)**: 845-858.

Fernstrom JD & Wurtman R 1972. Brain serotonin content: physiological regulation by plasma neutral amino acids. *Journal of science.* **178 (4059)**: 414-416.

Ghassemzadeh H, Mojtabai R, Karamghadiri N & Ebrahimkhani N 2005. Psychometric properties of a Persian-language version of the Beck Depression Inventory-Second edition: BDI-II-PERSIAN. *Depression and anxiety.* **21 (4)**: 185-192.

Godos J, et al. 2019. Adherence to the mediterranean diet is associated with better sleep quality in Italian adults. *Journal of nutrition.* **11 (5)**: 976.

Gonzalez-Sanchez J, et al. 2019. Relationship between the presence of insomnia and walking physical activity and diet quality: a cross-sectional study in a sample of Spanish adults. *Medicina clinica.* **152 (9)**: 339-345.

Grandner MA, Kripke DF, Naidoo N & Langer RD 2010. Relationships among dietary nutrients and subjective sleep, objective sleep, and napping in women. *Sleep medicine.* **11 (2)**: 180-184.

Hashimoto S, et al. 1996. Vitamin B12 enhances the phase-response of circadian melatonin rhythm to a single bright light exposure in humans. *Neuroscience letters.* **220 (2)**: 129-132.

Hayley AC, et al. 2014. Excessive daytime sleepiness and body composition: a population-based study of adults. *PloS one.* **9 (11)**: e112238.

Hosseini Esfahani F, Asghari G, Mirmiran P & Azizi F 2010. Reproducibility and relative validity of food group intake in a food frequency questionnaire developed for the Tehran Lipid and Glucose Study. *Journal of epidemiology.* **20 (2)**: 150-158.

Hysing M, Pallesen S, Stormark KM, Lundervold AJ & Sivertsen B 2013. Sleep patterns and insomnia among adolescents: a population- based study. *Journal of sleep research.* **22 (5)**: 549-556.

Johns MW 1991. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep.* **14 (6)**: 540-545.

Kurotani K, et al. 2015. Dietary patterns and sleep symptoms in Japanese workers: the Furukawa Nutrition and Health Study. *Sleep medicine.* **16 (2)**: 298-304.

Linder MC 1991. Nutritional biochemistry and metabolism: with clinical applications.

Lowden A, et al. 2004. Performance and sleepiness during a 24 h wake in constant conditions are affected by diet. *Biological psychology.* **65 (3)**: 251-263.

Manjavong M, Limpawattana P, Mairiang P & Anutrakulchai S 2016. Prevalence of insomnia and related impact: An analysis from a university community. *International journal of psychiatry in medicine.* **51 (6)**: 544-553.

Martins AJ, Martini LA & Moreno CR 2019. Prudent diet is associated with low sleepiness among short-haul truck drivers. *Nutrition.* **63**: 61-68.

Matthews KA & Pantesco EJ 2016. Sleep characteristics and cardiovascular risk in children and adolescents: an enumerative review. *Sleep medicine.* **18**: 36-49.

Meoli AL, et al. 2005. Oral nonprescription treatment for insomnia: an evaluation of products with limited evidence. *Journal of clinical sleep medicine.* **1 (02)**: 173-187.

Norrby K 2002. Mast cells and angiogenesis. *Apmis.* **110 (5)**: 355-371.

Pereira ÉF, Teixeira CS & Louzada FM 2010. Sonolência diurna excessiva em adolescentes: prevalência e fatores associados. *Revista paulista de pediatria.* **28 (1)**: 98-103.

Peuhkuri K, Sihvola N & Korpela R 2012. Diet promotes sleep duration and quality. *Nutrition research.* **32 (5)**: 309-319.

Roberts RE, Ramsay Roberts C & Chan W 2008. Persistence and change in symptoms of insomnia among adolescents. *Sleep.* **31 (2)**: 177-184.

Rostami H, et al. 2019. The relationship between adherence to a Dietary Approach to Stop Hypertension (DASH) dietary pattern and insomnia. *BMC psychiatry.* **19 (1)**: 1-7.

Sadeghniiat Haghighi K, et al. 2013. The Epworth Sleepiness Scale: translation and validation study of the Iranian version. *Sleep breathing.* **17 (1)**: 419-426.

Shi Z, McEvoy M, Luu J & Attia J 2008. Dietary fat and sleep duration in Chinese men and women. *International journal of obesity.* **32 (12)**: 1835-1840.

Tanaka E, et al. 2013. Associations of protein, fat, and carbohydrate intakes with insomnia symptoms among middle-aged Japanese workers. *Journal of epidemiology.* **23 (2)**: 132-138.

Wurtman RJ, et al. 2003. Effects of normal meals rich in carbohydrates or proteins on plasma tryptophan and tyrosine ratios. *American journal of clinical nutrition.* **77 (1)**: 128-132.

Yazdi Z, Sadeghniiat-Haghighi K, Zohal MA & Elmizadeh K 2012. Validity and reliability of the Iranian version of the insomnia severity index. *Malaysian journal of medical sciences.* **19 (4)**: 31-36.

Yoneyama S, et al. 2014. Associations between rice, noodle, and bread intake and sleep quality in Japanese men and women. *PloS one.* **9 (8)**: e105198.

Yu C, et al. 2017. Dietary patterns and insomnia symptoms in Chinese adults: the China Kadoorie Biobank. *Nutrients.* **9 (3)**: 232.

Zadeh SS, Begum K & practice 2011. Comparison of nutrient intake by sleep status in selected adults in Mysore, India. *Nutrition research.* **5 (3)**: 230-235.

Zivari-Rahman M, Lesani M & Shokouhi-Moqaddam S 2012. Comparison of Mental Health, Aggression and Hopefulness between Student Drug-Users and Healthy Students (A Study in Iran). *Addiction & health.* **4 (1-2)**: 36-42.