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Dietary behavior and insomnia

The association between dietary behaviors and insomnia among adolescent girls in Iran

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ABSTRACT

Background: Insomnia is associated with a poor quality of life and increased risk of somatic and social problems. The aim of current study was to investigate the relationship between dietary behaviors and insomnia in Iranian adolescent girls.
Methods: This cross-sectional study was performed among 988 girls aged 12-18 years. A questionnaire was used to determine dietary behaviors in nine domains. To assess insomnia, a validated Iranian version of the Insomnia Severity Index was applied. Multivariable logistic regression examined the association between dietary behaviors and insomnia in crude and adjusted models.
Results: Highest adherence to regular meal consumption was related to the lowest odds of insomnia (odds ratio [OR]: 0.44, 95% confidence interval [CI]: 0.24-0.81). Compared with individuals who consumed breakfast never or once a week, those who always consumed breakfast had a lower likelihood of insomnia (OR: 0.56, 95% CI: 0.36-0.88). These associations remained significant in all adjusted models. Subjects who ate spicy food every day had 4.73 times greater odds of insomnia than individuals who never ate spicy food (OR: 4.73, 95% CI: 1.09-20.56). After controlling for age, menstruation, parent death, parents' divorce and parents' (mother and father) employment status, this relationship remained (OR: 4.59, 95% CI: 1.05-20.10); however, the association was no longer significant after controlling for the other covariates. No significant relationship was found between other dietary habits and insomnia for the unadjusted or adjusted models.
Conclusion: Lowest rates of insomnia were found among participants who had the lowest frequency of eating spicy foods and the highest frequency of eating breakfast and eating regular meals. Further prospective studies are required to confirm these findings.

Introduction

Sleep disorders are associated with an increased risk of chronic health conditions, including cardiovascular disease, endocrine disruption, and psychological disturbance.[1,2] Insomnia is a common sleep disorder often associated with poor quality of life and increased risk of somatic and social problems.[3,4] Adolescence is a critical period for an almost 3-fold increase in prevalence of insomnia, particularly among girls.[5] In puberty, cultural transitions, brain maturation, biological, and psychological changes predispose adolescents to sleep problems.[6,7] Along with psychological and physiological disorders, diet and lifestyle are the main determinants for sleep quality and quantity.[8] Findings from 2 epidemiological studies suggest that a higher dietary intake of fish, fruits, and vegetables improves sleep quality, whereas a high dietary intake of carbohydrates is related to poor sleep health.[3,9-11]

Dietary behavior is considered a principal component of nutrition-related lifestyle, which includes the regularity of breakfast, main

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meal, and snack consumption; the quality of food (eg, fried and spicy food); and sufficient chewing.[12] Poor dietary behaviors are associated with an increased risk of obesity, type 2 diabetes, metabolic syndrome, cardiovascular disease, gastrointestinal diseases and mental health problems.[13–15] These noncommunicable diseases are all associated with poor sleep outcomes.[16,17] Although some studies have investigated the association between diet-related practices and overall sleep health, limited data are available about the relationship between dietary behavior profiles and chronic insomnia. Detrimental effects of some unhealthy dietary behavior, including energy-dense food consumption at night and frequent breakfast skipping, on poor sleep outcomes have been reported.[3,13] Additionally, some studies have indicated that poor oral health is associated with sleep problems. A cross-sectional study reported a positive association between gingival inflammation and sleep problems,[18] and a cohort study showed that individuals with fewer than 10 teeth were at a higher risk of sleep disorders than adults with at least 20 teeth.[19]

To the best of our knowledge, no published studies have investigated the relationship between dietary behavior and insomnia in Iranian adolescents. Given the importance of dietary behavior and adverse consequences of poor sleep health, we explored the association between dietary behavior profiles and chronic insomnia in Iranian adolescent girls.

Materials and methods

Study population and design

This cross-sectional study was performed in January 2015 in the cities of Mashhad and Sabzevar, Iran. The population consisted of 988 female students aged 12-18 years recruited using random cluster sampling from schools in these cities. Exclusion criteria included individuals with autoimmune disease, cancer, metabolic bone disease, hepatic or renal failure, cardiovascular disorders, malabsorption or thyroid, parathyroid, adrenal diseases, and anorexia nervosa or bulimia. Additionally, participants were excluded if they took, within the last 6 months, any medication categorized as anti-inflammatory, antidepressant, antidiabetic, or antiobesity; vitamin D or calcium supplements; or hormone therapy.[20] The Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran, approved the study, and all participants and their parents provided written informed consent.

Dietary behavior assessment

To assess dietary behaviors during the past month, we used a dietary behavior questionnaire, with the following questions: How many main meals do you eat per day? (1/ 2/ 3); How many times do you consume snacks throughout a day? (Never/ 1-2/ ≥ 3 times); Do you have consistent meal consumption timing? (Never/ sometimes/ almost/ always); How many days do you eat breakfast during a week? (Never/ 1 day/ 2-4 days/ 5-6 days/ every day); How much do you chew your food? (Low/ moderate/ high); Can you chew any food? (Yes/ only soft food/ no), Do you drink fluids with your meals? (Never/ sometimes/ almost/ always); How many times do you eat fried foods during a week? (Never/ 1-3 in week/ 4-6 in week/ every day); How many times do you eat fried foods during a week? (Never/ 1-3 in week/ 4-6 in week/ every day).[20]

Insomnia assessment

To evaluate insomnia, we used the Insomnia Severity Index (ISI) questionnaire, which has 7 questions with scores ranging between 0 and 4, stratified into 5 categories: 0 (None), 1 (Mild), 2 (Moderate), 3 (Severe), and 4 (Very Severe). The total ISI score ranges from 0 to 28. Insomnia is defined as total ISI score was >7.[21]

Covariate measurements

General information including age, menstruation status, parental death or divorce, and father's and mother's occupation was collected by face-to-face interview using a standard questionnaire. Physical activity was assessed through a validated modifiable activity questionnaire[22] and provided as metabolic equivalents in hours per week. Weight and height were measured using standard protocols, and the mean of 2 measurements was reported. Body mass index (BMI) was calculated as weight (kg) divided by square of the height (m^2). Dietary intake was evaluated during face-to-face interview by a valid and reliable food frequency questionnaire with 147 food items.[23] Reported dietary intakes were converted to grams and entered into the Nutritionist IV software. To calculate daily nutrient intake values for each participant, the US Department of Agriculture's national nutrient databank was used.[24]

Statistical analyses

The normality of data was assessed using the Kolmogorov-Smirnov test. To compare continuous and categorical variables between subjects with vs. without insomnia, independent samples t-test and chi-square tests were used, respectively. *P* values <.05 were used to compare the distribution of quantitative or qualitative variables across categories of dietary habits or insomnia status. Logistic regression was applied to evaluate the relationship between dietary behavior and insomnia prevalence in crude and adjusted models. Adjustments for age, menstruation, parents' death, parents' divorce, and father's and mother's employment status were performed in Model I. Physical activity, BMI and energy intake were additionally adjusted in the Model II. Bonferroni correction was applied to all models to adjust for multiple comparisons. The significance level was assessed in 2 steps: traditional cutoff of *P* values <.05 and Bonferroni correction of *P* value <.006. To analyze the data, the Statistical Package for Social Sciences (SPSS) (version 23.0, SPSS Inc, Chicago, IL) was used.

Results

The general characteristics of the study participants are summarized in Table 1. The prevalence of insomnia was 17%. There were no significant differences for age, BMI percentile, or physical activity between individuals with and without insomnia. The prevalence of menstruation and parental death or divorce were significantly higher in subjects with insomnia.

Dietary intakes are summarized in Table 2. There were no significant differences for dietary intakes between individuals with and without insomnia in the crude or energy-adjusted models. The distribution of insomnia prevalence across categories of dietary behaviors is provided in Table 3. Significant differences were observed for insomnia prevalence across frequency of main meal intake; regular meal consumption (consistent meal consumption timing); and frequencies of breakfast, fried food, and spicy food consumption ($P < .05$; Table 3). However, there was no difference for insomnia prevalence by rate of chewing food, snack consumption, or chewing sufficiency.

For the crude and multivariable-adjusted models, the odds ratios for the association between dietary behavior and insomnia are presented in Table 4. The highest adherence to regular meal consumption was related to lowest odds of insomnia (odds ratio [OR]: 0.44, 95% confidence interval [CI]: 0.24-0.81). This association remained significant after adjustments for potential confounding variables in Model I (OR: 0.47, 95% CI: 0.25-0.87) and Model II (OR: 0.46, 95% CI: 0.22-0.95). Compared with individuals who never consumed

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Table 1
General characteristics of study participants with and without insomnia

Variables		Insomnia		*P* value*
		No (n = 814)	Yes (n = 174)	
Age (y)		14.52 ± 1.52	14.71 ± 1.55	.097
Menstruation (yes) (%)		87.7	92.9	.041
Parents' death (yes) (%)		3.7	4.0	.007
Parents' divorce (yes) (%)		3.7	7.1	.001
Father employment status (employed) (%)		99.1	99	.600
Mother employment status (employed) (%)		5.9	7.1	.461
Body mass index percentile (%)	<25	41.9	42.8	.885
	25-50	28	27	
	50-85	10.5	9	
	≥85	19.7	21.2	
Physical activity (MET.h/week)		45.35 ± 3.57	45.56 ± 3.62	.444

* Obtained from independent samples t-test for continuous variables and chi-squared test for categorical variables.

breakfast or consumed breakfast once a week, those who always consumed breakfast had a lower chance of insomnia (OR: 0.56, 95% CI: 0.36-0.88). This significant relationship was observed in all adjusted models; Model I (OR: 0.57, 95% CI: 0.36-0.89) and Model II (OR: 0.47, 95% CI: 0.27-0.80). Subjects who ate spicy food every day had 4.73 times greater odds for insomnia than the individual who never ate spicy food (OR: 4.73, 95% CI: 1.09-20.56). This significant association was observed only in the first adjusted model (OR: 4.59, 95% CI: 1.05-20.10). In crude and adjusted models, there was no significant relationship with insomnia for other dietary habits, including main meal intake, snack consumption, rate of food chewing, intake of fluid with meal, consumption of fried foods, and chewing sufficiency. After applying the Bonferroni correction, the inverse association between highest adherence to breakfast consumption and odds of insomnia remained significant only in the final adjusted model (*P* value < .005).

Discussion

The aim of the present study was to investigate the association between dietary behaviors and the prevalence of insomnia in adolescent girls. Eating breakfast most days of the week and regular meal consumption were related to the lowest odds of insomnia, while the highest frequency of spicy food intake increased the chance of insomnia. To the best of our knowledge, this is the first study to investigate dietary behaviors and insomnia prevalence.

We found that the highest adherence to regular meal consumption was associated with decreased odds of insomnia. Wehrens et al reported that meal timing alters human molecular clocks and circadian rhythms, which may influence sleep-wake schedules.[25] In addition, previous studies have reported that irregular meal timing can produce a disruption in the circadian system that might lead to

Table 2
Energy and dietary intakes of study participants between subjects with and without insomnia

		Insomnia		*P* value*
		No (n = 578)	Yes (n = 174)	
Energy intake (Kcal)		2693.3 ± 833.8	2733.9 ± 843.2	.577
Carbohydrate (% energy)		54.8 ± 7.34	54.79 ± 7.5	.956
Protein (% energy)		13.7 ± 2.2	13.5 ± 2.2	.344
Fat (% energy)		33.78 ± 7.8	34 ± 2.2	.708
Cholesterol (mg)	Crude	233.3 ± 127.8	251.2 ± 166	.131
	Energy adjusted	235.6 ± 114.8	250.8 ± 151.5	.224
Potassium (mg)	Crude	3717 ± 1362	3754 ± 1403	.763
	Energy adjusted	3740 ± 777	3721 ± 712	.774
Sodium (mg)	Crude	4163 ± 1803	4206 ± 1661	.777
	Energy adjusted	4172 ± 1386	4160 ± 1235	.921
Sucrose (gr)	Crude	22.2 ± 14.2	22.07 ± 14.2	.881
	Energy adjusted	22.9 ± 13.07	22.5 ± 13.01	.683
Vitamin A (mcg)	Crude	587.5 ± 593.5	610.7 ± 415.6	.630
	Energy adjusted	590.4 ± 576.9	605.9 ± 368.5	.738
Vitamin C (mg)	Crude	95.8 ± 63.5	94.5 ± 56.2	.814
	Energy adjusted	191.1 ± 63.5	189.8 ± 56.2	.814
Folic acid (mcg)	Crude	606.5 ± 197.6	600. ± 214.2	.753
	Energy adjusted	656 ± 176.13	638.4 ± 152.7	.200
Calcium (mg)	Crude	1130 ± 488.5	1182 ± 530.6	.256
	Energy adjusted	1137.9 ± 368.7	1172 ± 410.8	.311

* Obtained from independent samples t-test.

Table 3
The distribution of insomnia prevalence across categories of dietary behaviors

Type of dietary habit		Insomnia (%)		*P* value*
		No	Yes	
Main meal intake	1 time	4 (28)	3.2 (7)	.033
	2 times	25.4 (177)	34.4 (75)	
	3 times	70.6 (492)	62.4 (136)	
Snack consumption	Never	5.2 (36)	7.1 (15)	.093
	1-2	58.3 (402)	55.2 (117)	
	3-5	32 (221)	29.2 (62)	
	>5	4.5 (31)	8.5 (18)	
Regular meal consumption	Never	9.7 (68)	12 (26)	.007
	Sometimes	38 (265)	46.1 (100)	
	Almost	30.2 (211)	30 (65)	
	Always	22.1 (154)	23.7 (26)	
Rate of food chewing	Low	11.4 (80)	15.5 (34)	.247
	Moderate	78.5 (552)	74 (162)	
	High	10.1 (71)	10.5 (23)	
Breakfast consumption	Never or 1 day	14.6 (101)	18.7 (40)	.013
	2-4 day	25.8 (179)	29.9 (64)	
	5-6 day	14.9 (103)	19.2 (41)	
	Every day	81.8 (310)	32.2 (69)	
Intake of fluids with meal	Never	5.5 (38)	6.9 (15)	.117
	Sometimes	35.6 (248)	30 (65)	
	Almost	29.7 (207)	26.3 (57)	
	Always	29.3 (204)	36.9 (80)	
Consumption of fried food	Never	3.5 (24)	1.4 (3)	.033
	1-3 in week	67.2 (467)	59.8 (131)	
	4-6 in week	24.6 (171)	33.3 (73)	
	Every day	4.7 (33)	5.5 (12)	
Consumption of spicy food	Never	3.1 (22)	0.9 (2)	.008
	1-3 in week	28.8 (202)	25.3 (55)	
	4-6 in week	39.6 (278)	34.1 (74)	
	Every day	28.5 (200)	39.6 (86)	
Chewing sufficiency	Yes	96.9 (678)	93.6 (204)	.093
	Only soft foods	2.7 (19)	5.5 (12)	
	No	0.4 (3)	0.9 (2)	

* Obtained from chi-squared test.

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Table 4
Multivariable-adjusted odds ratio of the association between dietary behaviors and insomnia

Type of dietary habit	Crude	Model I	Model II
Main meal intake			
1 time	1	1	1
2 times	1.69 (0.71-4.05)	1.72 (0.72-4.14)	3.16 (0.91-11.01)
3 times	1.11 (0.47-2.58)	1.15 (0.49-2.72)	2.23 (0.65-7.63)
P trend	.085*	.128	.578
Snack consumption			
Never	1	1	1
1-2	0.70 (0.37-1.32)	0.69 (0.36-1.32)	0.63 (0.31-1.28)
3-5	0.67 (0.37-1.31)	0.67 (0.34-1.33)	0.62 (0.29-1.32)
>5	1.39 (0.6-3.22)	1.52 (0.64-3.59)	1.39 (0.52-3.74)
P trend	.526	.410	.600
Regular meal consumption			
Never	1	1	1
Sometimes	0.98 (0.60-1.64)	0.1.02 (0.61-1.70)	1.187 (0.66-2.15)
Almost	0.80 (0.47-1.37)	0.83 (0.48-1.43)	0.90 (0.42-1.48)
Always	0.44 (0.24-0.81)	0.47 (0.25-0.87)	0.46 (0.22-0.95)
P trend	.002	.003	.002
Rate of food chewing			
Low	1	1	1
Moderate	0.69 (0.44-1.07)	0.71 (0.45-1.10)	0.63 (0.38-1.05)
High	0.76 (0.41-1.41)	0.78 (0.42-1.45)	0.57 (0.27-1.22)
P trend	.308	.353	.111
Breakfast consumption			
Never or 1 day	1	1	1
2-4 day	0.90 (0.56-1.43)	0.90 (0.56-1.44)	0.91 (0.53-1.58)
5-6 day	1.00 (0.60-1.60)	0.99 (0.59-1.67)	0.90 (0.50-1.64)
Every day	0.56 (0.36-0.88)	0.57 (0.36-0.89)	0.47 (0.27-0.80)
P trend	.005	.007	.001#
Intake of fluids with meal			
Never	1	1	1
Sometimes	0.66 (0.34-1.28)	0.67 (0.35-1.31)	0.53 (0.25-1.16)
Almost	0.70 (0.36-1.35)	0.72 (0.36-1.40)	0.60 (0.28-1.33)
Always	0.99 (0.51-1.9)	1.01 (0.52-1.95)	0.81 (0.38-1.76)
P trend	.154	.147	.293
Consumption of fried foods			
Never	1	1	1
1-3 in week	2.24 (0.66-7.59)	2.12 (0.62-7.24)	1.39 (0.40-4.89)
4-6 in week	3.41 (0.99-11.7)	3.42 (0.99-11.82)	2.40 (0.66-8.61)
Every day	2.91 (0.74-11.45)	2.78 (0.69-11.12)	2.21 (0.51-9.61)
P trend	.011	.007	.009
Consumption of spicy foods			
Never	1	1	1
1-3 in week	2.99 (0.68-13.13)	2.87 (0.65-12.70)	1.58 (0.34-7.33)
4-6 in week	2.93 (0.67-12.73)	2.85 (0.65-12.50)	1.58 (0.34-7.30)
Every day	4.73 (1.09-20.56)	4.59 (1.05-20.10)	2.25 (0.49-1.40)
P trend	.003	.003	.088
Chewing sufficiency			
Yes	1	1	1
Only soft foods	2.10 (1.00-4.39)	2.19 (1.30-4.66)	2.00 (0.815-4.92)
No	2.21 (0.37-13.35)	2.07 (0.34-12.59)	2.38 (0.39-14.95)
P trend	.042	.001	.090

Model I: adjusted for age, menstruation, parent's death, parent's divorce, parent's (mother and father) employment status.
Model II: additionally, adjusted for physical activity, BMI and energy intake.
* *P* for trend based on logistic regression.
\# Significant after Bonferroni correction.

unhealthy consequences such as glucose intolerance and obesity-related factors.[26,27]

In the current study, more than 62% of individuals who consumed only one or 2 main meals per day did not consume breakfast. Skipping breakfast appears to be an unhealthy and frequent dietary behavior observed in many populations, especially young people and adolescents.[14] Breakfast is considered to be the "most important meal of the day,"[28] and a main indicator of a healthy lifestyle.[29] Indeed, skipping breakfast is a growing problem, especially among adolescent girls.[30] Our findings showed the highest frequency of breakfast consumption was associated with the lowest chance of insomnia among adolescent girls. These results are consistent with previous studies that reported an association between the lack of regular breakfast consumption and sleep disorders in adolescents.[14,31] Skipping breakfast is related to lower sleep duration and higher sleep disturbances,[32,33] and adolescents with a greater frequency of breakfast intake have a lower likelihood of insomnia.[14] Arakawa et al[34] reported that skipping breakfast was directly associated with later bedtimes among 3754 high school students. Also, lower stress, anxiety and depression levels were observed among individuals who consumed breakfast on a daily basis.[35]

A greater frequency of spicy food consumption was associated with increased odds of insomnia in our sample. A trial on a group of young healthy men revealed a clear relationship between spicy meals and sleep disturbances.[36] Indeed, the effect of spicy foods on sleep may be mediated through 2 mechanisms. Firstly, isothiocyanates and capsaicin directly induce oxygen consumption through stimulation of heat-producing tissues.[37] Second, capsaicin is concentrated in central and peripheral nervous tissue and causes brain reflexes by direct stimulation of sensory C fibers that relate to poor sleep.[38] There is strong evidence that individuals who have higher intake of spicy foods experience more intense symptoms of functional gastrointestinal disorders (FGIDs),[39,40] an important risk factor for sleep-related disorders.[41,42]

Some important points should be considered in interpreting the results of our study. We cannot determine the direction of the associations revealed in our cross-sectional design. Previous studies have demonstrated that sleep quality and sleep duration may directly modulate hormones involved in appetite and energy balance, and these, in turn, might alter dietary intakes and food choices.[43,44] Ghrelin is one of the strongest appetite hormones, while leptin is commonly considered a major anorexigenic hormone. Several previous reports indicated ghrelin and leptin levels were altered in sleep disturbances.[45-47] Sleep is the most important behavior that aligns the circadian clock with other human behaviors, such as eating. Individuals with poor sleep often tend to follow irregular sleep schedules, which could determine whether they would have regular meal timing during the day or how often they would skip breakfast.[48,49] In a study on adolescents in Taiwan, adequate sleep duration was related to healthy dietary behavior such as eating breakfast every day.[50]

To the best of our knowledge, our study is the first to examine the relationship between adherence to specific dietary behaviors and prevalence of insomnia. It was carried out on a large sample population of adolescent girls, and we considered multiple confounding factors. Nevertheless, some limitations should be considered. First, the cross-sectional nature of the study is a major limitation. Second, the dietary behavior and insomnia data relied on self-reported questionnaires, which may be susceptible to misreporting. The current study was performed only on adolescent girls, limiting generalizability; and we did not account for potential confounding by parental income or food insecurity.

Conclusion

In summary, the lowest rates of insomnia were found among participants who had the lowest frequency of eating spicy foods and the highest frequency of eating breakfast and eating regular meals. We are unable to explore any significant associations between insomnia and other dietary habits, including main meal intake, snack consumption, rate of food chewing, chewing sufficiency, fluid intake with meals and consumption of fried foods. Further studies, particularly of a prospective nature, are required to examine the associations between adherence to specific dietary behaviors and the risk of sleep-related disorders.

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Authors' contributions

The paper was drafted by S.B. with contributions from all authors. S.S.K., A.S.A., and M.G.M. designed the study. M.M. and S.S.K.H. participated in field implementation and sampling. M.G.M. and S.S.K. involved in clinical examination and patient confirmation. S.B., M.M., and I.D. contributed to statistical analyses. M.G.M., S.S.K.H., and I.D. supervised the study. Final linguistic revision was done by I.D. All authors contributed to the development of, read and approved the final version of the manuscript.

Declaration of conflict of interest

The authors have declared no conflicts of interest.

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