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The relationship between dietary patterns and insomnia in young women

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Abstract

Aim: There is mounting evidence that eating habits affect sleeping patterns and their quality. The goal of this study was to evaluate the associations between major dietary patterns, identified using principal component analysis (PCA) and insomnia in young women.

Methods: The study subjects comprised 159 healthy young women aged 18–25 years. Neuropsychological assessment was performed using standard instruments, including a cognitive ability questionnaire (CAQ), depression and anxiety stress scales (DASS-21), insomnia severity index (ISI), Epworth sleepiness scale (ESS), and quality of life questionnaire (QLQ). Dietary patterns were obtained from a 65-item validated food frequency questionnaire (FFQ) in this study, using PCA.

Results: Two major dietary patterns were identified that were termed: "Traditional" and "Western." The Western pattern was characterized by a high intake of snacks, nuts, dairy products, tea, fast foods, chicken, and vegetable oils. Subjects with moderate/severe insomnia were found to have lower scores for total cognitive ability task, nocturnal sleep hours, and physical and mental health, but higher scores for depression, anxiety, stress, and daytime sleepiness compared to those without insomnia ($p < 0.05$). After adjustment for potential confounders, high adherence to the Western dietary pattern was associated with higher odds of insomnia (OR = 5.9; 95% confidence intervals: 1.9–18.7; $p = 0.003$).

Conclusion: Our findings indicated adherence to Western pattern may increase the odds of insomnia. Prospective research is required to determine the feasibility of targeting dietary patterns to decrease the odds of insomnia.

KEYWORDS
depression, insomnia, quality of life, stress, Western dietary

1 | INTRODUCTION

Sleep, described as a mental state of conceptual disengagement with few responses to the environment, is a crucial part of life.[1] Sleep is necessary for functional, psychological, and emotional health.[2] The quality of sleep is necessary for maximum cognitive performance and sleep disturbances, which include having problems falling or staying asleep, having a regular sleep/wake cycle, and sleepiness may affect an individual's ability to function effectively and cause impairment in cognitive and behavioral abilities.[3–5]

It has been reported that sleep disorders may be associated with memory impairment, reduced learning capacity, poor academic function, tiredness, attention deficiency, and depression.[6] Insomnia, described as having trouble falling and maintaining sleep, early awakening, and experiencing no refreshing sleep,[7] is usually linked to adverse consequences in behavioral and occupational areas, including interference in a person's ability to function, exhaustion, overeating, impaired memory, and depression.[8–10] Insomnia, one of the most common sleep-related complications, also affects the quality of life in a high percentage of people globally.[11–13]

It has been suggested that diet is an important determinant of sleep quality and a contributor to insomnia.[14–16] An association between sleep and dietary habits has been found in a cross-sectional survey of 3129 female workers, suggesting that a diet composed of low vegetable and fish consumption, besides high carbohydrate intake and weak eating habits was linked to poor sleep quality.[9] After a six-month dietary intervention in obese men with insomnia, Tan et al. showed that the diet group, which was advised to consume optimized nutrients and 300–500 kcal less energy per day, experienced a prolonged total sleep period, and improved objective sleep efficiency, compared with the control group.[17]

Previous investigations on sleep disorders and dietary intake have explored the effects of dietary styles, such as a "prudent" or "Mediterranean" pattern, on insomnia,[18,19] suggesting that some dietary patterns may affect daily alertness, nocturnal sleep, and have related eating habits with sleep quality.[18,20–22] For instance, adherence to the Mediterranean diet (MD) leads to fewer features of insomnia, such as difficulty initiating sleep in females.[23] It has been shown that a high intake of sweets, sugary drinks, and carbohydrates was correlated with poor sleep quality, but vegetables and oily fish consumption, probably due to the great quantity of docosahexaenoic acid (omega-3) and vitamin D, was correlated with better sleep quality.[15,21,23] Beigrezaei and co-workers investigated the relationship between probable insomnia and dietary habits using a food frequency questionnaire (FFQ) with 147 food items among adolescent girls in Iran and showed that a lower intake of spicy foods and eating breakfast and regular meals, was associated with a reduced risk of insomnia.[24] Since the diet is consumed as a complex combination of nutrients, it is challenging to distinguish between the various effects related to confounding and interactions because of the high association between the intake of particular nutrients and foods.[25] To resolve these difficulties, research on nutritional epidemiology has increasing focused on dietary pattern analysis. Dietary patterns are aggregate assessments of many foods or dietary groups that are believed to have a higher impact on disease risk than any single nutrient.[26]

An important question, which previous studies have not adequately addressed, is whether dietary patterns can influence sleep complications, especially insomnia. Several studies reported that the "traditional Iranian" dietary pattern was highly loaded with legumes, vegetables, fruits, red meat, potato, egg, refined grain, sugar, French fries, and tea.[27–29] Due to the great economic burden, the potential impact of sleep deprivation on psychological health, and the high prevalence of insomnia, we carried out this investigation to explore the relationship between major dietary patterns and insomnia in young women, a group that is significantly more prone to sleep disorders and sleep insufficiency due to multiple contributing factors such as hormonal fluctuations and menopausal transition.[13,30]

2 | MATERIALS AND METHODS

2.1 | Study design

Our study sample comprised 159 female students aged 18–25 y, who were recruited from 5 universities in Birjand province, Iran, between December 2019 and February 2020.[31] Individuals with any severe or persistent systemic disorders or a previous medical record of any psychological conditions that included depression and aggressiveness were excluded. The Ethics Committee of our university approved the study and volunteers gave written informed consent.

2.2 | Dietary intake assessment

A validated semi-quantitative FFQ was used, which contained 65 food items with 5 frequency categories (consumption basis per day, week, month, rarely, and never) for each food item.[32,33] The FFQ is a checklist of the dietary history that allows an estimate of long-term dietary intakes in a simple, cost-effective, and time-saving method. The FFQ was completed by an experienced nutritionist via a face-to-face interview. The dietary nutrient intakes of participants were calculated,[34] and then dietary patterns were determined based on 24 pre-defined food groups (Table 1) conforming to the similarity of FFQ food items.

2.3 | Anthropometric and cardiometabolic variables evaluation

Demographic and anthropometric variables were measured using standard methods.[35] Body mass index (BMI) was computed by dividing weight (kg) by height squared (m^2).[35] Blood specimens were collected after an overnight fast. A full blood count was determined using a SysmexK-800 auto-analyzer.

2.4 | Neuropsychological evaluation

2.4.1 | Insomnia

The Insomnia Severity Index (ISI) is a short self-report instrument that quantitatively quantifies the intensity of insomnia based on the patient's perception. The questionnaire contains 7 questions. Each item is rated on a 0 to 4 point to provide a total score ranging from 0 to 28. Higher scores show more severe insomnia. Scores may be classified as no insomnia (0–7), subthreshold or mild[8–14] insomnia,[15–21] and severe insomnia.[22–28] A higher score indicates more degree of insomnia. The Persian version of this test has been validated previously and is used in clinical research.[36,37]

2.4.2 | Sleepiness

The ESS is a validated approach for measuring the level of daytime sleepiness. The ESS is a brief, self-administered questionnaire, that estimates the probability of falling asleep in numerous situations. It has 8 items with a 4-point Likert scale which wants the subject to evaluate on a scale of 0–3 the chances that he frequently has dozed in common daily situations. The Sum of scores can range from 0 to 24 and higher scores specify deteriorate sleepiness.[37,38]

2.4.3 | Quality of life (QoL)

Health-related quality of life was evaluated by the SF-12. This version used in this study is a shortened version of SF-36 called SF-12, which applies 12 questions from SF-36.[39] The validity of this test has been confirmed by the Iranian people.[40] The questionnaire analyzes 8 aspects of health to determine physical and intellectual health. Higher numbers demonstrate major well-being.[41]

2.4.4 | Depression anxiety stress

The DASS is a 42-item self-evaluation survey used to scale the intensity of psychological states. DASS-21 is a shorter form of evaluating 42-item detail on depression, anxiety, and stress (DASS).[42] This test contains 21 items with 3 subscales with a 4-Likert measure scored 0–3 and the final score of each subscale should be doubled. A higher score represents poorer emotional reactions. The Persian revision of DASS-21 has been validated formerly.[43]

2.4.5 | Cognitive ability assessment

The Cognitive Abilities Questionnaire is a valid instrument that measures cognitive abilities in 7 defined components of memory and cognition and cognitive flexibility.[44] This questionnaire includes 30 items rated on a 5-point Likert measure. Higher scores reflect better cognition abilities.

TABLE 1 Food grouping used in factor analysis of dietary patterns.

Refined grains	**White breads (lavash, baguettes), rice, macaroni, pasta**
Whole grains	Dark breads (Iranian)
Fast foods	Pizza, processed meat
Snacks	Biscuits, cakes and pastries, chocolate, ice cream, chips
Dairy products	Whole milk, low-fat milk, yogurt, breakfast cheese, Dough
Solid fats	Butter, cream, solid oil, tall, salad dressing
Liquid fats	Liquid oil, olive oil
Sugars	Honey, sugar loaf, diabetic sugar, sugar
Fruits	Tree fruit, seasonal fruit, fruit compote, fruit juice, dried fruits
Carbonated beverages	Soft drinks, beer, diet drinks
Teas	Tea
Coffee drinks	Coffee, coffee and milk, Nescafe
Legumes	Beans, soy
Pickled foods	Pickles, salty Cucumber
Green vegetables	The vegetables, lettuce, spinach
Other vegetables	Garlic, onion, tomato, Cucumber, salad (mixed salad of tomato, Cucumber, and onion)
Potatos	Boiled potato, other potatoes, French fries, cutlet, and potato cutlets
Liquid foods	Soup
Eggs	Boiled egg, scrambled eggs
Red Meats	Lamb meat, beef, hunting meat
Organ meats	Heart, liver and kidney, intestine, and viscera
Sea foods	Fish, fish tuna, shrimp
Chicken	Chicken feed
Nuts	Walnut, all types of nuts

2.5 | Statistical analysis

All statistical analyses were undertaken using SPSS, version 16 software. Principal component analysis (PCA) was applied to identify major dietary patterns regarding 24 pre-defined food groups. Varimax rotation was managed to make a simple and final component matrix. We derived 2 factors with Eigenvalues of more than 1 and analysis of a scree plot. So, 2 dietary patterns were distinguished and labeled based on our data explanation and the past reports. For all participants, the factor scores of each identified pattern were accumulated by summing up intakes of foods weighed by their factor loading. Individuals were sub-grouped based on their insomnia status. First, variables were assessed for normality, by recruiting the Kolmogorov–Smirnov test, and normally distributed variables were compared using parametric tests. Continuous and categorical indices are displayed by mean ± SD and number (percent), respectively.

ANOVA test and post hoc Tukey were applied to measure the significant difference in normal variables among groups. Eventually, logistic regression in different models was used for exploring the association between the tertiles of two main dietary patterns with insomnia. All analyses were considered using two-tailed tests, and a *p*-value less than 0.05 was set as significant.

3 | RESULTS

3.1 | Recognition of main dietary patterns

Principal component analysis (PCA) was used to determine dietary patterns within the study population; two major dietary patterns were identified that we labeled as traditional and Western patterns. A traditional dietary pattern was characterized by a high intake of green leafy vegetables, other vegetables, organic meat, potato, solid oils, fruits, beans, refined grains, red meat, eggs, whole grains, and sugars. A Western dietary (WD) pattern is described by a high intake of snacks, nuts, dairy products, tea, fast foods, chicken, and vegetable oils. The factor-loading matrixes for 2 dietary patterns are demonstrated in Table 2.

3.2 | Association between the general characteristics of participants across the insomnia category

Participants were categorized into 3 groups based on their ISI scores (Table 3): participants with no insomnia ($n=91$), subjects with mild insomnia ($n=46$), and cases with moderate/severe insomnia ($n=22$). The age was significantly different across insomnia categories, and participants with moderate/severe insomnia were older compared to those without insomnia ($p=0.047$). However, we found no significant differences between anthropometric parameters, hematological indices, and cardiometabolic factors across these three groups ($p>0.05$).

3.3 | Association between neuropsychological function and insomnia category

We found an association between the results of the neuropsychological functions and insomnia severity as shown in Table 4. Subjects with moderate/severe insomnia had lower scores for memory, inhibitory control, and selective attention, social cognition, cognitive flexibility, total cognitive ability task, nocturnal sleep hours, physical and mental health, but higher degree of depression, anxiety, stress, and daytime sleepiness compared to those without insomnia ($p<0.05$). No significant differences were found in decision-making, planning, and sustained attention across insomnia between the groups ($p>0.05$).

TABLE 2 Food loading matrix for major dietary patterns.

Food group	Dietary patterns: Traditional	Dietary patterns: Western
Other vegetables	0.77	-
Organ's meat	0.66	-
Potato	0.66	-
Green vegetables	0.58	-
Solid oils	0.46	-
Fruits	0.44	-
Legumes	0.37	-
Refined grains	0.34	-
Red meat	0.34	-
Eggs	0.28	-
Whole grains	0.25	-
Sugars	0.21	-
Pickled foods	-	-
Sea foods	-	-
Liquid foods	-	-
Snacks	-	0.82
Nuts	-	0.78
Dairy products	-	0.76
Tea	-	0.51
Fast foods	-	0.41
Chicken	-	0.33
Vegetable oils	-	0.30
Carbonated Beverages	-	-
Coffee drinks	-	-

Values less than 0.20 are not reported.

3.4 | Food group and nutrients intake of study participants across tertiles of major identified dietary patterns

The consumption of food groups and nutrients across tertiles of the 2 dietary patterns are shown in Table 5. Tertile 1 is set as the lowest tertile (lowest adherence), and tertile 3 is the highest tertile (highest adherence). Dietary intake of chicken, total monounsaturated fatty acids (MUFAs), and vitamin A were significantly lower in the third tertile of the traditional pattern versus the first tertile. Moreover, consumption of red meat, organs meat, dairy products, fruits, whole grains, refined grains, vegetable oil, eggs, potato, total fiber, green vegetables, other vegetables, total polyunsaturated fatty acids (PUFAs), and vitamin C was higher in the 3rd tertile of traditional pattern versus the 1st tertile ($p<0.05$). Lower intake of vitamin A was seen in the highest tertile of WD compared with the 1st tertile. However, the intake of dairy products, snacks, nuts, carbonated beverages, sugars, MUFAs, PUFA, and vitamin E was increased in the third tertile of WD versus the first tertile.

TABLE 3 Association between the general characteristics of participants across insomnia category.

Variables	No insomnia ($n=91$)	Mild insomnia ($n=46$)	Moderate/severe insomnia ($n=22$)	p-value*
Age (y)	20.9 ± 1.7	20.5 ± 1.5	21.6 ± 2.1	**0.047**
BMI (Kg/m^2)	21.2 ± 3.1	20.8 ± 2.4	20.7 ± 2.1	0.69
Weight (Kg)	55.6 ± 8.6	54.2 ± 6.8	54.8 ± 7.3	0.65
WHR	0.73 ± 0.05	0.73 ± 0.03	0.73 ± 0.03	0.90
SBP (mmHg)	10.6 ± 0.8	10.8 ± 1.0	10.7 ± 1.3	0.48
DBP (mmHg)	7.1 ± 0.7	7.1 ± 0.8	7.1 ± 0.8	0.98
Hb (g/dl)	13.9 ± 1.5	14.0 ± 1.3	13.6 ± 1.0	0.61
Hct (%)	41.6 ± 4.1	41.9 ± 2.8	40.9 ± 2.5	0.65

Abbreviations: BMI, Body mass index; DBP, diastolic blood pressure; Hb, hemoglobin; Hct, hematocrit; SBP, systolic blood pressure; WHR, waist-to-hip ratio.

Note: Data presented as mean ± SD.

*By using one-way ANOVA test. Significance of bold values are $p < 0.05$.

TABLE 4 Association between neuropsychological function and insomnia category.

Variables	No insomnia ($n=91$)	Mild insomnia ($n=46$)	Moderate/severe insomnia ($n=22$)	p-value*
Test of cognitive abilities				
Memory	25.6 ± 3.5	25.9 ± 3.2	23.7 ± 4.0	**0.039**
Inhibitory control and selective attention	21.9 ± 4.1	22.7 ± 2.7	19.2 ± 4.1	**0.001**
Decision making	18.6 ± 3.8	19.4 ± 3.2	17.8 ± 3.4	0.182
Planning	11.3 ± 2.8	11.4 ± 2.3	9.9 ± 2.8	0.064
Sustain attention	9.6 ± 2.3	9.6 ± 2.6	8.9 ± 2.3	0.42
Social cognition	10.3 ± 2.0	11.3 ± 2.0	11.0 ± 2.5	**0.036**
Cognitive flexibility	14.4 ± 2.7	15.3 ± 2.4	13.5 ± 3.3	**0.035**
Total cognitive ability task	111.7 ± 14.3	115.6 ± 10.5	103.5 ± 14.0	**0.003**
Dass-21				
Depression	10.2 ± 8.2	9.8 ± 8.4	17.6 ± 11.0	**0.001**
Anxiety	7.5 ± 5.4	8.7 ± 5.7	14.3 ± 7.7	**<0.001**
Stress	16.2 ± 9.8	16.4 ± 9.2	24.4 ± 10.0	**0.002**
Quality of life (SF-12)				
Physical health	16.5 ± 2.2	15.9 ± 1.8	13.0 ± 3.1	**<0.001**
Mental health	17.3 ± 3.6	15.9 ± 3.8	14.2 ± 3.3	**0.001**
SF-12 score	33.9 ± 4.7	31.9 ± 4.7	10.7 ± 5.3	**<0.001**
Test of sleep pattern				
Daytime sleepiness score (ESS)	4.0 ± 5.5	8.9 ± 4.6	10.7 ± 53	**<0.001**
Nocturnal sleep hours	7.5 ± 1.2	6.9 ± 1.2	6.4 ± 1.6	**<0.001**

Note: Data presented as mean ± SD.

*By using one-way ANOVA test. Significance of bold values are $p < 0.05$.

3.5 | Multivariate-adjusted odds ratios (95% CIs) for insomnia across tertiles of identified dietary patterns

Linear regression analysis showed a direct association between the consumption of red meat, carbonated beverage, and total PUFAs with scores of insomnias (Table 6). Refined grains, total fat, and vitamin E intake were inversely related to insomnia scores ($\beta = -0.006$, $p = 0.046$; $\beta = -0.047$; $p = 0.029$, and $\beta = -0.053$; $p = 0.047$, respectively).

Odds ratios for insomnia across tertiles of two main dietary patterns are assessed using crude and adjusted models in Table 7. In the first model, regression was adjusted for age, BMI, and WHR. Further adjustments were made for depression, anxiety,

TABLE 5 Dietary intake of study participants by tertiles (T) categories of dietary pattern scores.

Variables	Traditional pattern Tertile 1	Traditional pattern Tertile 3	*p*-value†	Western pattern Tertile 1	Western pattern Tertile 3	*p*-value†
Food groups (g)						
Red meat	29.6 ± 26.1	62.9 ± 26.6	**0.005**	53.3 ± 78.3	41.5 ± 38.3	0.52
Organ's meat	0.06 ± 0.24	2.6 ± 5.6	**<0.001**	0.72 ± 2.43	1.31 ± 4.8	0.66
Dairy product	156.6 ± 109	249.2 ± 137.1	**<0.001**	146.8 ± 82.8	242.6 ± 137.7	**<0.001**
Fast foods	51.7 ± 96.5	90.5 ± 119.9	0.16	51.7 ± 75.3	87.6 ± 130.1	0.20
Fruit	138.5 ± 117.2	316.0 ± 272.3	**<0.001**	170.3 ± 141.6	236.7 ± 169.2	0.22
Chicken	40.4 ± 34.0	21.6 ± 24.0	**0.001**	25.1 ± 23.1	28.9 ± 31.9	0.78
Legumes	19.7 ± 16.2	25.7 ± 30.0	0.38	27.9 ± 24.2	20.7 ± 18.4	0.24
Coffee	301.8 ± 1904	34.6 ± 63.5	0.44	22.5 ± 48.7	357 ± 2017	0.28
Whole grains	15.4 ± 17.0	39.5 ± 47.5	**0.014**	31.5 ± 49.1	36.4 ± 47.1	0.84
Refined grains	157.6 ± 74.8	266.3 ± 248.9	**0.003**	163.9 ± 131	199.4 ± 127	0.55
See foods	16.0 ± 18.9	16.7 ± 26.4	0.98	13.1 ± 9.8	15.5 ± 21.4	0.81
Snacks	58.6 ± 57.5	45.0 ± 34.3	0.30	25.6 ± 13.7	90.7 ± 62.3	**<0.001**
Nuts	17.7 ± 37.6	26.4 ± 33.9	0.38	7.9 ± 12.7	44.6 ± 48.7	**<0.001**
Vegetable's oil	26.0 ± 33.7	47.0 ± 41.6	**0.013**	33.6 ± 38.5	45.1 ± 45.5	0.27
Eggs	10.3 ± 8.5	23.4 ± 19.7	**<0.001**	19.4 ± 17.8	15.0 ± 14.2	0.27
Potato	28.0 ± 16.7	92.4 ± 67.8	**<0.001**	53.7 ± 55.4	63.6 ± 58.2	0.57
Pickled food	55.7 ± 132.8	50.7 ± 87.3	0.96	31.2 ± 51.1	58.6 ± 132.2	0.31
Carbonated beverage	50.1 ± 65.6	77.4 ± 121.8	0.45	47.9 ± 75.7	118.2 ± 174.7	**0.005**
Green vegetables	4.4 ± 4.8	10.0 ± 8.9	**<0.001**	13.4 ± 17.1	9.6 ± 11.9	0.38
Other vegetables	43.7 ± 36.2	221.4 ± 165.5	**<0.001**	104.3 ± 104.1	130.2 ± 144.8	0.54
Sugar	12.4 ± 13.4	18.5 ± 29.5	0.46	7.6 ± 7.2	28.6 ± 40.9	**<0.001**
*Nutrients**						
Protein (g)	61.3 ± 17.3	63.4 ± 24.4	0.87	62.4 ± 24.9	57.6 ± 23.9	0.34
Total carbohydrates (g)	113.7 ± 45.5	128.3 ± 73.9	0.42	103.5 ± 51.2	125.5 ± 66.4	0.14
Total fiber (g)	11.2 ± 4.0	15.9 ± 7.5	**<0.001**	13.6 ± 5.3	12.6 ± 5.4	0.68
Total fat (g)	32.1 ± 21.5	23.4 ± 28.5	0.19	33.8 ± 21.5	30.0 ± 27.4	0.74
Total SFAs (g)	17.7 ± 7.0	16.9 ± 11.5	0.89	18.8 ± 8.8	16.6 ± 9.6	0.47
Total MUFAs (g)	22.4 ± 24.6	13.9 ± 15.9	**0.049**	15.1 ± 8.0	25.2 ± 27.9	**0.013**
Total PUFAs (g)	25.4 ± 22.8	42.4 ± 26.7	**0.002**	29.6 ± 25.1	43.4 ± 28.4	**0.012**
Vitamin C (mg)	84.2 ± 57.0	173.7 ± 153	**<0.001**	114.7 ± 84.8	122.9 ± 16.3	0.98
Vitamin E (mg)	24.5 ± 21.1	40.0 ± 27.1	0.69	29.1 ± 25.3	40.3 ± 23.9	**0.035**
Vitamin A (μg)	103.4 ± 67.2	38.3 ± 34.1	**<0.001**	86.9 ± 60.3	40.9 ± 40.2	**<0.001**

Abbreviations: MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acids.

*All values are mean ± SD and adjusted for energy intake. †By using one-way ANOVA. Significance of bold values are $p < 0.05$.

and stress. In the other model, additional adjustments were made for daytime sleepiness and cognitive abilities. Using an unadjusted model, adhering to the WD pattern was associated with increased odds of insomnia (OR = 2.25, 95% CI 1.01–4.96; *p*-value = 0.003); after controlling for additional potential confounders, the findings remained significant in all 3 adjusted models. No significant relationship was found between adherence to traditional dietary patterns and insomnia in the crude model (OR = 1.4, 95% CI: 0.64–3.05; *p*-value = 0.125); and these relationships did not alter post-adjustment.

4 | DISCUSSION

The association between dietary habits and sleep is an emerging area of study. In this current study, we have explored the relationship between two dietary patterns, defined by PCA, and insomnia status. The results of the current cross-sectional investigation suggested that adherence to a WD style, described by high consumption of snacks, fast foods, chicken, and vegetable oil, was correlated with greater odds of insomnia, even after adjustment for several confounding factors. Insomnia is a common sleep disorder that interrupts an individual's life

TABLE 6 Multivariate linear regression between intake of each component of the dietary Pattern and score of insomnia.

	Insomnia			
	Crude		Adjusted*	
Component of the score	β	p	β	p
Red meat	0.022	**0.007**	0.019	**0.010**
Dairy product	0.057	0.051	0.056	0.053
Fast foods	0.023	0.128	0.024	0.128
Fruit	−0.031	0.182	−0.002	0.71
Chicken	−0.042	0.111	−0.040	0.130
Legumes	0.023	0.256	0.023	0.258
Whole grains	−0.001	0.938	0.0001	0.974
Refined grains	−0.007	**0.009**	−0.006	**0.046**
See foods	−0.036	0.085	−0.036	0.086
Snacks	0.019	0.127	0.020	0.108
Nuts	−0.025	0.158	−0.024	0.181
Eggs	−0.040	0.130	−0.041	0.295
Carbonated beverage	0.029	**0.002**	0.029	**0.002**
Potato	0.003	0.636	0.003	0.640
Protein (g)	0.001	0.978	0.001	0.973
Total carbohydrates (g)	−0.001	0.903	−0.001	0.903
Total fiber (g)	0.066	0.716	0.063	0.726
Total fat (g)	−0.049	**0.023**	−0.047	**0.029**
Total SFAs (g)	−0.166	0.116	−0.162	0.126
Total MUFAs (g)	0.016	0.600	0.016	0.602
Total PUFAs (g)	0.052	**0.048**	0.049	**0.049**
Vitamin C (mg)	−0.010	0.352	−0.013	0.229
Vitamin E (mg)	−0.055	**0.045**	−0.053	**0.047**
Vitamin A (μg)	0.005	0.139	0.005	0.139

*Adjusted for age, BMI and WHR. Significance of bold values are $p < 0.05$.

TABLE 7 Multivariate-adjusted odds ratios (95% CIs) for insomnia across tertiles of dietary pattern scores.

	Crude	Model I	Model II	Model III
Traditional pattern				
T1	1.0	1.0	1.0	1.0
T2	0.75 (0.35–1.61)	0.52 (0.22–1.21)	0.62 (0.24–1.50)	0.51 (0.19–1.33)
T3	1.4 (0.64–3.05)	1.5 (0.63–3.43)	1.7 (0.71–4.33)	1.8 (0.69–4.6)
Western pattern				
T1	1.0	1.0	1.0	1.0
T2	1.05 (0.48–2.27)	1.64 (0.68–3.98)	1.98 (0.78–5.0)	1.2 (0.44–3.59)
T3	2.25 (1.01–4.96)*	4.25 (1.62–11.1)**	6.0 (2.1-17.1)***	5.9 (1.9-18.7)**

Note: Tertile 1 is reference category. Model I: adjusted by age, BMI, and WHR. Model II: additionally, adjusted for depression, anxiety, and stress. Model III: further adjustments for daytime sleepiness and cognitive abilities. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

efficiency by decreasing physical and psychological capacity. Previous investigations showed that individuals distressed by sleep complications are prone to a higher risk of being overweight, blood pressure, having diabetes, and having psychological disorders.[16,45]

Some previous studies have reported remarkable correlations between dietary patterns and insomnia in different populations.[16,17,46] For instance, adherence to an MD-style diet was associated with sufficient sleep duration, fewer sleeplessness symptoms, and a lower possibility of changes in sleep duration.[18,22] Peltzer et al. found that among Indonesian 15 years and older individuals, the risk of insomnia was higher in those who consumed a low quantity of fruit and vegetables but were high in fast foods and soft drinks.[47] This diet may improve sleep quality because of its high content of fruit, vegetables, dried fruit, grains, and fish and low intake of saturated fat and red meat.[48] Similarly, Lana et al., poor sleep quality in non-pregnant women was associated with a high intake of meat-derived protein (red meat or white). Red meat and its by-products may have a negative impact on how well you sleep due to their high protein content. Tyrosine and tryptophan, two amino acids with the ability to synthesize melatonin, serotonin, and dopamine, may be responsible for the protein's effects on sleep quality (sleep–wake cycle).[49] It has been hypothesized that a high protein intake could lower the tryptophan/tyrosine ratio in the blood, which might lead to a decrease in the production of brain sleep-inducing substances and, finally, to a worsening of sleep parameters, which is consistent with our results.[49–51]

Several studies have demonstrated that a WD has a bidirectional relationship with obesity[47,52] and insufficient sleep may lead to an increased risk of being overweight, due to changes in endocrine, behavioral, and neurological systems.[17,46,53] There is accumulating evidence that suggests that obesity is an important predisposing factor for insomnia and although the nature of this connection is not understood, some longitudinal and cross-sectional studies indicated that fat individuals had a greater chance of sleep disorders compared to non-obese ones.[53–56] Singareddy et al. demonstrated that sleep disorders are two times more frequent in fat individuals, compared to non-obese.[56] According to epidemiological research, individuals with short sleep duration (SSD) consume more energy-dense foods with a higher ratio of calories coming from fat or refined carbohydrate than individuals who receive a sufficient amount of sleep.[57,58] Also, in comparison to normal sleepers, Indian individuals with insomnia consumed less protein, carbohydrates, thiamine, folate, vitamin B12, and iron.[59] Furthermore, a study has demonstrated that vitamin E can improve sleep quality.[60] Another study investigated the neuroprotective effect of vitamin E on memory damage induced by chronic sleep deprivation in rats, and the results showed that chronic sleep deprivation reduces antioxidant defense mechanisms, and vitamin E treatment through antioxidant activity in the hippocampus prevents this damage.[61] Insufficient sleep, increased intake of high-energy foods, and beverages such as sugar-sweetened beverages (SSBs) have all been suggested as predisposing factors for the raised outbreak of obesity.[62]

SSBs consumption can cause short sleep duration, due to the effects of sugar and caffeine, and their intake before sleep can influence sleep.[62–64] Caffeine usually prolongs sleep latency, decrees the total sleep period, and worsens sleep quality. Caffeine consumption leads to a reduction in electroencephalographic slow-wave activity while increasing stage-1 wakefulness.[65] Additionally, results from a prospective study demonstrated that higher dietary glycemic index (GI) and added sugars may elevate the risk of insomnia occurrence in postmenopausal females.[66] A possible mechanism that explains how a high-GI diet can elevate insomnia risk is its effects on blood glucose. High blood glucose, occurring after sugar intake, can cause sleepiness.[67] Glycemic load provides insulin demand in healthy persons[68] and hyperinsulinemia can reduce blood sugar to amounts that endanger brain glucose, increasing the production of counter-regulatory proteins like adrenaline and cortisol.[69] Higher-GI diets can also trigger inflammatory and immune reactions that inhibit sleep through increasing anti-inflammatory cytokines secretions.[66,70] Lack of sleep can negatively influence physiological and psychological well-being and affect some behaviors (e.g., food habits). Therefore, health is compromised when an individual has little or insufficient sleep.[71]

Although we observed that subjects with elevated adherence to the WD diet, who consume snacks more frequently, are more prone to insomnia, a recent investigation suggested that there is no meaningful statistical relationship between either Western or Iranian traditional dietary styles or insomnia states. However, they indicate that people with healthy dietary habits are less prone to insomnia.[6] Protein shortage has been linked to reduced sleep duration and the amount and source of dietary protein have been reported to characterize the relation between food intake and sleep disturbances and may be the reason for this discrepancy.

Our results showed that PUFA intake is increased in the WD, and higher PUFA intake may also be associated with elevated risk of insomnia. Magzal et al showed that higher concentrations of acetate, butyrate, and total short-chain fatty acids (SCFAs), were associated with lower sleep efficiency (SE) and longer sleep onset latency (SOL) after controlling for BMI.[72] Previous studies have evaluated the relationship between energy intake and sleep characteristics.[46,73,74] Although the mechanisms linking decreased energy intake and better nocturnal sleep aren't totally clear, it has been shown that a reduction in dietary energy intake can accelerate sleep initiation in fat individuals.[15] An animal study showed that chronic fat consumption can reduce pre-pro-orexin concentrations in the hypothalamus in mice.[75] Orexin is a neuropeptide involved in alertness and adjusting energy balance. We assume that total energy recessive reduction may enhance orexin signaling in the hypothalamus and this can induce stable alertness and shorter daytime sleepiness. Therefore, calorie reduction may enhance the response of orexin neurons.[76,77]

We found insomnia has a positive connection with depression, anxiety, and stress. This result is consistent with Goyal et al.'s findings, indicating that delayed sleep onset is firmly related to depressive symptoms.[78] Previously, an association was shown between insomnia and a higher risk of depression, anxiety, and cognitive impairment.[79–81] A study, carried out among perinatal women, has shown that insomnia symptoms are related to symptoms of depression and anxiety.[82] Riemann and colleagues demonstrated that insomnia was one of the major predisposing factors for depression symptoms over time.[79] The significant time spent awake at night can lead to nocturnal rumination and increase depression and anxiety.[83]

This study demonstrated an association between WD patterns and insomnia status in young women. Our findings indicate that decreasing adherence to the WD pattern can be an efficient way to alleviate sleep disorders. We estimated dietary intake by FFQ and information was collected with a high level of quality control.

To show the correlation of WD style with insomnia, we applied multivariate-adjusted odds ratios using several scores. However, this investigation was subjected to several limitations. Concerning a cross-sectional design cannot confirm causality. In addition, students undergoing insomnia can have changed their dietary patterns. Also, we did not assess the physical activity and exercise habits. Applying self-reported information may lead to recall bias and public desirability bias is a major limitation of the present investigation. However, further investigations on patients who endure insomnia are necessary to confirm our findings.

5 | CONCLUSION

We found a significant positive relationship between adherence to a WD and insomnia in young women. We found an association between a WD characterized by high consumption of snacks, tea, fast foods, and chicken as an unhealthy dietary pattern correlated with a significant increase in insomnia, depression, anxiety, and stress, and a decrease in quality of life. Although future longitudinal studies are necessary to validate current findings.

AUTHOR CONTRIBUTIONS

Afsane Bahrami designed the study and developed data collection tools. Samira Karbasi contributed to developing the study proposal and drafting the manuscript. Zahra Asadi, Zabihullah Mohaghegh, and Farhad Saeedi performed material preparation, data collection, and data analysis. Gordon A. Ferns revised the final version of the manuscript. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

No conflict of interest.

DATA AVAILABILITY STATEMENT

The raw data of the article are available as supplementary Excel data files.

ETHICS STATEMENT

Ethical approval was obtained from the Birjand University of Medical Sciences and informed written consent was completed by all participants (code: IR.BUMS.REC.1398.402).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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