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Sadat, S., Salehi-Sahlabadi, A., Pourmasoumi, M., Feizi, A., Clark, C. C. T., Akkasheh, G. & Ghiasvand, R.

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A Healthy Dietary Pattern May be Associated with Primary Insomnia Among Iranian Adults: A Case-Control Study

Samaneh Sadat [1],Ammar Salehisahlabadi [1], Makan Pourmasoumi [2], Awat Feizi [3], Cain C. T. Clark [4], Goudarz Akkasheh [5], Reza Ghiasvand *[6]

[1] Research Committee and Department of nutrition, School of Nutrition and Food Science, Isfahan University of Medical Sciences, Isfahan, Iran

[2] Gastrointestinal & Liver Diseases Research Center (GLDRC), Guilan University of Medical Sciences, Rasht, Iran.

[3] Department of Biostatistics and Epidemiology, School of Public Health, Isfahan University of Medical Sciences, Isfahan, Iran.

[4] Faculty Research Centre for Sport, Exercise and Life Sciences, Coventry University, Coventry, UK.

[5] Kashan University of Medical Sciences, Kashan, Iran.

[6] Department of Community Nutrition, School of Nutrition and Food Science, Isfahan University of Medical Sciences, Isfahan, Iran.

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***Correspondence to:**

Dr. Reza Ghiasvand, Ph.D.

Associate Professor of Nutrition

Department of Community Nutrition

School of Nutrition and Food Sciences

Isfahan University of Medical Sciences (http://mui.ac.ir)

Isfahan, Iran.

ORCID address: http://orcid.org/0000-0002-2203-8670

PO Box: 8174673461

Tel: +98-311-7923153

Fax: +98-311-6682509

Email: ghiasvand@hlth.mui.ac.ir

Abstract

Objective: While it has been reported that both foods and nutrients for individuals are connected with sleep, there is no evidence regarding the association of dietary patterns, identified by factor analysis, with primary insomnia. The present study sought to evaluate the association between major dietary patterns and the chance of having primary insomnia.

Methods: The present case-control study was performed using 444 people (111 cases and 333 control), aged 18 to 60 years, referred to Isfahan health centers. Dietary intake was assessed via a food frequency questionnaire in a case-control study in Isfahan, Iran. Principal component analysis was used to determine major dietary patterns. The presence of primary insomnia was measured via the insomnia severity index questionnaire, and the subjects were grouped as healthy or insomniac.

Results: Three major dietary patterns were recognized, and named; Western, Iranian Traditional and Healthy, respectively. The cumulative percentage of variance explained by three dietary patterns was 48.2%. Those in second (OR=0.30; 95%CI: 0.2-0.46) and third (OR=0.22; 95%CI: 0.15-0.35) tertiles of healthy dietary pattern were less likely suffer with insomnia. This association remained significant only in the highest tertile after adjusting potential confounders (OR=0.45; 95%CI: 0.32-0.95). We found no significant association between greater adherence to Western or Iranian traditional dietary patterns and primary insomnia.

Conclusions: The findings showed that although no statistically significant association was observed between both Western and Iranian traditional dietary patterns with primary insomnia, people with greater adherence to the healthy dietary pattern are less likely to have primary insomnia.

Key words: Primary Insomnia, Dietary Pattern, Sleep Disorder, Nutrition, Factor Analysis.

1. Introduction

Impairment in the quantity and/or quality of sleep [1] may be defined as insomnia, which includes difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), or early morning awakening (EMA), despite having sufficient opportunity for sleep with diminished daytime functioning [2]. Insomnia is purportedly the most prevalent sleep complaint, with substantial, deleterious, long-term consequences to health, affecting approximately 30% of the general population [3, 4]. The International Classification of Diseases, 10th Revision (ICD-10-CM F51.01), has a clear definition for primary insomnia - a sleep disorder that does not occur in the context of another sleep disorder and, etiologically, it is not linked to a mental disorder, substance use, or a general medical condition. Based on the definition used, its prevalence globally is around 10 to 50 percent, most of which are women, infants, and the elderly [5]. Whilst in Iran, the prevalence of insomnia is estimated to be 59.2% among the general population [6].

It has been empirically demonstrated that sleep disorders lead to memory weakness, decreased learning capacity, educational function, increased time of response, tiredness and attention defect, reduced quality of life, rise in health cost, as well as chronic diseases, such as depression, hypertension [7], diabetes, coronary heart disease [8]. Furthermore, previous studies have revealed that sleep restriction causes excess weight-gain and leads to obesity [9]. Recently, the role of diet as an etiologic factor of insomnia disorders has received great attention [10, 11]. Nonetheless, it should be noted that most previous studies have assessed the effect of individual foods, such as fermented milk [12], cherries beverage [13], kiwifruits [14] or single nutrients like magnesium [15], vitamin D [8], B-group vitamins [16-18], protein, fat, carbohydrate [19] on various aspects of sleep. Such studies, however, are unable to distinguish the individual effects of highly correlated foods, nor are they able to account for synergistic interactions of food combinations, as well as their components. A rationale for this is that people do not eat isolated nutrients, but consume meals comprising of a variety of foods with complex combinations of micro- and macronutrients. Indeed, in contemporary literature, dietary patterns are used to elucidate the mutual impacts of multiple dietary constituents, create substitute dimensions to ascertain diet–disease relationships, concomitant to representing a valuable asset in guiding dietary modification to lessen disease risk [20, 21]. Currently, only a few studies have assessed the association between dietary patterns and sleep parameters among different population [22-25]; however, there is a dearth of evidence regarding dietary patterns and primary insomnia, thus, the aim of the present study was to assess the relationship between dietary patterns and the risk of primary insomnia among adults.

2. Methods

2.1. Study Design and Participants

The present case-control study was performed using 444 people (111 patients as case and 333 individuals as control), aged 18 to 60 years, referred to Isfahan health centers between July 2016 and August 2017. The cases were recruited among patients with moderate or severe primary insomnia as diagnosed by a neurologist, based on the Insomnia Severity Index (ISI) questionnaire. The control participants were selected among individuals without clinically significant insomnia, whose age, sex and socio-economic status matched those in insomnia group. The exclusion criteria were as follows: participants with acute heart failure, chronic kidney disease, restless leg syndrome, severe joint diseases (based on self-reported history of disease), severe depression, stress, severe mental illness (screened by GHQ28 questionnaire), apnea and sleep-related respiratory disorders (screened by Stop questionnaire), any recent stressful events such as divorce, death or a serious illness of a family member, consuming alcohol, intake of stimulants, supplement intake for more than three days a week, shift work, pregnancy and breast feeding. Participants were also excluded if did not respond to more than 35 food items in the food frequency questionnaire, or caloric intake was outside the range of 800 to 4200 kcal (**Figure 1)**. All eligible individuals signed an informed consent form prior to participation. Furthermore, this study was conducted in accordance with the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the ethics committee of Isfahan University of medical sciences (Ethical approve number: IR.MUI.REC.1395, 3.411). Written informed consent was obtained from all subjects/patients prior to study commencement.

2.2. Assessment of Primary Insomnia

The presence of primary insomnia was measured by a brief, reliable, validated self-reporting questionnaire, the insomnia severity index (ISI) [26]. The content of questionnaire corresponds closely to ICD-10-CM F51.01 and DSM-IV criteria for insomnia, and clearly evaluates the subject's current understanding of symptom severity (DIS, DMS, EMA), sleep related satisfaction, and daytime impairment by 7 questions with a 5-point Likert scale (0–4) with the total score of 28. The score of 0-7 represents no clinically significant insomnia, 8-14 sub threshold insomnia, 15-21 clinical insomnia of moderate severity and 22-28 indicates severe clinical insomnia [26]. According to Smith and Trinder [27], who suggest a cut-off score of 14 to distinguish subjects with insomnia from normal controls, we stratified case and controls groups.

2.3. Assessment of Dietary Intake

Habitual dietary intake was assessed by a semi-quantitative valid and reliable food frequency questionnaire (FFQ), containing 168 food items [28], and recorded during face-to-face interviews. The subjects were asked about the frequency of consuming each portion size of items in the questionnaire during the preceding year (the year before the interview) as daily, weekly, monthly or annually. Each participant's intake was reported based on grams per day using standard household measures [29]. Finally, Nutritionist IV software, modified for Iranian foods, was utilized to determine the energy, macronutrients and micronutrients of the actual food intake (g/day).

2.4. Evaluation of Anthropometric Indicators

Weight, with minimum clothing, was measured and recorded to the nearest 100-grams. Height of participants was measured, in a standing position and unshod, to the nearest 0.1 mm. Body mass index was calculated by dividing the weight (kg) by the height in meters squared (square meter). Waist circumference was measured in the narrowest area between the last rib and the iliac crest, and the hip circumference was assessed around the largest part of the hip, with a precision of 0.1 centimeters.

2.5. Demographic Data Evaluation

Demographic characteristics (age, sex, and marital status), smoking, alcohol consumption, history of disease and drug use, as well as the socioeconomic status (SES) were all collected through a general self-reported questionnaire. SES was calculated as a total score of some binary variables including educational level of both the person and his family head (academic/non-academic), their occupational situation (yes/no), household size (lower than 4/higher than 4), owning a car (yes/no), possessing home (owner/tenant), foreign journeys (yes/no).

2.6. Evaluation of Other Variables

Since severe depression and apnea can lead to secondary insomnia, the participants were screened using the General Health Questionnaire (GHQ28) and Stop questionnaires. GHQ28 includes four sub-scales for measuring physical complaints, anxiety and insomnia, social dysfunction and severe depression. Each sub-scale contains 7 questions with 4 replies with the cut-off point of 6 for each sub scale and a general cut point of 24. Based on this questionnaire, whose validity and reliability have been confirmed in various studies [30], those who scored more than 6 for the subscale of depression were excluded from the study. The Stop questionnaire, approved for screening the risk of obstructive sleep apnea (OSA), consists of 4 questions with two answers: yes or no, which are scored as 0 and 1. The cut-off point for this questionnaire was considered: 2, and those who scored equal to or greater than 2 were considered to be at high

risk for OSA [31] and were excluded from the study. The amount of daily physical activity, expressed as metabolic equivalent for task (MET)-min/week, was assessed by completing a reliable short form of international physical activity questionnaire (IPAQ), whose reliability and validity have been previously confirmed [32].

2.7. Statistical Analysis of Data

To analyze dietary pattern, we classified 168 food items into 35 pre-defined food groups based on food similarity (**Table 1**). Then, we used factor analysis with a principal component approach (PCA), to identify major dietary patterns. The number of factors (dietary patterns) for final analysis were determined via Eigenvalues > 1 and the Scree plot. To interpret the obtained factors, they were rotated by Varimax rotation, then interpreted based on loading food groups and our understanding from previous studies. We calculated the factor scores of each pattern by total, receiving of food groups weighted by factor loading. Then, a factor score was assigned to each participant for each recognized pattern. The sample size sufficiency and the ability to implement the factor analysis method were performed using KMO and Bartlett tests. Next, we conducted a confirmatory factor analysis (CFA) to assess how well the factors extracted from EFA fit to the observed data. We used four fit indices (chi-square/df [relative chi-square], root mean square error of approximation [RMSEA], comparative fit index [CFI], and Tucker-Lewis index [TLI]) to evaluate the goodness of fit model. Relative chi-square 0.90, and a RMSEA value of <0.08 were considered as acceptable model fit [33, 34]. An independent T-test was utilized for comparison of quantitative variables between cases and controls. All participants were classified according to the tertile of dietary pattern scores. The means of quantitative variables were compared among the tertile of each dietary pattern using one-way analysis of variance (ANOVA). The comparison of qualitative variables among tertile was performed using chi-square test. The average of adjusted dietary intakes for age, sex and energy were compared across tertiles of dietary patterns using a general linear model. Multivariate Logistic regression was used to investigate the association between the identified dietary patterns with primary insomnia. Odds ratio (OR) and 95% confidence interval for OR (95%CI for OR) were calculated in crude and adjusted models. Age, sex, marital status and education were adjusted in model 1; BMI, smoking, physical activity and SES adjustments were also used in model 2, GHQ score adjustment was added in model 3, and model 4 was further adjusted for energy, shown in table 6. The normality of continuous data was evaluated using the Kolmogorov-Smirnov test. All continuous variables were presented as mean ± SD, and qualitative variables as frequency (percent). SPSS software version 16 (IBM, Chicago, IL) was utilized for data analysis. In this study, statistical significance was accepted, a priori, at $p < 0.05$.

3. Results:

Table 2 shows the characteristics of study participants; where the mean age of participants was 31.7±9.9 years, of which 78.6% were women. Demographic and anthropometric comparison between healthy (control) and insomniac (case) groups revealed that the mean of BMI, waist circumference (WC), GHQ score, ISI score, DIS, DMS and EMA were significantly higher in cases than those in controls ($p<0.05$).

The comparison of participants' general characteristics across tertiles of three dietary patterns is shown in **Table 3**. Participants with greater adherence to a healthy dietary pattern had lower weight, BMI, WC, and were more educated. In addition, they were less likely to be insomniac. Across the tertiles of the Western dietary pattern, those in highest tertile compared with lowest tertile were younger, with lower WHR and SES, and most were single. Within various intakes of the Iranian traditional dietary pattern, those with higher intake also had higher weight, BMI, WC, and SES than the those with lower intake.

Figure 2 compares the intake of energy and some macro and micro nutrients known to be involved in insomnia. While there is greater adherence to a healthy dietary pattern, there is greater intake of potassium, as well as less intake of caffeine. Across the levels of adherence to the Western pattern, the intake of carbohydrate, calcium, potassium, magnesium, vitamin D and energy were significantly lower among those in the highest tertile. The intake of such nutrients, in addition to caffeine, is higher with greater adherence to the Iranian traditional pattern.

In the current study, based on factor analysis, three major dietary patterns were identified, and termed; Healthy, Western, and the Iranian Traditional, respectively. In the healthy dietary pattern, fish, skinless poultry, yogurt drink, fruits (fresh, canned, dried), fruit juice, vegetables, legumes, nuts, olive, garlic, condiments and pickles accounted for the highest loading factors. The Western dietary pattern was highly loaded by processed meats, organ meats, poultry with skin, high fat diary, soft drink, fast food, salty snacks, desserts, hydrogenated fats, mayonnaise, salt and tomato sauce. The Iranian traditional dietary pattern was rich in red meats, poultry (with skin and skinless), eggs, dairy (low and high fat), tea, coffee, fruits, vegetables, grain (whole and refined), vegetable oils, potatoes, pickles and tomato sauce. (**Table 4** shows the factor loading matrix for these dietary patterns). These factors explained 48.2% of the total variance. The obtained dietary patterns (factors), following exploratory factor analysis, were confirmed by conducting a confirmatory factor analysis; values of goodness of fit indices were within predefined acceptable limits (Chi-square/df = 2.6, RMSEA = 0.056; CFI = 0.974; TLI = 0.968), and all items were loaded significantly on their respective factors.

Crude and multiple adjusted odds ratio (95% confidence interval for OR) for the association of primary insomnia with the tertiles of dietary patterns are provided in table 6. The lowest tertile of all dietary patterns in adjusted models was considered as reference. Then, the odds ratio of association between various levels of dietary patterns and the risk of primary insomnia was calculated. Those in the middle (OR=0.30; 95%CI: 0.2-0.46) and highest (OR=0.22; 95%CI: 0.15-0.35) tertiles of the Healthy dietary pattern were less likely to be insomniac. However, after being adjusted for confounders, this association remained only remained significant I the highest tertile (OR=0.45; 95%CI: 0.32-0.95). In conclusion, we found no significant association between greater adherence to Western and Iranian traditional dietary patterns and primary insomnia (**Table 5).**

4. Discussion:

The current study found that people with greater adherence to a Healthy dietary pattern, including fish, skinless poultry, yogurt drink, fruits (fresh, canned, dried), fruit juice, vegetables, legumes, nuts, olive, garlic, condiments and pickles, are less likely to have primary insomnia. However, no statistically significant association was found between Western or Iranian traditional dietary patterns and primary insomnia. To the author's knowledge, this is the first study to assess the relationship between dietary pattern and primary insomnia. In recent years, only a few studies have assessed dietary patterns with different aspects of sleep, such as sleep quality [35], but not in association with primary insomnia.

In congruence with our findings, some previous findings suggest an inverse association exists between higher intake of several healthy foods and lower risk of insomnia. Jaussent et al. [36] indicated that greater adherence to the Mediterranean diet, which is similar to the Healthy dietary pattern observed in this study, leads to fewer insomnia symptoms (DIS, DMS, EMA) in women. One study in Chinese adults revealed that high intake of meat, poultry, fish, eggs, fresh fruit, dairy products and wheat is associated with a decreased prevalence of DIS, DMS and EMA [23, 37]. Furthermore, Cao et al. (2013) showed that a prudent dietary pattern, which is to some extent, the same as our Healthy pattern, i.e. rich in vegetable, fruits and legumes, was closely related to a reduced sleep onset latency (SOL) [24].

Most previous studies have suggested a strong relationship between both vegetable and fruit intake, respectively, and sleep quality and quantity, respectively [22]. It can be hypothesized that the mechanism with which fruits and vegetables beneficially impact sleep may be attributable to their anti-oxidative and anti-inflammatory properties. It has been documented that oxidative stress may be related to disordered sleep, and healthy foods, such as fruits and vegetables, can reduce such stress through an increase in the serotonin, melatonin, and phytonutrient profile [22-25,

36]. Another putative mechanism may be related to fish consumption and its poly unsaturated fatty acids. High content of vitamin D as well as omega-3 fatty acids in fish oil are important for the regulation of serotonin, and subsequently sleep, which might conceivably lead to improvement in sleep quality via enhancing serotonin levels [38].

The present study does not indicate any significant association between the primary insomnia and the Western dietary pattern (defined by high intake of protein, saturated fat, salt and high glycemic index carbohydrate sources) or the Iranian traditional dietary pattern (characterized by rich in dairy products, caffeine, fruits and vegetables and sources of both complex and simple carbohydrate, protein and fat). Findings from previous studies are equivocal regarding the association between such nutrients and foods included in such dietary patterns on sleep quality or quantity. A cross-sectional analysis of non–shift workers [19] described that low protein intake (<16% of total energy) accompanied poor sleep quality, and was slightly related to DIS, whereas, high protein intake (>19% of total energy) was associated with DMS. Having utilized a controlled-feeding crossover study design, Lindseth et al. [39] suggested that the consumption of the high-protein diet decreased the number of wake episodes compared to the control diet. Furthermore, a placebo-controlled trial of 49 insomniac subjects showed a 5.5% increase in total sleep time with increased protein-sourced Tryptophan (Trp) consumption [40]. Protein deficiencies have also been linked to shorter sleep time [11], where, in addition to the amount of dietary protein, the source of protein plays a determinative role in relationship between diet and sleep disorders, and may conceivably be the reason for these discrepancies.

Carbohydrates are a major component in both Iranian and Western dietary patterns, and numerous studies have investigated the association between carbohydrate and sleep. Indeed, Tan X et al. [41] reported that overweight individuals with sleep disorders, including insomnia, had lower carbohydrate intake compared to healthy counterparts. In addition, the effects of Glycemic Index (GI) on sleep architecture of men has been investigated; where SOL was significantly lower, and subjective ratings of sleepiness were significantly higher, after a high-GI meal consumed 4 hours before bed time [42]. Mechanistically, it has been suggested that the effect of higher intake of carbohydrate is manifest via higher blood concentrations of Tryptophan (Trp), which is a precursor of serotonin, and subsequently melatonin, has been linked to sleep promotion [42]. Trp enters the brain in a competitive manner with branched-chain amino acids (BCAAs); after a high carbohydrate (HC) meal, especially one with a high-GI, the enhanced insulin facilitates the uptake of BCAAs by the muscles. Therefore, Trp's entry into the brain is favored, and both melatonin and serotonin production - sleep onset promoters - are upregulated [43]. Nevertheless, HC intakes, particularly in the

case of simple sugars, may adversely affect subsequent sleep quality [44]. Moreover, according to Katagiriet al. [45], it is possible that high-GI carbohydrates improve sleep quantity, but negatively impact its quality.

Another component of the Western dietary pattern is saturated fat; indeed, high intake of saturated fat is connected to a reduction in overall sleep quality and lower deep sleep profile at night [46, 47]. According to Tan X et al. [41] insomniac overweight individuals have a higher fat intake than healthy peers. In addition to saturated fatty acid, it is claimed that salt is independently associated with DMS [48]. Furthermore, caffeine is another food substance that can negatively influence on sleep. It is known to be a competitive antagonist to adenosine, a hormone that regulates sleep/wake cycles, and can alter sleep patterns, including prolonged initiation of sleep, shorter total sleep duration, sleep inefficiency, worsened sleep quality, and REM sleep behavior disorder for many hours after intake [49].

The inverse effects of discussed nutrients on different aspects of sleep, as mentioned above, could neutralize each other. In addition, the complex nature of these patterns may also explain a lack of clear association between both Western and Iranian traditional dietary patterns and risk of primary insomnia. Consistent with our findings, Yingting Cao et al. [24] did not find any association between a Western dietary pattern (high intake of processed meat, snacks, and red meat and take away foods) and a mixed diet (food in Western dietary pattern in addition to vegetables, fruits and legumes) with any sleep outcomes. Moreover, no association between sleep quality and a processed meat, cheese and pasta pattern was observed among pregnant women [25].

Notwithstanding, although some common elements exist, dietary patterns differ among populations and the differences in relation to sleep parameters should be taken into account. The strengths of this study include; the use of validated dietary questionnaire to collect the information on food intake, detailed information related to potential confounding factors, and additionally adjusting for them, considering both sexes, and focusing on individuals with a specific sleep disorder. The limitations are, firstly, the fact that the case-control study design does not permit casual inference to be made; hence, a possibility of the reciprocal influence of primary insomnia on dietary patterns cannot be excluded. Secondly, using the semi-quantitative FFQ increases the risk of recall bias. Thirdly, the measurement of sleep problems was self-reported on a subjective scale, in which misreports may affect the results. Finally, although we did not include participants with chronic conditions, and adjusted for a series of covariates, the possibility of residual confounding and unknown confounders cannot be excluded. Future studies should include a larger sample size, objective measurements, such as polysomnography or multiple actigraphy, and investigate the causality of the

relationship between dietary patterns and primary insomnia. In addition, studies should test whether the timing of the intake of specific foods is important in modulating sleep at night.

5. Conclusion:

In conclusion, the present study suggests that adherence to a Healthy dietary pattern is associated with lower risk of primary insomnia. However, no statistically significant association was found between Western or Iranian traditional dietary patterns and primary insomnia. Both sleep and diet are vital for the general and mental health of a person; accordingly, the results of this study have provided more detailed insight into the relationship between sleep and dietary patterns. Although these findings suggest a promising association, which may provide a new approach to the management of sleep problems, due to the nature of observational studies, it cannot be generalized to the wider population, nor establish causality. Therefore, the authors recommend that further prospective studies be undertaken to confirm the veracity of these findings.

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Conflict of interest

Authors declared no personal or financial conflicts of interest.

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Table 1: Food groups defined in the factor analysis

Food groups	Food items
Processed meats	Sausage, deli meat, hotdog
Red meats	Lamp, beef, ground meat
Organ meats	Heart, liver , kidney, head, tongue and leg of lamb or beef, lamb tripe
Fish	Fish, canned tuna fish
Skinless poultry	Chicken without skin
Poultry- skin	Chicken with skin
Eggs	Eggs
Low fat dairy	Skim milk, low fat milk, , cheese, yogurt, kashk*
High fat diary	High fat milk, whole chocolate and cocoa milk, high fat yogurt, creamy yogurt, creamy cheese, other full fat cheese, cream, chocolate and vanilla ice cream
Yogurt drink	Dough**
Soft drink	Soft drink
Tea	Tea
Coffee	Coffee
Fruits	Cantaloupe ,melon, watermelon, pear, apricot, cherry, apple, peach ,nectarine plum, fig, grapes, kiwi, grapefruit, orange ,persimmon, tangerine, pomegranate ,date, black cherry, strawberry, banana, sweet lemon, lime, cranberry, pineapple, , mulberry
Natural juices	Grapefruit juice, orange juice, apple juice, melon juice
Canned fruits	Canned fruits, canned pineapple
Dried fruits	Dried fig , dried peach ,dried apricot ,dried mulberry, raisin
Vegetables	Lettuce, tomato, cucumber, fresh basil, mixed vegetables, squash, eggplant, celery, green peas, green beans, carrot, onion, cabbage, spinach, bell pepper, mushroom, turnip
Nuts	Seeds (pumpkin, sunflower, watermelon), walnuts, pistachios, hazelnuts, almonds, peanuts
Legumes	Lentils, kidney beans, chickpeas, broad beans, soy beans, mung beans, split peas
Whole grains	Iranian dark bread (barbari, sangak, taftoon), cooked barley, oat
Refined grains	White breads (lavash), french bread, white rice, spaghetti, vermicelli, noodles, wheat flour, biscuits
Fast foods	Fried potato, hamburger, pizza
Mayonnaise	Mayonnaise

Tomato sauce	tomato sauce
Salty snacks	Crackers, cheese puffs, potato chips
Olive	Green olive, olive oil
Sugar-sweets-desserts	Muffins, other cakes, sugar, white granulated sugar, honey, jam, iranian sweet (gaz, sohan, halva), hard candy, chocolates, caramel flan, donuts
Hydrogenated fats	Butter, margarine, hydrogenated fats, animal fats
Vegetables oils	Vegetable oils
Potato	Boiled potato
Garlic	Garlic
Condiments	Pepper, lime juice
Salt	Salt
Pickles	Cucumber pickles, mixed vegetables pickles

[*] A type of drained yogurt, [**] A yogurt-based beverage

Table 2: Characteristics of study participants overall and based on ISI score.

		Total	Controls (healthy)	Cases (insomniac)	P-Value
Age (year)		31.77±9.99	30.70±9.45	32.00±10.87	0.28
Weight (kg)		66.72±12.36	66.07±12.40	68.65±12.10	0.057
BMI (kg/m^2)		24.66±3.55	24.43±3.49	25.49±3.90	0.008
Waist-circumference (cm)		85.34±10.36	84.54±10.28	87.74±10.26	0.005
Hip-circumference (cm)		102.54±9.61	102.65±9.68	102.22±9.40	0.69
Physical Activity (MET-min/wk)		1276.49±1507.00	1306.67±1536.47	1185.40±1417.16	0.465
ISI score		9.99±5.76	7.44±3.91	17.65±2.95	<0.001
SES		7.79±1.64	7.79±1.68	7.80±1.54	0.923
GHQ		16.63±7.17	15.15±6.50	20.95±7.43	<0.001
Sex (n %)	male	95(21.4%)	68(20.4%)	27(24.3%)	0.385
	female	349(78.6%)	265(79.6%)	84(75.7%)	
status Marital	Married	247 (55.6%)	177(53.2%)	70(63.1%)	0.078
	widow	34 (7.7%)	30(9.0%)	4(3.6%)	
	Single	163 (36.7%)	126(37.8%)	37(33.3%)	
Education	Secondary school	54 (12.2 %)	34(10.2%)	70(63.1%)	0.106
	Diploma	152 (34.2%)	119(35.7%)	4(3.6%)	
	BSc	181 (40.8%)	134(40.2%)	37(33.3%)	
	Higher than BSc	57 (12.8%)	46(13.8%)	11(9.9%)	
DIS	At all or Mild	280(63.1%)	260(78.7%)	20(18%)	<0.001
	Moderate	92(20.7%)	59(17.9%)	33(29.7%)	
	Severe or Very Severe	69(15.5%)	11(3.3%)	58(52.2%)	
DMS	At all or Mild	281(63.3%)	257(78.1%)	24(21.6%)	<0.001
	Moderate	111(25%)	67(20.4%)	44(39.6%)	
	Severe or Very Severe	47(10.6%)	4(1.26)	43(38.7%)	
EMA	At all or Mild	277(62.4%)	244(74.9%)	33(30.5%)	<0.001
	Moderate	111(25%)	71(21.8%)	40(37%)	
	Severe or Very Severe	46(10.4%)	11(3.4%)	35(32.4%)	

Obtained from independent t-test or Chi-square test for quantitative and qualitative variables, respectively
Quantitative variables: mean ± standard deviation (SD)
Qualitative variables: number (present)
P values<0.05 were considered significant.
Controls: subjects with ISI score<14, Cases: subjects with ISI score>14
BMI: body mass index, ISI: insomnia severity index, SES: socioeconomic status, GHQ: general health questionnaire, DIS: difficulty initiating sleep, DMS: difficulty maintaining sleep, EMA: early morning awakening

Table 3: The comparison of anthropometric and demographic characteristics of study participants by tertile categories of dietary pattern score.

Variable		Western dietary pattern				Traditional dietary pattern				Healthy dietary pattern			
		T1	T2	T3	P-value	T1	T2	T3	P-value	T1	T2	T3	P-value
Age(year)		34.94±11.33	32.47±9.65	27.66±7.5	<0.001	32.64±10.52	31.27±9.97	31.14±9.70	0.401	31.62±10.51	32.21±10.21	31.21±9.50	0.716
Weight(kg)		66.77±12.97	65.77±13.74	67.15±10.55	0.646	63.35±8.91	65.48±11.05	70.84±15.40	<0.001	69.40±11.14	65.83±13.14	64.48±12.61	,0.003
BMI(kg/m^2)		25.02±3.76	24.42±3.67	24.54±3.21	0.338	24.21±3.10	24.59±3.46	25.16±4.01	0.081	25.29±3.60	24.57±3.38	24.12±3.61	0.023
Waist-circumference(cm)		86.00±11.59	85.07±10.46	84.86±9.19	0.635	83.33±8.81	84.28±11.28	88.30±10.47	<0.001	87.81±10.11	85.63±9.82	85.31±10.44	<0.001
Hip-circumference(cm)		102.45±7.88	100.37±9.35	105.34±10.87	<0.001	103.31±9.36	102.63±9.40	102.24±10.19	0.655	101±9.20	104±10.01	103.15±9.52	0.030
Physical activity(MET-min/wk)		1089±1441	1581±1616	1172±1500	0.018	1903±2000	908±1029	1038±1206	<0.001	1138±1391	1231±1617	1471±1570	0.184
SES		8.36±1.64	7.58±1.45	7.56±1.71	<0.001	7.50±1.62	7.97±1.76	8.02±1.49	0.015	7.82±1.68	7.68±1.70	7.99±1.54	0.317
GHQ		17.44±7.44	15.26±6.01	17.17±7.76	0.27	15.95±7.33	17.80±7.16	16.11±6.92	0.064	17.11±7.40	16.27±7.01	16.50±7.11	0.613
Sex	Male	20(14.8%)	24(17.6%)	41(30.1%)	0.004	14(10.4%)	27(19.9%)	44(32.4%)	<0.001	49(36.3%)	22(16.2%)	14(10.3%)	<0.001
	Female	115(85.2%)	112(82.4%)	95(69.9%)		121(89.6%)	109(80.1%)	92(67.6%)		86(63.7%)	114(83.8%)	122(89.7%)	
Marital status	Married	91(67.4%)	82(60.3%)	57(41.9%)	<0.001	87(64.4%)	70(51.5%)	73(53.7%)	0.233	75(55.6%)	72(52.9%)	83(61.0%)	0.257
	Widow or separated	11(8.1%)	9(6.6%)	10(7.4%)		9(6.7%)	10(7.4%)	11(8.1%)		6(4.4%)	14(10.3%)	10(7.4%)	
	Single	33(24.4%)	45(33.1%)	69(50.7%)		39(28.9%)	56(41.2%)	52(38.2%0		54(40%0	50(36.8%)	43(31.6%)	
Education	Lower than diploma	13(9.6%)	23(16.9%)	9(6.6%)	<0.001	17(12.6%)	16(11.8%)	12(8.8%)	0.427	18(13.3%)	18(13.2%)	9(6.6%)	<0.001
	diploma	37(27.4%)	58(42.6%)	44(32.4%)		44(32.6%)	45(33.1%)	50(36.8%)		63(46.7%)	37(27.2%)	39(28.7%)	
	bachelor	60(44.4%)	44(32.4%)	66(48.5%)		61(45.2%)	51(37.5%)	58(42.6%)		43(31.9%)	61(44.9%)	66(48.5%)	
	higher than bachelor	25(18.5%)	11(8.1%)	17(12.5%)		13(9.6%)	24(17.6%)	16(11.8%)		11(8.1%)	20(14.7%)	22(16.2%)	
Insomnia	Yes	36(26.7%)	32(23.5%)	33(24.3%)	0.823	27(20.0%)	37(27.2%)	37(27.2%)	0.285	44(32.6%)	25(18.4%)	32(23.5%)	0.023
	No	99(73.3%)	104(76.5%)	103(75.5%)		108(80.0%)	99(72.8%)	99(72.8%)		91(67.4%)	111(81.6%)	104(76.5%)	

Calculated by Chi-square and ANOVA for qualitative and quantitative variables, respectively. P values<0.05 were considered significant.
Controls: subjects with ISI score<14, Cases: subjects with ISI score>14
Quantitative variables: mean ± standard deviation (SD); Qualitative variables: number (present).
BMI: body mass index, ISI: insomnia severity index, SES: socioeconomic status, GHQ: general health questionnaire

Table 4. Factor-loading matrix of main food groups contributed in the major dietary patterns

	Dietary Pattern		
Food groups	Western	Traditional	Healthy
Processed meats	0.67	—	—
Red meats	—	0.43	—
Organ meats	0.42	—	—
Fish	—	—	0.38
Skinless poultry	—	0.30	0.25
Poultry- skin	0.24	0.24	—
Eggs	—	0.47	—
Low fat dairy	—	0.28	—
High fat diary	0.27	0.36	—
Yogurt drink	—	—	0.33
Soft drink	0.63	—	—
Tea	—	0.28	—
Coffee	—	0.38	—
Fruits	—	0.43	0.36
Natural juices	—	—	0.43
Canned fruits	—	—	0.43
Dried fruits	—	—	0.57
Vegetables	—	0.53	0.4
Legumes	—	—	0.23
Nuts	—	—	0.38
Whole grains	—	0.23	—
Refined grains	—	0.38	—
Fast foods	0.65	—	—
Salty snacks	0.39	—	—
Olive	—	—	0.44
Sugar-sweets-desserts	0.56	—	—
Hydrogenated fats	0.34	—	—
Mayonnaise	0.48	—	
Vegetables oils	—	0.22	—
Potato	—	0.44	—
Garlic	—	—	0.35
Condiments	—	—	0.35
Salt	0.50	—	—
Pickles	—	0.29	0.31
Tomato sauce	0.33	0.36	—

Cumulative percentage of variance explained by three dietary patterns was 48.2%

factor loadings <0.20 were exclude

Table 5: Crude and multivariable-adjusted odds ratios and their 95% confidence interval of the associations between primary insomnia and tertiles of dietary patterns scores

	Western dietary pattern				**Traditional dietary pattern**				**Healthy dietary pattern**			
	1	**2**	**3**	**P-trend**	**1**	**2**	**3**	**P-trend**	**1**	2	3	P-trend
Crude model	1	0.96(0.55-1.67)	1.14(0.65-1.96)	0.82	1	1.49(0.85-2.63)	1.49(0.85-2.63)	0.28	1	0.30(0.2-0.46)	0.22(0.15-0.35)	<0.001
Model1	1	0.81(0.45-1.47)	0.93(0.51-1.70)	0.77	1	1.25(0.72-2.19)	1.36(0.77-2.38)	0.54	1	0.71(0.4-1.25)	0.48(0.27-0.86)	0.049
Model2	1	0.85(0.47-1.54)	0.96(0.52-1.79)	0.84	1	1.28(0.7-2.35)	1.35(0.74-2.45)	0.59	1	0.74(0.42-1.31)	0.49(0.27-0.89)	0.063
Model3	1	1.04(0.54-1.98)	1.09(0.56-2.13)	0.97	1	1.7(0.87-3.33)	1.34(0.69-2.62)	0.30	1	0.74(0.4-1.39)	0.49(0.26-0.94)	0.097
Model4	1	1.11(0.42-2.51)	1.28(0.6-2.86)	0.85	1	1.72(0.75-3.83)	1.41(0.68-2.71)	0.68	1	0.80(0.5-1.68)	0.45(0.32-0.95)	0.218

Model 1: adjusted for sex, age, marital status, education
Model 2: adjusted for model 1 + SES, BMI, smoking and physical activity
Model 3: adjusted for model 2 + GHQ score
Model 4: adjusted for model 3 + energy

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