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Relations of Dietary patterns and sleep disorders in shift workers

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Abstract

Background & aims

Few studies have been done on the association of dietary intakes with SDs among shift workers, in particular those exposed to air pollution. We aimed to investigate the association of major dietary patterns with risk of SDs in shift workers of a cement factory in Iran.

Methods

This cross-sectional study was carried out on 257 male shift workers in a cement factory in Iran. Usual dietary intake of participants was assessed using a validated self-administrated 147-item dish-based FFQ. To examine sleep disturbances of participants, we used the Epworth Sleepiness Scale (ESS).

Results

Three major dietary patterns including Classic Iranian (CI), Modern Iranian (MI), and High Protein Low Fruit and vegetables (HPLF) were identified. The CI pattern was mainly consisted of high-protein animal foods, fruit and vegetables, while, the MI pattern had high amounts of refined grains, solid oils, and caffeine drinks. No significant association was found between adherence to the CI pattern and risk of SDs (OR: 2.33; 95% CI: 0.69, 7.81) and also for the MI dietary pattern (OR: 0.62; 95% CI: 0.20, 1.93). However, we found a significant direct association between the HPLF dietary pattern and risk of SDs (OR: 3.92; 95% CI: 1.03, 14.86).

Conclusion

This study showed a significant direct association between a dietary pattern high in animal proteins and solid oils and low in fruit and vegetables with risk of sleep disorders among shift workers in the cement factory. However, no such association was found for the two other dietary patterns.

Introduction

Sleep Disorders (SDs) are common among shift workers (1). Shift working disturbs normal sleep in these subjects (2). Disturbances in circadian rhythm might cause metabolic disorders such as hypertension, dyslipidemia, hyperglycemia, and abdominal obesity (3). Cement factory shift workers are frequently suffered from SDs, which are intensified by air pollution in such environment (4). SDs cause various health problems in these subjects and will reduce their ability to work (5).

Unhealthy dietary intakes are among the most important risk factors of SDs (6, 7). High intake of fruit and vegetables has been associated to the lowered risk of SDs (8, 9). In contrast, a significant direct association has been found between high intake of red meat and processed foods, as well as fried foods with risk of SDs (10). In addition, some studies have shown that SDs were less common among those with frequent caffeine intake (11). However, some other studies showed significant increase in SDs following high intake of caffeine (12). Shift workers are susceptible to SDs because of their working programs (1). In addition, air pollution is one of the factors causing SDs in cement factory workers (4). Shift working also alters the dietary intake of workers, which might result in several mental disorders (13). Adherence to a healthy dietary pattern, characterized by high intakes of vegetables, mushrooms, potatoes, seaweeds, soy products, and eggs, once or more a week in a study among Japanese workers, was associated with a decreased prevalence of difficulty in sleep (14). In another study in Japanese workers, low intake of vegetables and fish, high intake of sweets and noodles and unhealthy eating habits were independently associated with poor sleep quality. Poor sleep quality was also associated with high carbohydrate intake in that study (15).

Few studies have been done on the association of dietary intakes with SDs among workers, in particular shift workers. In addition, this association might be influenced by the environment of the workplace. Moreover, studies on the association of dietary pattern with sleep disorders are commonly done among western populations, we all know that dietary patterns are greatly different between populations. Therefore, we aimed to investigate the association of major dietary patterns with risk of SDs in shift workers of a cement factory in Iran.

Methods

Study design and participants

This cross-sectional study was carried out on 257 male workers in one of the biggest cement factories in Iran. Participants had at least a 6-month experience and were 20–60 years old. All workers examined were shift workers with shift periods of three weeks. The first two weeks they work on alternate days from 3 pm to 7 am, and the last week their work schedule is daily from 7 am to 3 pm. Shift workers who had a body mass index of less than 40 kg /m^2, without kidney, liver, cardiovascular, and thyroid diseases or diabetes or cancer, did not take any supplements, vitamins or minerals in the past month or omega-3 supplements in the last three months, were included. Subjects who smoked or those who were on a specific dietary pattern, were not included in the current study. Full explanations about the purposes and methods of the study were given to the participants and then their written consent was obtained.

Assessment of dietary intake

Dietary intake of participants was assessed using a 147-item, semi-quantitative Food Frequency Questionnaire (FFQ). The reliability and validity of this questionnaire has been confirmed previously (16). Participants were asked to report the frequency of consumption of each food item per day, week, month, and year. These amounts were then converted to grams per day using household measurements. Finally, participants’ energy, macro- and micro-nutrients intake were calculated using the Nutritionist 4 software, modified for Iranian foods.

Assessment of sleep quality

Sleep quality was estimated with Epworth Sleepiness Scale (ESS), which has 8 questions (17). The subjects were asked to rate, on a 4-point scale (0–3), their probability of falling asleep while engaged in eight different activities. The ESS score was calculated by adding the scores for the eight questions. ESS scores were divided into two groups, zero to 10 as the desirable and 11–24 as the undesirable situation (18).

Assessment of other variables

Participants' physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) (19), and converted to metabolic equivalents (MET) in terms of min/week (MET-min/week) based on references. The validity of Persian version of the questionnaire had been approved previously (20). The participants' weight was measured using Seca digital scale (755, Germany) to the nearest 100 gram with the subjects wearing light clothing without shoes. Participants' height was also measured by a stadiometer while the subject's shoulders were in normal position to the nearest 1 cm. BMI was calculated by dividing the weight (kg) to height squared (m^2). Eventually, participants' waist circumference was measured in the middle of last rib and iliac crest to the nearest 1 cm.

Statistical analysis

Factor analysis was used to identify major dietary patterns. First, due to the large number of food items, we assigned each food item into 22 predefined food groups based on the similarity in their nutrient contents (Table 1). Principal component analysis was done with the factors rotated by orthogonal transformation. The natural interpretation of the factors in conjunction with eigenvalues ($\geq$ 1.3) and Scree plot determined whether a factor should be retained. Identified dietary patterns were labelled on the basis of our interpretation of data and on prior literature. The factor score for each pattern was calculated by summing intakes of food groups weighted by their factor loadings, and each participant received a factor score for each identified pattern. Participants were then categorized based on tertiles of dietary pattern scores. To determine the association of dietary patterns with sleep quality, we used multivariate logistic regression. The first tertile of dietary pattern scores was considered as the reference in each model. Regression analysis was controlled for participants' age, BMI, marital status, education, physical activity, and total energy intake in different models. All statistical analyses were done using the Statistical Package for Social Sciences software (SPSS Inc, version 16).

Table 1
Food grouping used in the dietary pattern analysis

Food group	Food items
Whole grains	Barley, corn
Refined grains	Vermicelli, spaghetti and pasta, boiled potato, cooked rice, breads, Baguettes
Egg	Egg
Legumes & nuts	Lentils, beans (white, red, pinto), chickpeas, soybeans, mung beans, split peas, peanuts, almonds, walnuts, pistachios, nuts, seeds
Red meat & by products	All kinds of red meats, heart, liver, kidney, tripe and rennet, tongue, brain, head sheep meat, leg sheep meat
Poultry	Chicken
Fish	Fish
Fast foods	Hamburger, pizza, sausage
Dairies	Low-fat milk, yogurt, cheese, dough, High fat milk, chocolate milk, whole yogurt, High fat yogurt, cream cheese, cream, ice cream, curd
Solid oil	Butter, margarine, hydrogenated fats, animal fats
Liquid oil	A variety of cooking oils, mayonnaise, olive oil
Olive	All kinds of pickle and salinity, red sauce, green olives
Yellow vegetables	Squash, carrots
Circus vegetables	all kinds of raw cabbages
Green vegetables	Lettuce, spinach, vegetables, stewed vegetables, beans, bell peppers, green peas, green beans, celery, green pepper
Other vegetables	Cucumbers, squash stew, eggplant, garlic, onions, turnips, mushrooms, tomatoes
Fruits	Cantaloupe melon, Honeydew melon, Water melon, pears, apricot, apple, peach, nectarine, greengage, fig (fresh and dried), grapes, kiwi, grapefruit, orange, persimmon, tangerine, date, Plum (red and yellow), mulberry, banana, Lemon(sweet and sour), sweet cherries, sour cherries, pomegranate, straw berry, juice, dried fruit

Food group	Food items
Dessert	Biscuit, cracker, cake, all kinds of dried sweets, all kinds of cream sweets, halva, hard candy, all kinds of chocolate, gaz, sohan, honey, sugar, jam
Snack	Fried potato, corn snack, potato chips
Spices	All kind of spice
Caffeine drinks	Tea and coffee
Industrial drinks	Soft drinks, Canned fruits, canned juice

Results

Overall, dietary intakes of 257 participants were available for final analyses. General characteristics and sleep scores of participants has been summarized in Table 2. Mean age and BMI of participants were 37 ± 2.88 years and 26.30 ± 2.81 kg/m^2, respectively. Dietary intakes of study participants are shown in Table 3. We found three major dietary patterns that named those as Classic Iranian (CI), Modern Iranian (MI), and High Protein Low Fruit and vegetables (HPLF). Main dietary components of these three patterns are shown in Table 4. The CI pattern was mainly consisted of high-protein animal foods, fruit and vegetables, while, subjects in the MI pattern consumed high amounts of refined grains, solid oils, and caffeine drinks. Moreover, HPLF dietary pattern was consisted of high amounts of animal proteins and solid oils as well as low amounts of fruit and vegetables.

Table 2
General characteristics of included participants

Age (y)	37 ± 2.88
BMI (kg/m^2)	26.30 ± 2.81
Sleep score	6.50 ± 3.07
Energy intake (Kcal/day)	3701.38 ± 2040.39
Physical activity (Mets/week)	2811.58 ± 4114.16
Married (%)	100
Educated (%)	60.5
Central obesity (%)	19.8
Supplements user (%)	2.3

Table 3
Dietary intakes of study participants

Food group	Mean	SD
Whole grains	12.85	24.64
Refined grains	957.66	1436.05
Egg	25.62	22.40
Legumes & nuts	108.17	100.25
Red meat & by products	30.41	32.48
Poultry	39.09	42.76
Fish	15.55	26.38
Fast foods	7.58	22.72
Dairies	541.74	468.40
Solid oil	18.52	18.84
Liquid oil	10.87	10.72
Olive	1.04	1.80
Yellow vegetables	22.89	22.06
Circus vegetables	9.05	14.23
Green vegetables	108.07	90.44
Other vegetables	216.29	209.91
Fruits	629.33	929.71
Dessert	48.91	58.08
Snack	8.68	16.07
Spices	3.64	3.39
Caffeine drinks	953.48	1294.87
Industrial drinks	83.28	146.61

Table 4
Factor loadings of food groups in major dietary patterns

Food group	Major dietary patterns		
	Classic Iranian	High protein low fruit and vegetables	Modern Iranian
Whole grains	.34	.67	− .35
Refined grains	.41	.33	.71
Egg	.61	− .43	.08
Legumes & nuts	.62	.19	− .22
Red meat & by products	.57	.16	− .05
Poultry	.19	.46	− .32
Fish	.48	.50	− .16
Fast foods	.78	− .35	− .04
Dairies	.67	− .14	.34
Solid oil	.44	.33	.40
Liquid oil	.57	− .24	.13
Olive	.32	− .34	.05
Yellow vegetables	.59	− .10	− .38
Circus vegetables	.72	− .34	− .17
Green vegetables	.79	.20	− .39
Other vegetables	.84	− .42	− .02
Fruits	.68	.02	− .24
Dessert	.18	.34	.08
Snack	.20	.14	− .16
Spices	.45	− .01	.46
Caffeine drinks	.29	.26	.82
Industrial drinks	.29	.55	.06

Multivariate-adjusted odds ratios and 95% CIs for sleep disturbance in relation to three major dietary patterns has been shown in Table 5. Before adjusting for the confounders, no significant association was found between adherence to the CI pattern and risk of SDs [Odds Ratio (OR): 1.53; 95% Confidence Interval (CI): 0.54, 4.35]. This finding remained unchanged after controlling for age and BMI in model 1

(OR: 1.60; 95% CI: 0.54, 4.76). It also did not change after additional controlling for marital status, education, and physical activity in model 2 (OR: 1.78; 95% CI: 0.57, 5.60), and further adjustment for energy intake in model 3 (OR: 2.33; 95% CI: 0.69, 7.81). There was also no significant association between adherence to the MI pattern and risk of SDs in the crude model (OR: 0.57; 95% CI: 0.20, 1.62), and in the full-adjusted model (OR: 0.62; 95% CI: 0.20, 1.93). Although no significant association was found between adherence to the HPLF dietary pattern and odds of SDs before adjustment (OR: 1.75; 95% CI: 0.62, 4.99) and in the model 1 (OR: 1.84; 95% CI: 0.63, 5.36) and model 2 (OR: 1.82; 95% CI: 0.61, 5.46), our analyses showed a significant direct association through the full-adjusted model (OR: 3.92; 95% CI: 1.03, 14.86).

Table 5
Multivariate-adjusted odds ratios and 95% CIs for sleep disturbance in relation to major dietary patterns

	Tertiles of Classic Iranian pattern			
	T_1 (n = 85)	T_2 (n = 87)	T_3 (n = 85)	P[a]
Crude	1	3.27 (1.13, 9.51)	1.53 (0.54, 4.35)	0.83
Model 1	1	3.31 (1.12, 9.81)	1.60 (0.54, 4.76)	0.41
Model 2	1	3.11 (1.02, 9.54)	1.78 (0.57, 5.60)	0.33
Model 3	1	3.11 (1.00, 9.68)	2.33 (0.69, 7.81)	0.15
	Tertiles of High protein low fruit and vegetables pattern			
	T_1 (n = 85)	T_2 (n = 87)	T_3 (n = 85)	P[a]
Crude	1	2.83 (0.98, 8.12)	1.75 (0.62, 4.99)	0.30
Model 1	1	2.96 (1.01, 8.65)	1.84 (0.63, 5.36)	0.27
Model 2	1	2.65 (0.89, 7.92)	1.82 (0.61, 5.46)	0.30
Model 3	1	3.08(1.01, 9.40)	3.92 (1.03, 14.86)	0.03
	Tertiles of Modern Iranian pattern			
	T_1 (n = 85)	T_2 (n = 87)	T_3 (n = 85)	P[a]
Crude	1	1.06 (0.38, 2.97)	0.57 (0.20, 1.62)	0.30
Model 1	1	1.12 (0.39, 3.20)	0.54 (0.19, 1.54)	0.25
Model 2	1	0.91 (0.30, 2.75)	0.50 (0.17, 1.50)	0.22
Model 3	1	0.97 (0.32, 2.93)	0.62 (0.20, 1.93)	0.42

Model 1: adjusted for age and BMI

Model 2: additionally, adjusted for marital status, education, and physical activity

Model 3: additional adjustment for energy intake

[a] The P for trend across increasing quintiles of adherence to dietary patterns was calculated using multivariable logistic regression by considering the categories as ordinal variables

Discussion

A significant association was found between adherence to the HPLF dietary pattern and the risk of SDs among shift workers of the cement factory. However, we failed to find such associations for CI or MI dietary patterns.

This study is the first investigation about the “Relations of Dietary patterns and sleep disorders in shift workers” association of dietary patterns with risk of sleep disorders among shift workers in Iran. In a recent cross-sectional study among female university students, four major dietary patterns including mixed, high protein, western, and healthy were identified. Significant association was found only for the mixed dietary pattern in relation to the increased sleep quality (21). It seems that subjects on the mixed dietary pattern received sufficient amounts of different micro- and macronutrients. Another study among schoolchildren found a significant inverse association between “dairy, bread, green leaves, maize/potatoes and sausages” dietary pattern and sleep duration (22). Low intake of fruit and vegetables and high levels of refined carbohydrates were common among participants in that pattern. Other studies also have shown that a higher diet quality is linked to a reduced risk of sleep disorders (23, 24). Overall, it seems that consumption of high-quality diets, rich in fruits and vegetables, is linked to a reduced risk of SDs, while, adherence to a dietary patterns with high amounts of saturated fatty acids and animal food items and low amounts of fruit and vegetables is linked to an elevated risk of SDs (25–27).

The exact mechanisms through which dietary intakes is associated with sleep quality are unknown. Consumption of a high-carbohydrate and low-protein diet has been associated to the best quality of sleep. Tryptophan, a precursor of serotonin (28), enters the brain in a competitive manner with large-chain neutral amino acids (LCNAAs) (29). Dietary carbohydrates, unlike proteins, increase brain tryptophan concentrations in the circulation (30). Tryptophan enters the brain and up-regulates serotonin production (31), which then promotes sleeping (32). In contrast, diets high in solid oils and saturated fatty acids and low in fibers may produce more nighttime arousals, and reduce overall sleep quality (21). Diets high in fats commonly have low amounts of carbohydrates. In addition, fat intake stimulates postprandial release of cholecystokinin, a satiety hormone released by the duodenum (33). Injection of cholecystokinin into rats has resulted in sleep promotion (34). Moreover, cholecystokinin was reported to be positively correlated with fatigue (35). Furthermore, meal time is another important factor that influences on the association of dietary intakes with sleep quality (21). Nocturnal eating, in particular consumption of a high-fat diet, is associated to the reduced overall quality of sleep (36). Therefore, night shift workers are susceptible to sleep disorders caused by nocturnal eating which becomes more serious by consumption of a high-fat and low fruit and vegetables diet.

This is the first study on the association of dietary patterns with sleep quality among shift workers. Adjustment for a list of probable confounding factors is a strength of the current study. However, limitations of the study also should be taken into account. This study had a cross-sectional design, therefore, it is impossible to confer the causality. In addition, a limited number of study participants had dietary data. A validated FFQ was used to assess dietary intakes of participants, however, misclassification of participants by using this assessment should not be neglected. Finally, sleep quality was measured by using a questionnaire in our study. Hence, self-reported information might be over- or under-estimated depending on the subject’s memory.

In conclusion, current study showed a significant direct association between a dietary pattern high in animal proteins and solid oils and low in fruit and vegetables with risk of sleep disorders among shift workers in a cement factory. However, we failed to find such an association for two other dietary patterns. Further studies with large sample sizes are required to shed light in this issue.

Declarations

Ethics approval and consent to participate: This research has been approved by the Research Ethics Committee of Tehran University of Medical Sciences and Health Services, Tehran, Iran. Full explanations about the purposes and methods of the study were given to the participants and then their written consent was obtained.

Consent for publication: The authors would like to advise that all authors listed have contributed to the work and approved the content of the submitted manuscript. All authors have agreed to submit the manuscript to the “annals of general psychiatry”.

Availability of data and material: All data generated or analysed during this study are included in this published article [Relations of Dietary patterns and sleep disorders in shift workers].

Competing interests: There is no conflict of interest in this study to declare.

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Authors' contributions: Gity Sotoudeh conceived and developed the idea for the paper and revised the manuscript; Reihaneh Khorasaniha contributed to data collection and wrote numerous drafts; Alireza Milajerdi and Farahnaz Khajehnasiri contributed to data analysis and interpretation of the data.

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