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Original Article

Does Interaction between Sleep Quality and Major Dietary Patterns Predicts Depression among Overweight and Obese Women in Iran?

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Abstract

Background: Although major dietary patterns and sleep quality independently affect psychiatric disorders, their interactive association on depression is not clear. This study assesses the independent association of dietary patterns and sleep quality on depression, and also investigates their interactive associations on depression among overweight and obese women in Iran

Methods: Cross-sectional study was conducted among 304 participants, age 18 and above in 2018 at Tehran Iran. Usual dietary intake was collected with 174-FFQ. Participants' biochemical parameters and depression were measured using standard protocol. Major dietary patterns were extracted by factor analysis and grouped into Fruits&Vegetable group (healthy dietary pattern), High Fat diary&Red Meat group (unhealthy dietary pattern) and Crackers&High Energy Drinks group (western dietary patterns).

Results: After adjusting for confounders poor sleep was associated with moderate and high depression; AOR (95%CI): 0.41(0.19-0.90) and 0.29(0.13-0.60) respectively. However, healthy dietary patterns (tertiles 2nd and 3rd) interact with sleep for depression; AOR (95%CI): 4.168(1.166-14.992) and 2.966(1.068-8.234) respectively. Unhealthy dietary pattern tertiles 2nd and 3rd interact with sleep for depression; AOR (95%CI): 2.925(1.055-8.113) and 4.216(1.182-15.042) respectively and Western dietary pattern tertile 3rd interacts with sleep for depression; AOR (95%CI): 4.264(1.494-12.169).

Conclusion: Sleep deprivation could be associated with depression. However, sleep quality could interacts with dietary patterns to be associate with depression among overweight and obese people.

Keywords: Overweight; Obesity; Dietary patterns; Sleep quality; Depression; Women; Iran

Introduction

Stress, Anxiety and Depression are major psychiatric disorders affecting many people throughout the world. Approximately 300 million individuals (4.4% of the world's population) suffer depressive disorders globally (1). In Eastern Mediterranean Region, over 50 million suffer anxiety and depression of which 4.9 and 4.6 percent of Iran's population is affected respectively (1). Sleep quality and major dietary patterns affect depression (2, 3). Fatigue, and mood change, which are associated with depression are often experienced during day following poor night sleep (4). Although sleep quality and major dietary patterns significantly predict depression, converging lines of evidences showed that these factors also predict overweight and obesity (5). The mechanisms through which major dietary patterns and sleep quality predict overweight and obesity are complex. At the molecular level, several hormones particularly leptin and ghrelin, which control hunger and satiety are largely involved (6). Ghrelin stimulates appetite for food while leptin suppresses it and stimulate energy utilization. Sleep quality controls the release of leptin and ghrelin (7), therefore, sleep deprivation can influence the misalignment of these hormone and cause eating disorders which consequently cause overweight and obesity.

Complex association exist between dietary patterns and sleep quality for depression (8). It is reported that people with poor sleep quality are more likely to consume high energy-dense foods, fewer vegetables servings, and have irregular eating patterns (8) which could increase the risk of overweight and obesity. In Japanese female study, women who reported poor sleep quality, intake high sweet and noodles, whereas those who reported good sleep, intake fish and high vegetables (9). For associations of overweight and obesity on depression, several studies showed significant relationships (10-12). Although sleep quality, dietary patterns, and overweight & obesity can act in tandem to predict depression, several studies only looked at the direct association of these variables on depression prevalence.

However, complex relations exist between sleep quality and major dietary patterns to predict depression. In this regard we hypothesized that interaction between sleep quality and major dietary patterns could significantly affect depression. To investigate this hypothesis, we sort to assess the association of sleep quality and major dietary pattern on depression, and also assess how sleep quality and major dietary pattern could interact to influence depression prevalence among overweight and obese women in Tehran Iran

Materials and Methods

Cross-sectional study was conducted among 304 overweight and obese women, aged 18 and above in 2018 at Tehran Iran. Blood samples and anthropometric measurements were collected from participants in the Biochemical Laboratory at the School of Nutritional Sciences and Dietetics, Tehran University of medical sciences, Tehran, Iran. Our study participants were healthy with body mass index (BMI) between 25 and 49 kg/m^2. The study protocol was approved by the Ethical Review board of Tehran University of Medical Sciences (IR.TUMS.VCR.REC.1395.1597). Each participant was requested to sign a written informed consent form before participating. Participants who have history of hypertension, cardiovascular disease, diabetes mellitus, smoking, pregnancy/lactation, and any chronic disease that may affect normal dietary intake were excluded

Assessment of Dietary Intake

Dietary intakes were measured using validated semi-quantitative 174-Food Frequency Questionnaires (174-FFQ). Participants were asked to report the frequency of the various food they intake over one-year period. They were asked to report portion size as well as cooking methods and type of oil they often used in cooking. Data obtained were processed using Nutri IV software.

Measurement of body composition

Body-weight, Fat-Mass, Fat-Free-Mass, Percentage Body Fat (%) and visceral fat mass were measured using multi-frequency bioelectrical impedance; InBody 770 scanner (Inbody Co., Seoul, Korea). This body-analyzer took approximately 20 seconds to measure resistance of electrical signals passing through participants' body. Participants' were asked to remove shoes, and heavy clothing according to the manufacturer's instructions, and stood on the scale with pair of feet and hands holding the machines for measurement to be taken. Electric currents were then made to flow through the feet and hands of the participants to different parts of the body in order to measure the amount and proportion of fat, and fat-free mass of participants' bodies.

Biochemical parameters

Venous blood samples were collected by phlebotomist between 8 am and 10 am after 10-12 h fasting. All samples collected were centrifuged for 15 min to obtain serum. The sera obtained were frozen at -80 ºC for later analysis. All samples were analyzed using Immunoassay. Fasting blood glucose (FBG) and triglyceride (TG) were evaluated using colorimetric method (GOD-PAP techniques), and cholesterol levels were evaluated using CHOD-PAP method. Immuno-inhibition assay was used in measuring high-density lipoprotein cholesterol (HDL-c) and total cholesterol levels. Pars Azmoon kit was used for all biochemical analysis (Pars Azmoon Inc. Tehran, Iran).

Measurement of sleep quality and pattern

Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality (13). This Sleep quality index measured sleep quality in adults and differentiates "poor" from "good" sleep by measuring seven components (Subjective sleep quality, sleep-latency, sleep duration, habitual-sleep-efficiency, sleep-disturbances, use of sleep medications, and daytime sleep-dysfunction over the last month prior to study). The PSQI contains 19 self-rated questions and 5 questions rated by bed partner (if available). However only self-rated questions were included in scoring participants' sleep quality. The 19 self-rated items were combined to form "7 components" score, which has points ranging from 0-3. Zero point indicates no difficulties with sleep, while 3 points indicate severe difficulties. The 7 components scores were summed up to form one "global" score which ranges 0-21 points, "0" point indicates no difficulty with sleep and 27 points indicates severe difficulties in sleep.

Measurement of Depression

A Twenty-one Depression, Anxiety, and Stress Scale (21-DASS) was used to assess participants' depression level (14). The purpose of this scale was to "assess severity of core symptoms of depression" but not to diagnose disorders relating to this disease. Each question measured depression prevalence of participants over one week prior to the study. Responses were in four-point Likert scale [0–3]. Score 0 indicates "not applicable to participant," and score 3 means "item apply most of the times to participants."

Measurement of other variables

Physical activity was measured with validated International Physical Activity Short Form-Questionnaire which included leisure, commuting occupation, and household activities (15). Height measurements were taken to nearest 0.1m while participants were in standing position without shoes. Overweight and obesity were defined as BMI $\geq$25 to $\geq$29.9 kg/m^2, and $\geq$30 kg/m^2 respectively.

Statistical analysis

IBM SPSS version 22.0 (SPSS, Chicago, IL, USA) was used in data analysis. Data normal distribution was checked with Kolmogorov-Smirnov test. Principal Component Analysis was used to extract dietary pattern into three (healthy, unhealthy and western dietary patterns). Each pattern was further categorized into three levels of adherence (tertile 1, 2 and 3).

One-way ANOVA with Post Hoc Multiple-Comparison test were used to assess significant mean differences between groups (adherence) in each dietary pattern. Independent sample *t* test was used

to determine mean difference in sleep quality. Multinomial-logistic-regression model was used to assess significant association of sleep quality and major dietary patterns as well as and their interactions on depression.

Results

Participants' depression prevalence and general characteristics are shown in Table 1. Low depression prevalence was (36.2 %,), Moderate (44.7%) and high (19.1%). Mean±SD of age for low, moderate and high depression were 35.60±8.85, 38.28±8.68 and 37.23±7.16 respectively. Three major dietary patterns were extracted using factor analysis with varimix rotation: "Healthy dietary pattern" (high consumption of vegetables, low fat foods, fruits, legumes, starchy vegetables, skinless chicken and olive oil), "Unhealthy dietary pattern" (high consumption of high fat dairy foods, salt, red meat, oil, highly polished rice, sweet nuts, and organ meat) and "Western dietary pattern" (high consumption of Biscuits/crackers, fast food, high energy drinks, mayonnaise and sausages). The three factors extracted explained 30.2% of total variance.

Table 1: Depression prevalence and participants' general characteristics

Variable	***Depression***			
	Low	Moderate	High	*P*-value [a]
n (%)	187 (49.7)	50 (13.3)	47 (12.5)	
Age(yr)	35.60±8.85[1]	38.28±8.68	37.23±7.16	0.122
Height (cm)	161.71±5.77 [b]	159.37±5.63 [b]	161.64±5.50	0.048
Weight (kg)	79.45±10.89	80.43±10.70	79.65±10.08	0.223
BMI	29.75±3.58	30.38±3.54	30.86±3.78	0.204
Lipid Profile				
T-Chol (mg/dl)	183.85±35.22	183.61±26.86	179.46±49.83	0.794
TG (mg/dl)	117.17±68.60	142.24±81.74	116.44±65.90	0.162
HDL-C (mg/dl)	47.58±10.91	45.03±8.90	43.46±12.53	0.162
LDL-C (mg/dl)	94.20±23.80	97.58±19.25	90.63±30.29	0.477

n (%) number (%); P-value [a] of Post hoc test; interval; [1]result in mean ± standard deviation; [b]significant mean difference between low and moderate depression with high in post hoc analysis; BMI, body mass index; T-chol, total cholesterol; TG, triglyceride; HDL-c, high-density lipoprotein cholesterol; LDL-c, low-density lipoprotein cholesterol; N=304

The participants' general characteristics on adherence to the three dietary patterns are shown in Table 2 and 3. After adjusting for confounders (physical activity, calories intake, BMI and education level), age was significantly associated with western dietary pattern (P = 0.001) while weight was significantly associated with healthy and unhealthy dietary pattern (P = 0.0001). Fat-mass index, glucose, total-cholesterol, HDL-cholesterol and LDL-cholesterol were significantly associated with healthy (P = 0.001), unhealthy (P = 0.001) and western dietary pattern (P = 0.001). Participants' General characteristics according to adherence to sleep quality are shown in Table 4. After adjusting for confounders (age, education calories intake physical activity and BMI), total cholesterol and LDL-cholesterol were significant for sleep quality $P < 0.05$.

Table 2: Participants general characteristics on adherence to healthy and unhealthy dietary patterns

Variable	***Adherence healthy (Fruits&Vegetable group)***				***Adherence unhealthy (High Fat diary&Red Meat group)***			
	Low (Tertile 1)	Mod. (Tertile 2)	High (Tertile 3)	*P*-value	Low (Tertile 1)	Mod. (Tertile 2)	High (Tertile 3)	*P*-value
n	119	120	121		119	120	121	
Age (yr)	35.97±8.84[1]	35.82±8.54	36.97±8.14	0.513	35.98±8.77	35.95±8.57	36.81±8.19	0.319
Weight (kg)	81.31±11.36[a]	78.09±9.34	75.61±8.77[a]	0.0001	7 7.647±9.37	78.50±10.03[b]	78.92±10.98 [b]	0.0001
Height (cm)	160.92±5.61	161.10±5.43	162.24±5.65	0.925	161.28±5.51	161.45±5.67	161.52±5.60	0.951
			Body composition					
BMI (kg/m^2)	12.51±2.81	12.46±2.98	120.93±3.03	0.501	30.54±3.53	30.55±3.45	29.91±3.96	0.935
Fat free mass	45.25±45.21[a]	45.94±5.47	47.85±5.66[a]	0.0001	46.26±5.07[a]	46.43±5.59	46.72±5.3[a]	0.0001
			Lipid Profile					
Chole (mg/dL)	191.16±45.73[c]	184.28±40.91	176.86±42.34	0.0001	184.55±31.56[c]	186.30±46.58	187.23±33.41	0.0001
TG (mg/dL)	110.02±54.81	120.77±65.13	122.84±78.84	0.110	13.45±64.70	119.36±56.42	120.38±78.68	0.230
HDL (mg/dL)	45.46±10.80	47.37±10.55	48.76±11.74	0.001	46.53±10.88	47.51±11.87	47.53±11.87	0.001
LDL (mg/dL)	101.18±33.23	90.90±24.94	95.16±22.87	0.0001	94.10±27.71	94.77±31.56	97.42±23.06	0.0001

[1]Results presented in Mean±standard deviation; [a]significant mean difference between tertial1 and tertial3 in post hoc analysis [b]significant mean difference between tertial2 and tertial3 in post hoc analysis; [c]significant mean difference between tertial1 and tertial2 in post hoc analysis BMI: - Body Mass Index; GLU: - Blood glucose; Chole: - Total cholesterol; TG: - Triglyceride; HDL: - High density lipoprotein cholesterol. N=304 `

Table 3: Participants general characteristics on adherence to of western dietary patterns

Variable	***Adherence healthy (Fruits&Vegetable group)***			
	Low (Tertile 1)	Mod. (Tertile 2)	High (Tertile 3)	*P*-value
n	119	120	121	
Age (yr)	38.13±7.79[a]	37.57±7.98[b]	33.05±8.81[ab]	0.0001
Weight (kg)	77.92±10.00[1]	78.43±10.77	78.68±9.67	0.939
Height (cm)	161.24±5.49	160.47±5.47[b]	162.53±5.63[b]	0.032
BMI (kg/m^2)	1.42±0.97	1.44±0.52	1.45±0.50	0.093
Fat free mass	32.71±6.45	32.93±7.93	33.07±7.25	0.419
Chole (mg/dL)	178.52±44.26	185.25±44.37	188.79±1.61	0.0001
TG (mg/dL)	124.19±77.12	117.65±66.59	111.39±55.85	0.187
HDL (mg/dL)	48.74±11.79	47.14±11.49	45.71±9.78	0.0001
LDL (mg/dL)	92.98±30.46	95.41±29.48	98.83±22.08	0.001

[a]significant mean difference between tertial1 and tertial3 in post hoc analysis; [b]significant mean difference between tertial2 and tertial3 in post hoc [1]results is presented in mean± standard deviation; BMI: - Body Mass Index; GLU: - Blood glucose; Chole: - Total cholesterol; TG: - Triglyceride; HDL: - High density lipoprotein cholesterol
N=304

Table 4: Participants general characteristics on adherence to sleep

Variable	*Sleep*		*P-value*
	Good	*Poor*	
N	116	96	
Age (yr)	36.40±8.28[1]	36.00± 8.82	0.601
Weight (Kg)	79.58±11.71	79.20±10.14	0.496
Height (cm)	160.95±6.104	161.43±5.53	0.740
BMI (Kg/m^2)	30.63±3.98	30.55±3.58	0.264
Fat free mass(kg)	46.41±5.99	46.20±4.76	0.583
Chole (mg/dL)	173.76±38.41	183.26±30.58	0.037
TG (mg/dL)	125.69±63.38	112.29±64.84	0.188
HDL (mg/dL)	47.78±9.78	45.46±10.62	0.112
LDL (mg/dL)	93.19±24.48	99.85±21.41	0.047

[1]results presented in mean± standard deviation; GLU: - Blood glucose; Chole: - Total cholesterol; TG: - Triglyceride; HDL: - High density lipoprotein cholesterol, N=304

The Association of adherence to sleep quality and major dietary patterns on depression are shown in Table 5. Sleep quality was significant for depression ($P < 0.05$). After adjusting for confounders (age, education calories intake physical activity and BMI), good sleep was significant for moderate and high depression AOR (95%CI): 0.41(0.19-0.90) and 0.29(0.13-0.60) respectively. Interaction between sleep quality and healthy dietary patterns (tertiles 2nd and 3rd) were significant for higher depression AOR (95%CI): 4.168(1.166-14.992) and 2.966(1.068-8.234) respectively. Interaction between sleep quality and unhealthy dietary patterns tertiles (2nd and 3rd) were significant for high depression AOR (95%CI): 2.925(1.055-8.113) and 4.216(1.182-15.042) respectively. Interaction between sleep quality and western dietary patterns tertiles 3rd was significant for moderate and high depression AOR (95%CI): 4.290(1.456-12.641) and 4.264(1.494-12.169) respectively.

Discussion

In this study we found low, moderate and high depression prevalence among participant to be 36.2%, 44.7% and 19.1% respectively. Three major dietary patterns (healthy, unhealthy and western) were extracted by factor analysis. There was no significant age difference in adherence to healthy and unhealthy dietary patterns, however, significant age difference was found for adherence to western dietary pattern. Weight was significant for adherence to healthy and unhealthy dietary patterns, and not significant for western pattern. Study shows that higher adherence to western dietary pattern was positively associated with overweight prevalence while prudent/healthy dietary pattern was inversely related (16). These findings are consistent with our study because we also found that fat mass, glucose, total cholesterol, HDL-cholesterol, and LDL-cholesterol were significant for adherence to healthy, unhealthy and western dietary pattern. Sabour H et al, also found

that high consumptions of processed meat, sweet desserts and soft drink were correlated with higher total cholesterol and LDL-cholesterol while consumption of poultry, green vegetable, tomatoes and other vegetables similar to "healthy dietary pattern" showed no difference (17).

Table 5: Interaction between sleep quality and major dietary patterns on depression

Variable	***No*** *Ref*	***Moderate*** *Crude OR (95%CI)*	**P-value*	***Moderate*** *Adj. OR(95%CI)*	***P-value*	***No*** *Ref*	***High*** *Crude OR (95%CI)*	**P-value*	***High*** *Adj. OR(95%CI)*	***P-value*
Adherence Sleep Quality										
Poor Ref.	1					1				
Good		).49(0.24-0.99)	0.050	0.41(0.19-0.90)	0.03		0.27(0.12-0.61)	0.001	0.29(0.13-0.60)	0.003
Adherence Dietary Patterns										
Hlthy. Ref.	1					1				
Unhlthy		0.80(0.45-1.64)	0.650	1.30(0.52-3.28)	0.580		0.74(0.40-1.40)	0.360	0.88(3.93-1.96)	0.750
Western		1.48(0.79-2.74)	0.220	0.42(0.15-1.21)	0.110		1.12(0.62-2.04)	0.710	0.35(0.38-1.92)	0.690
Hlthy. ter1	1					1				
PSQI*hlth ter2		0.48(0.17-1.34)	0.159	3.68(0.96-14.06)	0.057		0.5 (0.21-1.42)	0.213	0.97(1.07-8.23)	0.037
PSQI*hlthy ter3		1.69(0.49-5.75)	0.400	2.27(0.77-6.69)	0.138		1.54(0.46-5.15)	0.486	). 17(1.17-14.99)	0.029
Unhlthy ter1 Ref	1					1				
PSQI*unhlthy ter2		0.52(0.09-2.95)	0.460	2.93(1.05-8.21)	0.041		0.35(0.08-1.45)	0.147	2.97(1.06-8.11)	0.039
PSQI*unhlthy ter3		1.94 (0.47-8.00)	0.358	1.94(0.39-9.51)	0.415		0.82 (0.25-2.70)	0.747	4.22(1.18-15.04)	0.027
Wstrn ter1 Ref	1					1				
PSQI*wstrn ter2		0.36(0.14-0.95)	0.040	0.96(0.19-4.71)	0.959		0.35(0.09-0.13)	0.040	2.09(0.57-7.65)	0.263
PSQI*wstrn ter3		0.04(0.14-0.95)	0.040	4.29(1.46-12.64)	0.008		0.35(0.13-0.95)	0.040	4.26(1.49-12.17)	0.007

*No Dep:- no depression; Ref:- As reference; OR:- Odd ratio; CI:- confidence interval; *P-value results from unadjusted model; **P-value results after adjusting for physical activity, calories intake, BMI, age and education ;PSQI-;Sleep quality index, PSQI*Dietary pattern:- interaction between sleep quality and dietary patterns; PSQI*hlthy ter2:- interaction between sleep quality and healthy dietary pattern tertial2; PSQI*hlthy tertia13:- interaction between sleep quality and healthy dietary pattern tertial3; PSQI*unlthy. ter2:- interaction between sleep quality and unhealthy dietary pattern tertial2; PSQI*unhlthy. ter3:- interaction between sleep quality and unhealthy dietary pattern tertial3; PSQI*wstrn ter2:- interaction between sleep quality and western dietary pattern tertial2; PSQI*wstrn ter3:- interaction between sleep quality and western dietary pattern tertial3. N=304*

Darani Zad N et al, also show that total cholesterol, fasting blood glucose and HDL-cholesterol were associated with western dietary pattern (18). In our study, western dietary patterns characterized by consumption of Biscuit/crackers, Fast food, High energy drink, Mayonnaise and Sausages were significant for glucose, total cholesterol, HDL and LDL-cholesterol. The positive association of western and unhealthy dietary pattern on lipid profile in our study could be partially explained by the higher sugar and/or refined carbohydrate and saturated fat content in western and unhealthy dietary patterns. When foods high in sugar and refined carbohydrates are eaten, plasma glucose concentration surged and cause the liver to increase synthesis and conversion of fatty acid to triglycerides, which further packed into very

low-density lipoproteins and secreted into the blood, thus affecting lipid profile (19).

After adjusting for confounders (age, physical activity, BMI, calories intake and education level), we found that total cholesterol and LDL-cholesterol were significant for sleep quality in our study. These results were expected in our study. In Yusuke O et al, study, subjects who reported poor sleep were obese, had high levels of total cholesterol, fasting blood glucose and other metabolic parameters (20), which are consistent with our result.

We also evaluated the associations of sleep quality and major dietary pattern on depression. At the end of the study we found that poor sleep was associated with moderate and high depression. Overweight and obesity are risk factors for poor sleep and depression. It is reported that obesity increased depression by 57% and poor sleep by 22% (21). Since overweight and obesity affects depression and sleep quality, we expected significant increase in depression and poor sleep quality among our participants. With regard to major dietary patterns and depression we saw that individuals who gained higher scores in healthy dietary pattern had 88% lower odds of depression, while those with higher scores in unhealthy dietary pattern showed relatively higher odds (22). Study shows individuals with higher adherence to healthy dietary pattern have significantly lower odd [0.38 (95%CI; 0.176-0.834)] for depression, whereas higher odd [3.619 (1.593-8.220)] was reported among individuals with higher adherence to unhealthy dietary pattern (23). In our study, we found no significant association for adherence to dietary patterns and depression. The contradictory results of our study and others, could probably occur due to chance, or differences in study designs. While we adopted cross sectional study, the other studies adopted other study designs including case control studies. We also evaluated to see whether interactions exist between sleep quality and major dietary patterns for depression in our study. After we adjusted for confounders, we saw significant interactions between sleep quality and healthy dietary for depression. Moreover, we saw significant interaction between sleep quality and unhealthy dietary patterns for depression. Western dietary pattern was also shown to interact with sleep quality for depression.

Conclusion

To the best of our knowledge, our study is the first to investigate how interactions between sleep quality and major dietary patterns could influence depression. Although significant interactions were found between major dietary patterns and sleep quality on depression in our study, we could not strongly conclude based on these findings because we adopted cross-sectional study. Therefore we recommended that subsequent studies should use more powerful study designs to investigate this hypothesis.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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